

Preface to the Application

The British Columbia (B.C.) Ministry of Transportation and Infrastructure (Ministry) is proposing the George Massey Tunnel Replacement Project (Project) to meet regional, provincial, and national transportation management goals. The Project involves replacement of the George Massey Tunnel (Tunnel) crossing of the Fraser River with a new bridge and replacement of three interchanges. The new bridge will be built at the same location as the Tunnel, which will be decommissioned once the bridge is open to traffic. The new bridge includes multi-use pathways for pedestrian and cycling traffic, which will connect to cycling and pedestrian networks in Richmond and Delta. The Project also includes related minor improvements to the Highway 99 corridor to support efficient use of the new crossing and interchanges, including provision of transit/high-occupancy vehicle (HOV) lanes and transit exchanges.

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate the Project can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects. The section of the regulation that applies to the Project is:

- Part 5 (Water Management Projects): The Tunnel decommissioning may result in a change in and about the Fraser River, and in direct physical disturbance of more than two hectares (ha) of foreshore and submerged land (*Reviewable Projects Regulation*, Part 5, Table 9, Shoreline Modification).
- Part 8 (Transportation Projects): Upgrades to Highway 99 and related interchanges involves the modification of an existing public highway that results in the addition of equal to or greater than two lanes of paved public highway to an existing paved public highway over a continuous distance of equal to or greater than 20 kilometres (*Reviewable Projects Regulation*, Part 5, Table 14, Transportation Projects).

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

The Application for an EAC (Application), pursuant to the B.C. *EAA*, has been prepared in accordance with the Application Information Requirements approved by the EAO on May 24th, 2016, and complies with relevant instructions provided in the section 11 Order issued by the EAO on March 7th, 2016, pursuant to the B.C. *EAA*.

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Page xii | Table of Concordance | A Table of Concordance will be included in the Application. The Table of Concordance will demonstrate where the requirements in the AIR are found in the Application, with volume, section, and page references and following the format of Table 1 in the AIR. | Table of Concordance | |
| Page xv | Application Summary | <p>The Application will include a summary, including the following:</p> <ul style="list-style-type: none"> ▫ A summary of the proposed Project including the project scope, project benefits and applicable permits. If the proponent has already requested or intends to request concurrent permitting, this will also be stated. ▫ A brief overview of the assessment process including project reviewability, and the pre-application and application review stages of the EA. ▫ A brief overview of consultation approaches with Aboriginal Groups, the public and government agencies to date. ▫ A summary of the key issues raised by Aboriginal Groups, the public and government agencies. ▫ A summary of key adverse effects on Aboriginal Interests and mitigation measures. ▫ A summary of key effects, proposed mitigation measures and residual and cumulative effects on Valued Components. ▫ Proponent's conclusions regarding the potential for significant adverse effects on Valued Components. | Application Summary | Pages 1 to 15 |
| Section 1.0 Page 1 | Overview of the Proposed Project Proponent Description | <p>The Application will:</p> <ul style="list-style-type: none"> ▫ Describe the Proponent, including mandate, type of company or organization, affiliations | Overview of Proposed Project and Proponent | Part A – Introduction, Section 1.0, page 1.1-2 |
| | | <ul style="list-style-type: none"> ▫ Provide contact information for the proponent | Overview of Proposed Project and Proponent | Part A – Introduction, Section 1.0, page 1.1-2 |
| | | <ul style="list-style-type: none"> ▫ Include a list of parties involved in the preparation of the Application, their qualifications, and the section(s) for which they were responsible | Overview of Proposed Project and Proponent | Part A – Introduction, Section 1.0, page 1.1-3 |
| Section 1.1 Page 1 | Description of Proposed Project | <p>The Application will:</p> <ul style="list-style-type: none"> ▫ Describe the purpose of the proposed Project from the perspective of the Proponent, and identify whether the objectives of the proposed Project relate to any broader private or public sector policies, plans, or programs. ▫ Project Purpose | Project Purpose | Part A – Introduction, Section 1.1.1, pages 1.1-4 to 1.1-7 |
| | | <ul style="list-style-type: none"> ▫ Project Design Considerations ▫ General design considerations ▫ Alternative mode considerations ▫ Design refinements during detailed design | Project Design Considerations | Part A – Introduction, Section 1.1.7, pages 1.1-29 to 1.1-33 |
| | | Describe the location of the proposed Project and the latitude and longitude coordinates of the site, and include maps showing both regional context (identifying nearby communities and geographic features) and the specific location of the proposed project; proximity of the Project to federal lands will be clearly identified. | Project Location | Part A – Introduction, Section 1.1.4, pages 1.1-19 to 1.1-20 |
| | | Describe the location of the proposed Project relative to Aboriginal Groups' asserted traditional territories, and/or Treaty Nation territories. In addition to identifying traditional and Treaty Nation territories, to the extent possible, Indigenous place names of the areas in and around the Tunnel will be incorporated into this description. | Project Location | Part A – Introduction, Section 1.1.4.3, pages 1.1-23 to 1.1-25; Section 1.1.1, page 1.1-4 |
| | | Describe all phases of the proposed Project, including their duration and proposed scheduling. | Project Phases and Schedule | Part A – Introduction, Section 1.1.5, page |

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| | | | Project Activities by Phase | 1.1-24; 1.1.8, pages 1.1-36 to 1.1-60 |
| | | Describe all on-site and off-site components associated with the proposed Project, with figures. | Key Project Components | Part A – Introduction, Section 1.1.6, pages 1.1-26 to 1.1-29; Section 16.1 |
| | | <ul style="list-style-type: none"> ▫ Describe the activities associated with the components and phases of the proposed Project, with figures. Project-related activities are anticipated to include the following: <ul style="list-style-type: none"> • Pre-Construction and Site Preparation • Surveying • Geotechnical investigations • Clearing and grubbing of vegetation • Preloading, and aggregate and pre-load materials storage • Establishment of temporary access roads and detours • Installation of temporary drainage structures • Installation of erosion and sediment control measures • Installation of temporary barging facilities • Temporary lighting • Establishment of site office(s) and temporary staging and laydown areas • Construction <ul style="list-style-type: none"> • Highway Upgrades <ul style="list-style-type: none"> o Road Construction o Decommissioning of existing interchanges o Construction of new interchanges • Construction of the New Bridge • Decommissioning of the Tunnel and removal of the four in-river tunnel segments, which is anticipated to take place over the course of one construction season (i.e.: between freshets), involve the following key steps: <ul style="list-style-type: none"> o Measures, including adherence to least-risk timing windows, to avoid effects on fish and fish habitat and fishing o Cleaning of the inside of the Tunnel and removal of all non-structural elements o Removal of the sediment and sand fill and rock protection layer surrounding the Tunnel o Cutting of the closure joints between Tunnel elements o Release, lifting, and floatation of Tunnel elements out of the trench using barges and cranes o Transport of Tunnel elements for off-site recycling o Monitoring of the tunnel trench as it naturally fills with river sand over time • General Operation, Maintenance, and Rehabilitation activities | Project Activities by Phase | Part A – Introduction, Section 1.1.8, pages 1.1-36 to 1.1-60; Section 16.1 |
| | | Discuss the relevant history of the proposed Project, including exploratory or investigative history. This will include the following: <ul style="list-style-type: none"> ▫ Role of Highway 99 corridor in regional transportation network ▫ History of the Hwy 99 corridor/George Massey Tunnel ▫ Summary of current challenges | Project Development History | Part A – Introduction, Section 1.1.2, pages 1.1-7 to 1.1-12; page 1.1-33 |

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| | | <p>Summarize existing and planned land and marine use that overlaps or may be potentially impacted by the proposed Project components and activities, including:</p> <ul style="list-style-type: none"> ▫ Land ownership [e.g. private land, provincial Crown land, federal land (including Indian Reserves), Aboriginal title]. ▫ Local government zoning or plans. ▫ Tenures (municipal, provincial, federal), licences, permits or other authorizations. ▫ Non-tenured current land uses. ▫ Current and proposed marine use plans. ▫ Provincial land use plans (e.g. Land and Resource Management Plans) and provincial land use designations (e.g. Agricultural Land Reserve, Old Growth Management Areas, Forests and Range Practices Act designations) and provincial land use management objectives. ▫ Any other development or activities, whether or not directly related to the proposed Project. ▫ Maps showing locations of other uses referenced above in relation to the proposed Project. ▫ References to the Application section that assesses land use and potential overlaps/impacts in more detail. | Project Location | Part A – Introduction, Section 1.1.4, page 1.1-19 to 1.1-25 |
| | | <p>Describe the project's economic benefits.</p> <ul style="list-style-type: none"> ▫ Capital construction cost estimates, including: <ul style="list-style-type: none"> ▫ Breakdown of costs (e.g. land, buildings, equipment) associated with the proposed Project ▫ Estimated operating costs over the life of the proposed Project, including breakdown of costs by category (e.g. labour, supplies and materials, administration). ▫ Estimated costs for decommissioning/closure/abandonment/reclamation. ▫ Employment estimates, including: <ul style="list-style-type: none"> ▫ Direct employment to be created, by job category by project phase, in number of person year (PY) jobs for construction and decommissioning and full-time equivalent (FTE) jobs for operations. Direct employment estimates will be broken down into full-time, part-time and seasonal job categories. ▫ Average wages, by major job category, for the construction and operating periods. ▫ Breakdown of jobs that will be filled from local, provincial, national or international labour markets. ▫ Indirect and induced employment to be generated, by project phase. ▫ Information about an employment strategy, if any. | Costs Project Benefits-Economic | Part A – Introduction, Section 1.1.9, pages 1.1-60 to 1.1-61 Section 1.1.11.1, page 1.1-64-1.1-65 |
| | | <p>Outline contractor supply services estimates, including:</p> <ul style="list-style-type: none"> ▫ List of the major types of businesses/contractors to be used, broken down at the local, provincial, and national level, by project phase. ▫ Value of supply of service contracts expected, by project phase. ▫ Information about a local purchasing strategy, if any. <p>The above information, as applicable, will be presented under a sub-section titled Project Procurement and Delivery included under Section 1.1 (Description of the Proposed Project) of the Application.</p> | Project Procurement and Delivery | Part A – Introduction, Section 1.1.8.4, pages 1.1-58 to 1.1-60 |
| | | Provide an overview of anticipated annual government revenues, by type (e.g. income tax, license rent, property tax, mineral tax) and jurisdiction (e.g. local, provincial, federal), for all phases of the proposed Project. | Project Benefits-Economic | Part A – Introduction, Section 1.1.11.1, page 1.1-65 |
| | | A discussion on tolling in terms of its role in contributing to Project funding will be included as appropriate. | Project Operations and Maintenance | Part A – Introduction, Section 1.1.8.3, pages 1.1-57 to 1.1-58 |

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| | | Summarize any benefits the project may have to the five pillars of assessment (Environmental, Economic, Social, Health and Heritage). This will include an overview of anticipated Project-related improvements. This will include an overview of anticipated Project-related improvements. | Project Benefits | Part A – Introduction, Section 1.1.11, pages 1.1-64 to 1.2-72 |
| | | Provide all Canadian dollar estimates in real dollars, with an explanation of how they are measured (e.g. discount rates). | Project Benefits | Part A – Introduction, Section 1.1.10, pages 1.1-62 to 1.1-63 |
| | | State all assumptions and references for the above information | Business Case | Part A – Introduction, Section 1.1.10, page 1.1-62 to 1.1-63 |
| Section 1.2 Page 5 | Applicable Authorizations | The Application will: <ul style="list-style-type: none"> ▫ List in table format (Table 1.2-1 Potential Provincial and Federal Permits, Approvals, and Authorizations) all applicable licenses, permits and/or approvals that are already received or required for the phases of the proposed Project, and the associated responsible regulatory body. | Applicable Authorizations | Part A – Introduction, Section 1.2, pages 1.2-72 to 1.3-74 |
| | | State if the proponent has or intends to request concurrent permitting under the Act pursuant to the Concurrent Approval Regulation (BC Reg. 371/2002). | Provincial Permits and Authorizations | Part A – Introduction, Section 1.2.1, page 1.2-72 |
| Section 1.3 Page 8 | Project Design and/or Alternative Means of Carrying out the Project | The Application will include: <ul style="list-style-type: none"> ▫ An assessment of the alternative means of carrying out the proposed Project that are technically and economically feasible including, but not limited to, the alternatives identified in the AIR; and ▫ The rationale and criteria used to select the proposed means of undertaking the proposed project. | Alternatives to the Proposed Project | Part A – Introduction, Section 1.3, page 1.3-74 to 1.3-75 |
| Section 1.4 Page 8 | Alternatives to the Proposed Project | The Application will include: <ul style="list-style-type: none"> ▫ An assessment of the alternatives to the proposed Project that were technically and economically feasible including, but not limited to, the alternatives identified in the AIR. ▫ A description of the work undertaken to identify and analyze the five crossing scenarios, including the proposed Project, considered as options for replacement of the Tunnel. These four additional alternatives are: maintain (upgrade and improve) existing Tunnel, replace existing Tunnel with new tunnel, maintain existing Tunnel and build new crossing along existing Highway 99 corridor, and maintain existing crossing and build new crossing in new corridor. ▫ Alternatives are evaluated based on efficient transportation for all users, safety, agriculture, environment, jobs and economy, social and community considerations, and capital costs and risks. | Assessment of Project Alternatives | Part A – Introduction, Section 1.4, pages 1.4-75 to 1.4-82 |
| Section 2.1 Page 10 | Provincial EA Process | The Application will include: <ul style="list-style-type: none"> ▫ A statement that the proposed Project is subject to review under the Act, identifying the trigger(s) for the review under the Act. | Project Triggers under B.C. EAA | Part A – Introduction, Section 2.1.1.1, page 2.1-1 |
| | | A statement that the Application has been developed pursuant to the AIR approved by EAO and complies with relevant instructions provided in the section 11 Order and any other direction provided by EAO. | Application Development | Part A – Introduction, Section 2.1.1.2, page 2.1-2 |
| | | A table documenting applicable milestones, including, but not limited to, issuance of section 10 and 11 Orders, working group meetings, any public comment periods or open houses and the issuance of the AIR), including links to documents on EAO's public | Key EA Process Milestones | Part A – Introduction, Section 2.1.2, page |

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| | | <ul style="list-style-type: none"> ▫ A list of the government agencies and Aboriginal Groups that participated in the EA; a summary of their participation; and, a list of the key issues raised by each party and the status of issue resolution. (The Proponent will cross-reference, as appropriate, other sections of the Application that deal further with consultation and issues raised). | Aboriginal Group Participation Government Agency Participation | Part A – Introduction, Section 2.1.3, page 2.1-3 to 2.1-7 Part A – Introduction, Section 2.1.5, pages 2.1-13 to 2.1-16 |
| | | <ul style="list-style-type: none"> ▫ A summary of public participation in the EA, a list of the key issues raised and the status of issue resolution (with cross-references, as appropriate, to other sections of the Application that deal further with consultation and issues raised). | Public Participation | Part A – Introduction, Section 2.1.4, pages 2.1-8 to 2.1-12 |
| Section 3.0 Page 12 | Assessment Methodology | This section of the Application will describe the methods used to assess the potential adverse effects of the Project. The assessment methodology will be based on the EAO's Guideline for the Selection of Valued Components and Assessment of Potential Effects (September 2013), and will follow the methodological steps shown in Figure 3-1 Summary of Methodological Steps of the Application. | Assessment Methodology | Part B - Effects, Section 3.0, page 3.1-1 |
| Section 3.1 Page 12 | Issues Scoping and Selection of Valued Components | The Application will summarize the process and methodologies used to identify and select the VCs for assessment. The Application will also include the rationale for any differences in the list of VCs presented in the Application from those listed in the final AIR. | Issues Scoping and Selection of Valued Components | Part B – Effects, Section 3.1, pages 3.1-1 to 3.2-8; Appendix A, pages A-1 to A-6 |
| | | A list of candidate VCs, identified based on professional expertise of discipline experts involved in the assessment and input received from key stakeholders, Aboriginal Groups, and government agencies, and rationale for exclusion of any candidate VCs from the assessment will be provided in the Application. | Summary of Issues Identification and Valued Component Selection | Part B – Effects, Section 3.1 (Appendix A), pages A-18 to A-19 |
| Section 3.2.1 Page 14 | Spatial, Temporal, Administrative, and Technical Boundaries | <p>The Application will describe the methods used in identifying spatial, temporal, administrative and technical boundaries. Information on spatial, temporal, administrative and technical boundaries for specific VCs will be included in the appropriate VC sections of this document and will encompass all relevant project phases, components and activities. The Application will include the rationale for any differences in boundaries from those presented in the AIR.</p> <p>Presence of conservation lands (including provincial Wildlife management Areas, the National Wildlife Area, the Migratory Bird Sanctuary) and other conservation areas in the vicinity of the Project will be taken into consideration when defining the assessment boundaries for specific VCs.</p> | Assessment Boundaries | Part B – Effects, Section 3.2, pages 3.2-8 to 3.3-10 |
| Section 3.3 Page 14 | Existing Conditions | <p>For each VC section, (Environmental, Economic, Social, Heritage and Health), the Application will:</p> <ul style="list-style-type: none"> ▫ Describe the existing (or baseline) conditions within the study area in sufficient detail enable potential project-VC interactions to be identified, understood, and assessed. ▫ Describe the quality and reliability of the existing (or baseline) data and its applicability for the purpose used, including any gaps, insufficiencies and uncertainties, particularly for the purpose of monitoring activities. ▫ Reference natural and/or human-caused trends that may alter the environmental, economic, social, heritage and health setting, irrespective of the changes that may occur as a result of the proposed Project or other project and/or activities in the area. ▫ Explain if and how other past and present projects and activities in the study area have affected or are affecting each VC. ▫ Document the methods and data sources used to compile information on existing (or baseline) conditions, including any standards or guidelines followed. | Existing Conditions | Part B – Effects, Section 3.3, pages 3.3-10 to 3.3-12 |

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| | | <ul style="list-style-type: none"> ▫ Where additional Project and VC-specific field studies are conducted, the scope and methods to be used will follow published documents pertaining to data collection and analysis methods. Where methods used for the assessment deviate from applicable published guidance, the rationale for the variance will be provided in the Application. ▫ Describe what Traditional Ecological Knowledge (TEK), including Aboriginal Traditional Knowledge (TK), was used in the VC assessment. <p>Technical volumes describing baseline studies and existing conditions will be included as appendices to the Application and key findings contained in these technical volumes will be summarized in the Application in a manner that allows the reader to understand the effects assessment for each VC.</p> | | |
| Section 3.4 Page 15 | Potential Effects | The Application will summarize the overall process and methodologies used to identify and assess the potential effects of the proposed Project on the identified VCs. | Potential Effects | Part B – Effects Section 3.4, page 3.4-12 |
| | | <p>For each VC section, the Application will:</p> <ul style="list-style-type: none"> ▫ Identify the potential interactions of the proposed Project and the considered and selected VCs; ▫ Identify and describe the potential adverse effects resulting from the proposed Project; ▫ Demonstrate how feedback from Aboriginal Groups, the public, stakeholders and government agencies on VC selection and assessment was incorporated, as appropriate. | Potential Project Interactions with Valued and Supporting Components | Part B – Effects Section 3.4, page 3.4-12; Appendix B, page B-1 to B-2 |
| | | The Application will identify any project activity-VC interactions that were excluded from further assessment, including the methods and criteria used to justify the exclusion and input received from EAO, government agencies, Aboriginal Groups and the public regarding the exclusion. | Potential Effects | Part B – Effects, Section 3.4, pages 3.4-12 |
| Section 3.5 Page 15 | Mitigation Measures | <p>For each VC section, the Application will:</p> <ul style="list-style-type: none"> ▫ Describe the approach to identify and analyze mitigation measures, including any management and compensation plans proposed by the Proponent, which will be implemented to address potential effects. ▫ Describe the mitigation measures incorporated into the project, including site and route selection, project scheduling, project design, and construction and operation procedures and practices. ▫ Describe any standard mitigation assumed or proposed to be implemented, including consideration of best management practices, environmental management plans, environmental protection plans, contingency plans, emergency response plans, and other general practices. ▫ Indicate how the mitigation measures will mitigate the potential adverse effects on the VC. ▫ Provide the rationale for the proposed mitigation measures, including why further avoidance or reduction measures for adverse effects may not be considered feasible, and the need for and scope of any proposed compensation or offset. ▫ Evaluate the anticipated success of each mitigation measure and describe rationale and analysis for these evaluations. If there is little relevant/applicable experience with a proposed mitigation measure and there may be some question as to its effectiveness, describe the potential risks and uncertainties associated with use of the mitigation. ▫ Include the time required for mitigation to become effective, to enable understanding of the duration of residual effects and the temporal characteristics of reversibility. ▫ Summarize the mitigation measures for potential Project effects by Project phase and identify any mitigation measures that are in management or compensation plans <p>If appropriate, or applicable, mitigation strategies discussed in the Application will include measures or opportunities for</p> | Mitigation Measures | Part B – Effects, Section 3.5, page 3.5-13 |

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| | | enhancement of the environment in addition to avoiding or minimizing Project-related effects. | | |
| Section 3.6 Page 16 | Characterization of Residual Effects | Where residual effects are expected to persist after implementation of mitigation measures, such effects will be characterized for the relevant VC using the criteria listed below. The generalized criteria definitions presented in the list below will be used as a guide for establishing VC-specific effects characterization criteria, which will be described in the relevant effects assessment section of the Application. <ul style="list-style-type: none"> Direction (the overall nature of the residual effect): the direction of Project effects will be identified as positive (i.e., beneficial), neutral, or negative (i.e., adverse). | Characterization of Residual Effects | Part B – Effects, Section 3.6, pages 3.6-14 to 3.9-15 |
| | | <ul style="list-style-type: none"> Magnitude (the amount of change to the existing condition of a VC): magnitude will generally be measured in terms of the proportion of the VC that is affected relative to the range of natural variation (or historic variation, in the case of human environment VCs). | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.6-14 |
| | | <ul style="list-style-type: none"> Geographic extent (the area over which Project-related changes would occur): geographic extent of effects will generally be described as site-specific (limited to the Project Area, – i.e. project footprint plus project disturbance area), local (limited to the LAA), regional (limited to the RAA), or beyond. | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.6-14 |
| | | <ul style="list-style-type: none"> Duration (period of time for a VC to return to its existing condition): the duration of an effect will typically be described as short-term, long-term, or permanent; definitions of short- and long-term would vary by VC, and take into account VC-specific temporal characteristics. | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.6-14 |
| | | <ul style="list-style-type: none"> Frequency (the number of times an effect might occur within a specific time period): the frequency of an effect may be described as continuous, frequent, uncommon, or rare. | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.6-14 |
| | | <ul style="list-style-type: none"> Reversibility (degree to which existing conditions can be regained after the factors causing the effect are removed): effects will be described as reversible, permanent, or partially reversible. | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.6-14 |
| | | Residual effects will be discussed in the context of the VC's current and future sensitivity and its resilience to change caused by the Project. Consideration of context will be based on the description of existing conditions of the VC, which reflect cumulative effects of other projects, and activities that have been carried out, and especially information about the impact of natural and human-caused trends in the condition of the VC. | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.6-14 |
| | | The Application will describe, in a table format, the residual effects using the residual effects criteria context, magnitude, extent, duration, reversibility, and frequency, as defined in EAO's Guideline for the Selection of Valued Components and Assessment of Potential Effects. Where feasible, these criteria will be described quantitatively in the Application for each VC. When residual effects cannot be characterized quantitatively, the Application will characterize these effects qualitatively. Definitions will be provided when qualitative terms are used. | Characterization of Residual Effects | Part B – Effects, Section 3.6, pages 3.6-14 to 3.9-15 |
| | | The use of any qualitative terms (e.g. high, moderate, low, etc.) will be accompanied by distinct definitions for each of these rankings. An explanation will be included for the conclusion reached for each criterion used to characterize a residual effect. | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.9-15 |
| | | When residual effects on a VC are determined and the VC is also considered a “pathway” for other potential effects on other VCs, the Application will identify the linkages between the VCs and the discipline-specific studies to which the information has been forwarded for further evaluation. | Characterization of Residual Effects | Part B – Effects, Section 3.6, page 3.9-15 |

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| Section 3.7 Page 17 | Likelihood | The Application will assess the likelihood for all residual adverse effects using appropriate quantitative or qualitative terms and provide sufficient detail to help understand how the conclusions were reached. Definitions of any qualitative terms, such as 'low', 'moderate', or 'high' probability will be provided. | Likelihood | Part B – Effects, Section 3.7, page 3.9-15 |
| Section 3.8 Page 17 | Proponent's Determination of Significance | The Application will present the process and methodology used to define and evaluate the significance of residual effects, including how the term "significance" has been used in relation to each VC using quantitative and qualitative thresholds. | Proponent's Determination of Significance | Part B – Effects, Section 3.8, page 3.9-15 |
| | | A conclusion of significance of residual adverse effects will be provided for each VC. | Proponent's Determination of Significance | Part B – Effects, Section 3.8, page 3.9-15 |
| Section 3.9 Page 17 | Confidence and Risk | The Application will summarize the process and methodology used to evaluate the levels of confidence associated with residual effects predictions, and in particular, how any identified uncertainty may affect either the likelihood or the significance of the predicted residual effect. The Application will also describe any measures to reduce uncertainty through monitoring, adaptive management, or other follow-up programs. | Confidence and Risk | Part B – Effects, Section 3.9, Page 3.9-15 to 3.10-16 |
| | | The Application will summarize the process and methodology used to determine if additional risk analysis is required. If additional risk analysis is required, the Application will summarize the process and methodology used for this analysis and the conclusions, including the range of likely, plausible and possible outcomes with respect to likelihood and significance. | Confidence and Risk | Part B – Effects, Section 3.9, Page 3.9-15 to 3.10-16 |
| Section 3.10.1 Page 18 | Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities | The Application will use the steps outlined in Figure 3.10-1 Steps to Determine Residual Project and Cumulative Effects of the Application to determine residual Project effects and the subsequent cumulative effects assessment. | Cumulative Effects Assessment | Part B – Effects, Section 3.10, page 3.10-16 to 3.10-17 |
| | | The following development categories will be considered in the Application: <ul style="list-style-type: none"> ▫ Projects or activities that have already been built or conducted for which the environmental effects overlap with those of the proposed Project (i.e. certain): maintenance dredging of the lower Fraser River; Tilbury Liquefied Natural Gas (LNG) Facility Expansion Project; Port of Vancouver Habitat Enhancement Program; and Vancouver Airport Fuel Delivery Project. ▫ Projects that are either proposed (public disclosure) or have been approved to be built, but are not yet built, for which the environmental effects overlap the proposed Project (i.e. reasonably foreseeable), as identified in the AIR: Fraser Surrey Docks Direct Transfer Coal Facility (Texada Coal); WesPac Tilbury Marine Jetty Project; Pattullo Bridge Replacement; Roberts Bank Terminal 2 Project; Ladner Harbour Revitalization; South Richmond Terminal Project; Kinder Morgan Tran Mountain Pipeline Expansion Project; Relocation of BC Hydro's transmission line that runs through the Tunnel; Fortis BC Tilbury LNG Facility Expansion Project – future phase; and Lehigh Hanson South Richmond Terminal Project. | Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities | Part B – Effects, Section 3.10.1, pages 3.10-17 to 3.10-22 |
| | | The Application will describe the methodology for identifying potential interactions between residual Project effects and the effects of other developments, including a description of the following: <ul style="list-style-type: none"> ▫ The spatial boundaries for the cumulative effects assessment for each VC, including maps; ▫ The spatial and temporal boundaries of other developments; and ▫ The potential for interaction (spatial and temporal) and linkages (overlap) of VCs with other developments. | Conducting a Cumulative Effects Assessment | Part B – Effects, Section 3.10.2, pages 3.10-22 to 3.11-23 |
| | | The Application will include: <ul style="list-style-type: none"> ▫ A table of all past, present and reasonably foreseeable developments that will be included in the cumulative effects assessment, should one be required for a particular VC; ▫ A general description of the information sources used to identify reasonably foreseeable developments and activities; and ▫ A map showing the location of the projects and activities. | Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities | Part B – Effects, Section 3.10.1, page 3.10-17 and 3.10-22 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 3.10.2 Page 20 | Conducting a Cumulative Effects Assessment | The Application will summarize the process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects using the same methodology described above in sections 3.6 to 3.9 of the AIR. | Conducting a Cumulative Effects Assessment | Part B – Effects, Section 3.10.2, page 3.10-23 |
| Section 3.11 Page 20 | Follow-up Strategy | If a residual adverse effect or cumulative effect is identified for a specific VC, the Application will include a description of a follow-up strategy, where appropriate, that: <ul style="list-style-type: none"> ▫ Identifies the measures to evaluate the accuracy of the original effects prediction. ▫ Identifies the measures to evaluate the effectiveness of proposed mitigation measures. ▫ Proposes an appropriate strategy to apply in the event that original predictions of effects and mitigation effectiveness are not as expected. | Follow-up Strategy | Part B – Effects, Section 3.11, page 3.11-24 |
| Section 4.0 Page 21 | Environmental Effects Assessment | The Application will include an assessment of Environmental Effects VCs identified in the AIR. The assessment will be conducted in accordance with the methodology specified in Section 3.0 Assessment Methodology of the AIR, using the organizational structure demonstrated in this section. | Environmental Effects Assessment | Part B - Effects, Section 4.0 |
| | | The Application will identify the VCs selected for assessment according to the methodology specified in Section 3.1 Issues Scoping and Selection of Valued Components. The Application will also include the rationale for any differences in the list of VCs presented in the Application from those listed in the final AIR. | Environmental Effects Assessment | Part B – Effects, Section 4.0 |
| Section 4.1 Page 21 | River Hydraulics and River Morphology | River hydraulics and river morphology will be studied as an IC in the context of effects of the Project on the following VCs: <ul style="list-style-type: none"> ▫ Fish and fish habitat ▫ Marine mammals ▫ Marine use The river hydraulics and morphology study will focus on water levels, velocities, and flow patterns (river hydraulics) in the Fraser River South Arm and their influence on sedimentation and erosion (morphology). | River Hydraulics and River Morphology | Part B – Effects, Section 4.1, page 4.1-1 |
| Section 4.1.1 Page 22 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to river hydraulics and river morphology, including maps (Figure 4.1-1 River Hydraulics and Morphology Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 4.1.1.3, pages 4.1-2 to 4.1-5 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.1.2 Page 23 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.1.2, pages 4.1-6 to 4.1-16 |
| | | The following general approach has been adopted for collection of baseline information on river hydraulics and river morphology: <ul style="list-style-type: none"> • Review of existing field, modelling, and theoretical studies. This includes observed water levels (at Point Atkinson, New Westminster, Steveston, Deas Island Tunnel and Port Mann Pumping Station), and discharge, flow split, and velocity measurements from the March 7 and March 27, 2014 Acoustic Doppler current-profiler (ADCP) surveys conducted by Public Works and Government Services Canada (PWGSC). • Interpretation of airphotos of the lower Fraser River spanning 1938 to 2009. • Review of bathymetric surveys conducted by Public Works and Government Services Canada (PWGSC) in 1988/89, 2000/01, 2008/09, and 2014. | Baseline Data Collection Technical Volume - River Hydraulics and River Morphology Study | Part B Effects Section Section 4.1.2.1, page 4.1.6 Section 16.2, page 8 |
| | | The hydrodynamic program TELEMAC-3D was used to compute hydraulic conditions in the lower Fraser River. Scour and deposition around the Tunnel were computed by coupling the sediment transport and morphodynamic model SISYPHE to TELEMAC-3D. | Potential Effects Technical Volume - River Hydraulics and River Morphology Study | Part B- Effects Section Section 4.1.3.2, pages 4.1-18 to 4.1-19 Section 16.2, page 8 to 9 |
| | | In B.C., the ownership of water is vested in the Crown as stated in Section 5 of the Water Sustainability Act [SBC 2014] CHAPTER 15, the primary provincial statute regulating water resources. Since the Project involves potential works in or about the Fraser River, Sections 11 and 12 of the Water Sustainability Act and associated Water Sustainability Regulation would apply to such activities. Section 46 of the Water Sustainability Act, which provides additional protection to surface water bodies, beyond what is ensured by the Environmental Management Act and Waste Discharge Regulation, by prohibiting the introduction of foreign matter into streams and creating associated penalties, is also relevant in the Project context. | Regulatory Context | Part B – Effects, Section 4.1.2.2, page 4.1-6 |
| | | Details on the river hydraulics and morphology effects assessment will be included in the following technical volume appended to the Application: <ul style="list-style-type: none"> ▫ River Hydraulics and River Morphology Technical Study | Technical Volume - River Hydraulics and River Morphology Study | Section 16.2 |
| Section 4.1.3 Page 24 | Potential Effects | The Application will identify potential effects of the Project on water levels, velocities, and flow patterns (river hydraulics), and their influence on sedimentation and erosion (morphology) within the lower Fraser River in a manner consistent with section 3.4 Potential Effects of this AIR. | Potential Effects | Part B – Effects, Section 4.1.3, pages 4.1-16 to 4.1-25 |
| Section 4.1.4 Page 24 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to river hydraulics and river morphology in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.1.4, page 4.1-25- 4.1-26 |
| Section 4.1.5 | Residual Effects and their | If any residual effect on river hydraulics and morphology is identified, it will be described in sufficient detail to support the assessment of potential effects on the following ultimate receptor VCs: | Residual Effects | Part B – Effects, Section |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Page 24 | Significance | <ul style="list-style-type: none"> ▫ Fish and fish habitat ▫ Marine mammals ▫ Marine use | | 4.1.5, pages 4.1-26 to 4.1-32 |
| Section 4.1.6 Page 25 | Cumulative Effects and their Significance | <p>If a residual effect on river hydraulics and river morphology is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will describe it in sufficient detail to support the cumulative effects assessment of the following VCs: <ul style="list-style-type: none"> ▫ Fish and fish habitat ▫ Marine mammals ▫ Marine use | Cumulative Effects Assessment and their Significance | Part B – Effects, Section 4.1.6, page 4.1-32 |
| Section 4.1.7 Page 25 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.1.7, page 4.1-32 |
| Section 4.2 Page 25 | Sediment and Water Quality | <p>Sediment and water quality will therefore be studied as an IC in the context of effects of the Project on the following VCs:</p> <ul style="list-style-type: none"> ▫ Fish and fish habitat ▫ Marine mammals ▫ Vegetation ▫ At-risk Amphibians <p>The sediment and water quality study will focus on sediment texture/grain size distribution, sediment quality, and water quality in the Fraser River South Arm, Deas Slough, and Green Slough.</p> | Sediment and Water Quality | Part B – Effects, Section 4.2, page 4.2-1 Section 4.2.1.2, page 4.2-3 |
| Section 4.2.1 Page 26 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to sediment and water quality, including maps (Figure 4.2-1 Sediment and Water Quality Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR | Assessment Boundaries | Part B – Effects, Section 4.2.1.3, pages 4.2-3 to 4.2-6 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.2.2 Page 27 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.2.2, pages 4.2-6 to 4.2-2 |
| | | The following general approach has been adopted for collection of baseline information on sediment and water quality: <ul style="list-style-type: none"> Literature review, including review of background information on temporal trends in sediment and water quality parameters in the Fraser River South Arm, and causal relationships with environmental variables. Field studies to characterize surficial sediment and assess water quality. Sediment quality in the vicinity of the Tunnel will be characterized through field sampling. This will include a consideration of levels of contaminants of potential concern (COPCs) in sediments in the vicinity of the tunnel. | Baseline Data Collection | Part B – Effects, Section 4.2.2.1, pages 4.2-7 to 4.2-9 Section 16.3 |
| | | The following legislation and guidelines are relevant to the management of sediment and surface water quality in B.C: <ul style="list-style-type: none"> Water Act R.S.B.C. 1996, c. 483 Canadian Council of Ministers of the Environment’s (CCME) sediment quality guidelines (SQG) for the protection of aquatic life. CCME water quality guidelines (WQG) for the protection of aquatic life | Regulatory Context | Part B – Effects, Section 4.2.2.2, pages 4.2-10 |
| | | Results of sediment and water quality field studies conducted in September 2014 for the Project will be included as a technical appendix. | Results from Sediment and Water Quality Field Studies Conducted in September 2014 for the Project | Part B – Effects, Section 4.2, Appendix A, pages A-1 to A-7 |
| Section 4.2.3 Page 28 | Potential Effects | The Application will identify potential effects of the Project on sediment and water quality in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.2.3, pages 4.2-12 to 4.2-15 |
| Section 4.2.4 Page 28 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to sediment and water quality in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. If appropriate, opportunities for improving or enhancing water quality in Fraser River, Deas Slough, Green Slough, or other water courses through Project design will also be identified. | Mitigation Measures | Part B – Effects, Section 4.2.4, pages 4.2-15 to 4.2-17 |
| Section 4.2.5 Page 28 | Residual Effects and their Significance | If any residual effect on sediment and water quality is identified, it will be described in sufficient detail to support the assessment of potential effects on the following ultimate receptor VCs: <ul style="list-style-type: none"> Fish and fish habitat Marine mammals Vegetation At-risk Amphibians | Residual Effects | Part B – Effects, Section 4.2.5, page 4.2-17 to 4.2-22 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.2.6 Page 29 | Cumulative Effects and their Significance | <p>If a residual effect on sediment and water quality is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will describe it in sufficient detail to support the cumulative effects assessment of the following VCs: <ul style="list-style-type: none"> ▫ Fish and fish habitat ▫ Marine mammals ▫ Vegetation ▫ At-risk Amphibians | Cumulative Effects Assessment | Part B – Effects, Section 4.2.6, page 4.2-22 |
| Section 4.2.7 Page 29 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.2.7, page 4.2-23 |
| Section 4.3 Page 29 | Underwater Noise | Underwater noise will therefore be studied as an IC in the context of effects of the Project on the following VCs: <ul style="list-style-type: none"> ▫ Fish and fish habitat ▫ Marine mammals | Underwater Noise | Part B – Effects, section 4.3, page 4.3-1 |
| | | Results of the underwater noise study will be discussed in terms of sound pressure levels (SPL) and auditory injury thresholds, or the levels at which injury to hearing organs of fish and marine mammals can occur. | Existing Conditions Regulatory Context | Part B – Effects, Section 4.3.2, page 4.3-6 Section 4.3.3.2, page 4.3-7 |
| Section 4.3.1 Page 30 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to underwater noise, including maps (Figure 4.3-1 Underwater Noise Sampling Locations), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, section 4.3.1.3, page 4.3-3 to 4.3-5 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.3.2 Page 31 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.3.2, pages 4.3-5 to 4.3-8 |
| | | The following general approach has been adopted for collection of baseline information on underwater noise: • Measurement of underwater noise levels in the Fraser River South Arm channel and Deas Slough using an Autonomous Multichannel Acoustic Recorder (AMAR). | Baseline Data Collection | Part B – Effects, Section 4.3.2.1, page 4.3-6 |
| | | There are no regulatory thresholds for the management of underwater noise in Canada. For marine mammals and fish, noise thresholds that are used in the United States are typically adopted as an international guideline and industry best practices in EAs. | Regulatory Context | Part B – Effects, Section 4.3.2.2, pages 4.3-6 to 4.3-8 |
| | | Details on results of underwater acoustic measurements and modelling will be included in in the technical volume, Underwater Noise Modelling Study, Section 16.3 of the Application. | Technical Volume - Underwater Noise Modelling Study | Part B – Effects, Section 16.3 |
| Section 4.3.3 Page 31 | Potential Effects | The Application will identify potential effects of the Project on underwater noise within the Fraser River South Arm and Deas Slough in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.3.3, pages 4.3-9 to 4.3-11 |
| Section 4.3.4 Page 32 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to underwater noise in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.3.4, pages 4.3-12 to 4.3-13 |
| Section 4.3.5 Page 32 | Residual Effects and their Significance | If any residual effect on underwater noise is identified, it will be described in sufficient detail to support the assessment of potential effects on the following ultimate receptor VCs: ▫ Fish and fish habitat ▫ Marine mammals | Residual Effects and their Significance | Part B – Effects, Section 4.3.5, pages 4.3-13 to 4.3-19 |
| Section 4.3.6 Page 32 | Cumulative Effects and their Significance | If a residual effect on underwater noise is identified, unless stated otherwise by EAO, the Application will: ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will describe it in sufficient detail to support the cumulative effects assessment of the following VCs: ▫ Fish and fish habitat ▫ Marine mammals | Cumulative Effects and their Significance | Part B – Effects, section 4.3.6, page 4.3-19 |
| Section 4.3.7 Page 33 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, section 4.3.7, page 4.3-19 |
| Section 4.4 | Fish and Fish | The following sub-components have been selected to facilitate the assessment of potential effects of the Project on fish and fish | Methodology | Part B – Effects, |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Page 33 | Habitat | habitat: <ul style="list-style-type: none"> ▫ Salmon - Chinook salmon, chum salmon, coho salmon, pink salmon, and sockeye salmon ▫ Sturgeon - green sturgeon and white sturgeon ▫ Eulachon ▫ Trout - coastal cutthroat trout and rainbow/steelhead trout ▫ Char - Dolly Varden and Bull trout. | | Section 4.4.1.2, page 4.4-3 |
| | | The following indicators are proposed for describing existing conditions and assessing potential Project-related effects on fish and fish habitat: <ul style="list-style-type: none"> ▫ Likelihood of injury or mortality of fish ▫ Total suspended solid (TSS) levels (mg/L) and Turbidity (nephelometric turbidity units (NTU)) ▫ Underwater sound levels (SPL_{peak} and SEL_{cum}) ▫ Loss of habitat area (ha) | Methodology | Part B – Effects, Section 4.4.1.2, page 4.4-4 |
| Section 4.4.1 Page 33 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to fish and fish habitat, including maps (Figure 4.4-1 Fish and Fish Habitat Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR | Assessment Boundaries | Part B – Effects, Section 4.4.1.3, pages 4.4-4 to 4.4-6 |
| Section 4.4.2 Page 35 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.4.2, pages 4.4-7 to 4.4-21 |
| | | The following general approach has been adopted for collection of baseline information on fish and fish habitat: <ul style="list-style-type: none"> • A review of literature to describe fish species occurrence and distribution, and fish habitat characteristics (i.e., riparian vegetation, streambed type, water quality) in the Fraser River South Arm. • Field studies to address gaps in data on existing conditions in the Fraser River South Arm and determine fish habitat values in upland watercourses. | Baseline Data Collection Technical Volume - Fish and Fish Habitat Study | Part B – Effects, Section 4.4.2.1, pages 4.4-7 to 4.4-8 Section 16.4 – Technical Volume |
| | | Regulation and management of fish and fish habitat in B.C. occur primarily through the following federal and provincial legislation: <ul style="list-style-type: none"> • Federal Fisheries Act, R.S.C. 1985, c. F-14 (as amended on February 26, 2015) • Federal Species at Risk Act (SARA), S.C. 2002, c. 29 • B.C. Water Sustainability Act, S.B.C. 2014, c. 15 • B.C. Wildlife Act, R.S.B.C. 1996, c. 488 | Regulatory Context | Part B – Effects, Section 4.4.2.2, pages 4.4-8 to 4.4-9 |
| | | The following technical volume will be appended to the Application: <ul style="list-style-type: none"> ▫ Fish And Fish Habitat Study (Section 16.4) | Technical Volume - Fish and Fish Habitat Study | Section 16.4 – Technical Volume |
| Section 4.4.3 Page 35 | Potential Effects | The Application will identify potential effects of the Project on fish and fish habitat in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.4.3, pages 4.4-21 to 4.4-35 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.4.4 Page 36 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to fish and fish habitat in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.4.4, pages 4.4-36 to 4.4-43 |
| Section 4.4.5 Page 36 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 4.4.5, page 4.4-43 to 4.4-50 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Determination of Significance of Residual Adverse Effects | Part B – Effects, Section 4.4.5.1, page 4.4-49 to 4.4-50 |
| Section 4.4.6 Page 36 | Cumulative Effects and their Significance | If a residual effect is identified, unless stated otherwise by EAO, the Application will: <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects Assessment | Part B – Effects, Section 4.4.6, page 4.4-51 |
| Section 4.4.7 Page 37 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.4.7, page 4.4-52 |
| Section 4.5 Page 37 | At-risk Amphibians | At-risk amphibians will be assessed in terms of potential Project-related effects on the northern red- legged frog, one of the two at-risk amphibian species have the potential to occur in the vicinity of the Project, given available habitat conditions. | Methodology | Part B – Effects, Section 4.5.1.2, pages 4.5-2 to 4.5-3 |
| | | The following indicators are proposed for describing existing conditions and assessing potential Project-related effects on at-risk amphibians: <ul style="list-style-type: none"> ▫ Presence of at-risk amphibians ▫ Change in area of available at-risk amphibian habitat ▫ Change in water quality in at-risk amphibian habitat | Methodology | Part B – Effects, Section 4.5.1.2, page 4.5-3 |
| Section 4.5.1 Page 37 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to at-risk amphibians, including maps (Figure 4.5-1 At-Risk Amphibians Overview), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR | Assessment Boundaries | Part B – Effects, Section 4.5.1.3, pages 4.5-3 to 4.5-4 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.5.2 Page 38 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.5.2, pages 4.5-5 to 4.5-13 |
| | | The following general approach has been adopted for collection of baseline information on at-risk amphibians: <ul style="list-style-type: none"> • A review of literature to identify at-risk amphibian species with the potential to occur in the area. • Assessment of at-risk amphibian habitat in watercourses likely to be affected by the Project. • Field sampling and environmental deoxyribonucleic acid (eDNA) analysis to identify red-legged frog DNA present in aquatic features within the Project alignment and determine at-risk amphibian presence in the area. | Baseline Data Collection | Part B – Effects, Section 4.5.2.1 pages 4.5-5 to 4.5-9 |
| | | Regulation and management of at-risk amphibians in B.C. occur primarily through the following federal and provincial legislation. <ul style="list-style-type: none"> • Species at Risk Act (SARA), S.C. 2002 • Wildlife Act, R.S.B.C. 1996, c. 488 | Regulatory Context | Part B – Effects, Section 4.5.2.2 page 4.5-10 |
| | | Detailed information on habitat characteristics of the areas identified as having potentially suitable at-risk amphibian habitat will be provided in an appendix to the Application. | At-risk Amphibian Habitat Assessment Data | Part B - Effects; Section 4.5, Appendix A |
| Section 4.5.3 Page 39 | Potential Effects | The Application will identify potential effects of the Project on at-risk amphibians in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.5.3, pages 4.5-13 to 4.5-17 |
| Section 4.5.4 Page 39 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to at-risk amphibians in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.5.4, pages 4.5-17 to 4.5-22 |
| Section 4.5.5 Page 39 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 4.5.5, page 4.5-23 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 4.5.5, page 4.5-23 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.5.6 Page 40 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. <p>Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR.</p> | Cumulative Effects and their Significance | Part B – Effects, Section 4.5.6, page 4.5-24 |
| Section 4.5.7 Page 40 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.5.7, page 4.5-24 |
| Section 4.6 Page 40 | Marine Mammals | Marine mammals likely to occur within or near the Project alignment are limited primarily to seals and sea lions. Due to similar life histories, habitat requirements, prey preferences, hearing sensitivities, and ecological role between seals and sea lions, harbour seal was selected as the representative species in the assessment of potential Project-related effects on marine mammals. Rationale for selecting harbour seals as the representative species for assessing marine mammals, and supporting information confirming the absence of other marine mammals, including Southern Resident Killer Whale (SRKW), in areas where they could be affected by the Project and related activities will be presented in the Application. | Methodology | Part B – Effects, Section 4.6.1.2, pages 4.6-3-4.6-4 |
| | | Underwater noise is proposed as the indicator for describing existing conditions and assessing potential Project-related effects on marine mammals. | Methodology | Part B – Effects, Section 4.6.1.2, page 4.6-4 |
| Section 4.6.1 Page 41 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to marine mammals, including maps (Figure 4.6-1 Marine Mammals Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 4.6.1.3, pages 4.6-4 to 4.6-7 |
| Section 4.6.2 Page 42 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.6.2, pages 4.6-7 to 4.6-11 |
| | | The following general approach has been adopted for collection of baseline information on marine mammals: • A review of databases (e.g., Species at Risk Public Registry, COSEWIC Wildlife Species Database); and reference of government-administered data repositories such as the B.C. Cetacean Sightings Network through data requests for cetacean sighting information pertaining to the Fraser River and estuary. | Methodology | Part B – Effects, Section 4.6.1.2, pages 4.6-2 to 4.6-3 |
| | | Regulation and management of marine mammals in B.C. occur primarily through the following legislation: • Marine Mammal Regulations SOR/93-56 under the Fisheries Act, R.S.C. 1985, and c. F-14 • Species at Risk Act (SARA), S.C. 2002, c. 29. | Regulatory Context | Part B – Effects, Section 4.6.2.1, pages 4.6-7 to 4.6-8 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.6.3 Page 42 | Potential Effects | The Application will identify potential effects of the Project on marine mammals in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.6.3, pages 4.6-12 to 4.6-19 |
| Section 4.6.4 Page 43 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to marine mammals in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.6.4, page 4.6-20 to 4.6-21 |
| Section 4.6.5 Page 43 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 4.6.5, page 4.6-21 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 4.6.5, page 4.6-21 |
| Section 4.6.6 Page 43 | Cumulative Effects and their Significance | If a residual effect is identified, unless stated otherwise by EAO, the Application will: <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects and their Significance | Part B – Effects, Section 4.6.6, page 4.6-21 |
| Section 4.6.7 Page 44 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.6.7, page 4.6-22 |
| Section 4.7 Page 44 | Vegetation | The following sub-components have been selected to facilitate the assessment of potential effects of the Project on Vegetation: <ul style="list-style-type: none"> ▫ At-risk ecosystems ▫ At-risk plant species | Methodology | Part B – Effects, Section 4.7.1.2, page 4.7-2 |
| | | The following indicators are proposed for describing existing conditions and potential Project related effects on at-risk ecosystems and at-risk plant species respectively: <ul style="list-style-type: none"> ▫ Presence and extent of population(s), described in terms of spatial extent (m²) and locations. ▫ Presence and extent of individual species | Methodology | Part B – Effects, Section 4.7.1.2, pages 4.7-2 to 4.7-3 |
| Section 4.7.1 Page 44 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to vegetation, including maps (Figure 4.7-1 Vegetation Local and Regional Assessment Area), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 4.7.1.3, pages 4.7-3 to 4.7-6 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.7.2 Page 46 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.7.2, pages 4.7-6 to 4-7.16 |
| | | The following general approach has been adopted for collection of baseline information on vegetation: <ul style="list-style-type: none"> • Terrestrial ecosystem mapping to provide a baseline map of vegetation types, including agricultural lands as appropriate. • Rare plant surveys to verify presence of rare plant communities or determine presence of at-risk plant species. This included surveys for at-risk vascular plants, conducted by qualified professionals as per established guidelines. Non-vascular at-risk plant species were not identified during the preliminary review of at-risk plant species known to occur in the study area, and were therefore not included in the survey. | Baseline Data Collection | Part B – Effects, Section 4.7.2.1, pages 4.7-6 to 4-7.8 |
| | | The following legislation provides the regulatory context for management of vegetation in B.C.: <ul style="list-style-type: none"> • Species at Risk Act (SARA), S.C. 2002, c. 29 • Forest and Range Practices Act (FRPA), S.B.C. 2002, c. 69 | Regulatory Context | Part B – Effects, Section 4.7.2.2, pages 4.7-8 to 4-7.10 |
| | | The following technical report will be appended to the Application to support the vegetation effects assessment: <ul style="list-style-type: none"> ▫ Terrestrial Ecosystem Mapping Methods, Objectives, and Results. | Terrestrial Ecosystem Mapping Methods, Objectives, and Results | Part B – Effects, Section 4.7 (Appendix B) |
| Section 4.7.3 Page 46 | Potential Effects | The Application will identify potential effects of the Project on vegetation in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.7.3, pages 4.7-16 to 4.7-18 |
| Section 4.7.4 Page 47 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to vegetation in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, section 4.7.4, pages 4.7-18 to 4.7-22 |
| Section 4.7.5 Page 47 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, section 4.7.5, page 4.7-22 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, section 4.7.5, page 4.7-22 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.7.6 Page 47 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects and their Significance | Part B – Effects, section 4.7.6, page 4.7-23 |
| Section 4.7.7 Page 47 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.7.7, page 4.7-23 |
| Section 4.8 Page 48 | Terrestrial Wildlife | <p>Terrestrial wildlife will be assessed as a VC with the following sub-components:</p> <ul style="list-style-type: none"> ▫ Upland birds (American bittern, great blue heron, rough-legged hawk, peregrine falcon, barn owl, short-eared owl, olive-sided flycatcher, common nighthawk, barn swallow, and bald eagle). ▫ Riverine birds (double-crested cormorant, cackling goose, tundra swan, Caspian tern, and western grebe) and bat species. ▫ Small mammals (River otter, Trowbridge's shrew, southern red-backed vole, Olympic shrew, and Pacific water shrew). | Methods | Part B – Effects, Section 4.8.1.2, page 4.8-3 to 4.8-4 |
| | | The Application will include a detailed rationale for selection of the above subcomponents. | Methods | Part B – Effects, Section 4.8.1.2, page 4.8-3 to 4.8-4 |
| | | <p>The following indicators are proposed for describing existing conditions and potential Project related effects on terrestrial wildlife:</p> <ul style="list-style-type: none"> ▫ Habitat loss: amount and quality of foraging and/or breeding habitat that overlaps with Project components. ▫ Sensory disturbance: changes to usability of foraging and/or breeding habitat within the Project alignment. ▫ Collision: risk of mortality. | Indicators | Part B – Effects, Section 4.8.1.3, pages 4.8-4 to 4.8-5 |
| Section 4.8.1 Page 48 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to terrestrial wildlife, including maps (Figure 4.8-1 Terrestrial Wildlife Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 4.8.1.4, page 4.8-5 to 4.8-7 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.8.2 Page 49 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.8.2, pages 4.8-7 to 4.8-29 |
| | | The following general approach, informed in part by the results of the TEM study completed as part of vegetation assessment, has been adopted for collection of baseline information on terrestrial wildlife: <ul style="list-style-type: none"> • Barn owl habitat suitability assessment to determine suitability of the Project alignment as foraging habitat for barn owl. • Conspicuous raptor and heron surveys to document presence, and map locations of nests. • Breeding bird surveys to establish species presence in areas proposed for clearing or construction. • Common nighthawk call-playback surveys to establish baseline data for common nighthawk within the Project alignment. • Structure survey for nesting swallows to map presence of swallow nests in structures that would be removed or altered during Project construction. • Marsh bird call playback surveys to identify presence of marsh bird species in areas proposed for clearing or construction. • Nocturnal ultrasonic call monitoring in the spring and fall to assess bat species presence, seasonal abundance, and flight behaviour in the vicinity of the Tunnel crossing. • Radar and standwatch surveys to identify collision risk for avian and bat species due to construction of the new bridge and associated infrastructure. • Small mammal habitat quality assessment to determine the ability of habitat to provide the life requisites for small mammal focal species. • Pacific water shrew environmental DNA study to establish presence/absence of Pacific water shrew in watercourses within the Project alignment. | Baseline Data Collection | Part B – Effects, Section 4.8.2.1, pages 4.8-8 to 4.8-13 |
| | | The following legislation provides the regulatory context for management of terrestrial wildlife in B.C.: <ul style="list-style-type: none"> • Species at Risk Act (SARA), S.C. 2002, c. 29 • Forest and Range Practices Act (FRPA), S.B.C. 2002, c. 69 • Migratory Birds Convention Act (MBCA), S.C. 1994, c. 22 • Wildlife Act, R.S.B.C. 1996, c. 488 | Regulatory Context | Part B – Effects, Section 4.8.2.2, pages 4.8-13 to 4.8-14 |
| Section 4.8.3 Page 50 | Potential Effects | The Application will identify potential effects of the Project on terrestrial wildlife in a manner consistent with Section 3.4 Potential Effects of the AIR. This will include a consideration of potential effects of the Project on water quality, and river hydraulics and morphology and their influence on terrestrial wildlife. | Potential Effects | Part B – Effects, Section 4.8.3, pages 4.8-29 to 4.8-38 |
| Section 4.8.4 Page 51 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to terrestrial wildlife in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.8.4, pages 4.8-38 to 4.8-43 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.8.5 Page 51 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 4.8.5, pages 4.8-43 to 4.8-51 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Likelihood | Part B – Effects Section 4.8.5.2, pages 4.8-48 to 4.8-49 |
| | | | Proponent’s Determination of Significance | Section 4.8.5.3, pages 4.8-49 to 4.8-50 |
| | | | Confidence and Risk | Section 4.8.5.4, pages 4.8-50 to 4.8-51 |
| Section 4.8.6 Page 51 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects and their Significance | Part B – Effects, Section 4.8.6, pages 4.8-51 to 4.8-53 |
| Section 4.8.7 Page 52 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.8.7, page 4.8-53 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.9 Page 52 | Air Quality | <p>Air quality will be studied as an IC in the context of effects of the Project on the following VC:</p> <ul style="list-style-type: none"> • Human health <p>The air quality study will focus on criteria air contaminants, road dust, and toxic contaminants. Potential changes in concentrations of ground-level ozone will be estimated based on changes in emissions of mono-nitrogen oxides (NOx) and volatile organic compounds (VOCs). Estimates of Project-related changes in greenhouse gas (GHG) emissions will also be undertaken and will include the following:</p> <ul style="list-style-type: none"> • Future (2031) GHG emissions taking into account vehicles using the existing Highway 99 corridor with and without the proposed Project works; and • Comparisons between existing and future (2031) GHG emissions for the with and without the Project scenarios. <p>The assessment will include consideration of:</p> <ul style="list-style-type: none"> • Change in vehicle fleet characteristics (i.e. fuel efficiency standards and evolving emissions controls technologies); • The influence of traffic conditions (i.e. assumed vehicle speeds, congestions etc.) on GHG emissions; • Assumed future changes in mode share (e.g. increases in transit use identified within TransLink's Regional Transportation Strategy) • Inclusion of proposed highway improvements currently being planned (e.g. Pattullo Bridge Project) and transit projects (i.e., Surrey Transit, UBC Line, Evergreen Line), and • Assumed changes in future travel patterns consistent with the implementation of regional and local land use plans <p>An evaluation of potential Project-related change in greenhouse gas (GHG) emissions will also be included.</p> | Methodology | Part B – Effects, Section 4.9.1.2, Page 4.9-2 to 4.9-5 |
| Section 4.9.1 Page 52 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to air quality, including maps (Figure 4.9-1 Air Quality Local Assessment Area), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 4.9.1.3, pages 4.9-5 to 4.9-9 |
| Section 4.9.2 Page 53 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.9.2, pages 4.9-9 to 4.9-19 |
| | | The British Columbia Air Quality Dispersion Modelling Guideline (BC MOE, 2015), which outlines recommended steps for completing modelling projects, will be consulted. | Air Quality Study – Technical Details | Section 16.5 – Technical Volume |
| | | <p>The following general approach has been adopted for collection of baseline information on air quality:</p> <p>Emissions modelling: Estimate emissions from traffic along the Project alignment under existing conditions.</p> <ul style="list-style-type: none"> • Existing air quality data analysis: Analyze ambient air quality monitoring data from Metro Vancouver monitoring stations to determine the contribution of sources other than vehicle emissions to air quality in the vicinity of the Project and the lower Fraser Valley. • Air quality dispersion modelling: Model meteorology and emissions data to estimate ambient concentrations for various averaging periods. | Baseline Data Collection | Part B – Effects, Section 4.9.2.1, pages 4.9-9 to 4.9-12 Section 16.5 Technical Volume - Air Quality Study |
| | | <p>Details on the air quality effects assessment will be included in the following technical volume appended to the Application:</p> <ul style="list-style-type: none"> ▫ Air Quality Study - Technical Details | Technical Volume - Air Quality Study | Section 16.5 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.9.3 Page 54 | Potential Effects | The Application will identify potential effects of the Project on air quality in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.9.3, pages 4.9-19 to 4.9-27 |
| | | A conservative traffic scenario, based on a review of the range of possible future conditions, will be used in predicting potential Project-related effects on air quality. Rationale behind traffic volume assumptions used in predicting Project-related effects on air quality will be provided in the Application. | Technical Volume - Air Quality Study | Section 16.5 |
| Section 4.9.4 Page 54 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to air quality in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.9.4, pages 4.9-28 to 4.9-29 |
| Section 4.9.5 Page 54 | Residual Effects and their Significance | If any residual effect on air quality is identified, it will be described in sufficient detail to support the assessment of potential effects on the following ultimate receptor VCs: <ul style="list-style-type: none"> ▫ Human health | Residual Effects and their Significance | Part B – Effects, Section 4.9.5, page 4.9-30 to 4.9-34 |
| Section 4.9.6 Page 55 | Cumulative Effects and their Significance | If a residual effect on air quality is identified, unless stated otherwise by EAO, the Application will: <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. Where an adverse residual cumulative effect is identified, the Application will describe it in sufficient detail to support the cumulative effects assessment of the following VCs: <ul style="list-style-type: none"> ▫ Human health | Cumulative Effects and their Significance | Part B – Effects, Section 4.9.6, page 4.9-34 to 4.9-38 |
| Section 4.9.7 Page 55 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B - Effects, Section 4.9.7, page 4.9-38 |
| Section 4.10 Page 55 | Atmospheric Noise | Atmospheric noise will be studied as an IC in the context of effects of the Project on the following VCs: <ul style="list-style-type: none"> ▫ Human health ▫ Terrestrial wildlife ▫ Land use The atmospheric noise study will focus on noise-sensitive receptors in the vicinity of the Project. | Atmospheric Noise | Part B – Effects, Section 4.10, page 4.10-1 |
| Section 4.10.1 Page 56 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to atmospheric noise, including maps (Figure 4.10-1 Noise Monitoring Sites Overview), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 4.10.1.3, page 4.10-7 to 4.10-9 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 4.10.2 Page 57 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 4.10.2, pages 4.10-9 to 4.10-12 |
| | | The following general approach has been adopted for collection of baseline information on atmospheric noise: • Continuous noise monitoring (for 24-hour, 48-hour, and shorter periods) at select noise-sensitive receptor sites in the vicinity of the Project to establish existing ambient noise conditions. | Methodology | Part B – Effects, Section 4.10.1.2, pages 4.10-4 to 4.10-7 |
| | | Community noise effects associated with provincial highway projects in B.C. are addressed in the Ministry of Transportation and Infrastructure’s 2014 <i>Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways</i> . | Methodology | Part B – Effects, Section 4.10.2.1, page 4.10-5 |
| | | The following technical documents will be appended to the Application to support the atmospheric noise effects assessment: ▫ Atmospheric Noise Study - Technical Details | Technical Volume - Atmospheric Noise Study | Section 16.6 |
| Section 4.10.3 Page 58 | Potential Effects | The Application will identify potential effects of the Project on atmospheric noise in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 4.10.3, pages 4.10-13 to 4.10-16 |
| | | A conservative traffic scenario, based on a review of the range of possible future conditions, will be used in predicting potential Project-related effects on atmospheric noise. Rationale behind traffic volume assumptions used in predicting Project-related effects on atmospheric noise will be provided in the Application. | Technical Volume - Atmospheric Noise Study | Section 16.6 |
| Section 4.10.4 Page 58 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to atmospheric noise in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 4.10.4, pages 4.10-17 to 4.10-20 |
| Section 4.10.5 Page 58 | Residual Effects and their Significance | If any residual effect on atmospheric noise is identified, it will be described in sufficient detail to support the assessment of potential effects on the following ultimate receptor VCs: ▫ Human health ▫ Terrestrial wildlife ▫ Land Use | Residual Effects | Part B – Effects, Section 4.10.5, pages 4.10-21 to 4.10-30 |

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| Section 4.10.6 Page 58 | Cumulative Effects and their Significance | <p>If a residual effect on atmospheric noise is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. <p>Where an adverse residual cumulative effect is identified, the Application will describe it in sufficient detail to support the cumulative effects assessment of the following VCs:</p> <ul style="list-style-type: none"> ▫ Human health ▫ Terrestrial wildlife ▫ Land Use | Cumulative Effects and their Significance | Part B – Effects, Section 4.10.6, pages 4.10-30 to 4.10-32 |
| Section 4.10.7 Page 59 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 4.10.7, page 4.10-32 |
| Section 5.0 Page 60 | Socio-economic Effects Assessment | <p>The Application will include an assessment of social VCs identified in the AIR. The assessment will be conducted in accordance with the methodology specified in section 3.0 Assessment Methodology of this AIR and reported using the organizational structure demonstrated in the section 4.0 Environmental Effects Assessment.</p> <p>An overview of potential Project-related economic benefits will be included in Section 1.1 (Project Description) of the Application. Section 1.1 of the Application will also include a discussion on tolling in terms of its role in contributing to Project funding.</p> | Socio-economic effects Assessment | Part B – Effects, Section 5.0 |
| | | <p>The following socio-economic VCs have been identified for the assessment of Project-related effects:</p> <ul style="list-style-type: none"> ▫ Marine use ▫ Land use ▫ Agricultural use ▫ Visual quality <p>The following social component, which is not the ultimate receptor of Project-related effects, but is part of the effects pathway, will be studied as an IC to support the assessment of associated ultimate receptor VCs:</p> <ul style="list-style-type: none"> ▫ Traffic | Socio-economic effects Assessment | Part B – Effects, Sections 5.0 |

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| Section 5.1 Page 60 | Traffic | <p>As a transportation project intended to address existing traffic challenges in the Highway 99 corridor, the assessment of traffic relates to primary Project objectives including reducing congestion, improving travel time and reliability, improving safety, supporting goods movement, supporting transit, and accommodating pedestrians and cyclists. The assessment of traffic in the Application focuses on the potential influence of Project-related construction on traffic and the influence of the new bridge and upgraded highway on traffic conditions along the Highway 99 corridor. An overview of the influence of tolling on future trends in traffic will be included.</p> <p>Traffic will be studied as an IC in the context of effects of the Project on the following ICs and VCs:</p> <ul style="list-style-type: none"> ▫ Air quality (IC), which will inform the assessment of Project-related effects on human health and terrestrial wildlife, which will be assessed as VCs. ▫ Atmospheric noise (IC), which will inform the assessment of Project-related effects on human health and terrestrial wildlife, which will be assessed as VCs. ▫ Land use, which will be assessed as a VC. ▫ Terrestrial wildlife, which will be assessed as a VC. | Traffic | Part B – Effects, Section 5.1, page 5.1-1 |
| | | <p>The traffic study will focus on projected traffic conditions within the Project corridor during Project construction and operation. Results of the study will be discussed in terms of the following:</p> <ul style="list-style-type: none"> - Traffic volumes - Mode share (distribution/break-down) - Travel time and reliability | Methodology | Part B – Effects, Section 5.1.1.2, pages 5.1-2 to 5.1-3 |
| Section 5.1.1 Page 61 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to traffic, including maps (Figure 5.1-1 Traffic Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 5.1.1.3, pages 5.1-3 to 5-1.7 |
| Section 5.1.2 Page 63 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. In addition to existing conditions in the LAA, the existing conditions for Traffic will identify current and future trends, with and without the Project, related to traffic in the LAA and directly adjacent portions of the regional road network. | Existing Conditions Appendix B - Design Hourly Volumes | Part B – Effects, Section 5.1.3, pages 5.1-2 to 5.1-20 Section 5.1, Appendix B |
| | | <p>The following general approach has been adopted for collection of baseline information on traffic. Existing conditions and traffic forecasts for relevant areas in the LAA and RAA have been developed based on a program of:</p> <ul style="list-style-type: none"> • Desk top research • A number of key sources of truck traffic information were reviewed including traffic count station data, TransLink screenline surveys, and the Metro Vancouver Truck Classification and Dangerous Goods Survey (Transport Canada, 2014). • Regional transportation and growth management plans, including the Metro Vancouver Regional Growth Strategy (RGS) and TransLink's Regional Transportation Strategy (RTS) were reviewed to identify trends in population and employment growth in Richmond, Delta and Surrey as well as future regional transportation infrastructure considerations that may influence existing and future traffic conditions in the LAA and RAA. • Data collection • Origin and Destination surveys - A detailed analysis of 2013 and 2014 origin-destination travel patterns was performed for GMT | Baseline Data Collection | Part B – Effects, Section 5.1.3, pages 5.1-7 |

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| | | <p>and Alex Fraser Bridge to identify information for forecasting the shifts in traffic patterns caused by the new bridge</p> <ul style="list-style-type: none"> • Review of historical traffic data sources, including the following, to supplement the traffic data collection program: <ul style="list-style-type: none"> - Permanent Count Stations - TransLink Metro Vancouver Regional Screenline Surveys - Spring 2012 Traffic Counts - Cascade Gateway Data Warehouse USA / CDN Border Crossing Data (2006-2015) - Traffic Data provided by municipalities - Signal Data | | |
| | | <ul style="list-style-type: none"> • Traffic data collection program – a traffic data collection program was implemented in 2013 to study traffic patterns at the Tunnel, along the Highway 99 corridor, and other parts of the region. The following is a complete list of current traffic data collection that was undertaken: <ul style="list-style-type: none"> Permanent Count Stations • Short Count Stations • Tube Count Surveys • Manual Count Surveys • Vehicle Classification Surveys • Vehicle Occupancy Surveys • Origin-Destination (OD) Surveys • Travel Time Surveys • Queue Length Surveys • Aerial Photograph Surveys • Safety Assessment Surveys • Insurance Corporation of B.C. (ICBC) Collision Data • MoTI Collision Information System (CIS) Data • Traffic Signal Data Collection • Bike Shuttle Data • Transit Passenger Survey | Existing Conditions Appendix B - Design Hourly Volumes | Part B – Effects, Section 5.1.2.3, pages 5.1-8 to 5.1-21 Section 5.1, Appendix B |
| | | <p>Building on desk top research on data collection, two models were used to support the description of current traffic conditions (as well as traffic forecasts in 2031 and 2045) relevant to the assessment of traffic including:</p> <ul style="list-style-type: none"> • Gateway Program (GSAM) EMME2 Model – The GSAM model is limited to a short-term forecast horizon (2031). Results from this model were used to confirm/validate forecasts from newer models as they became available. • Regional Traffic Model (RTM) - The RTM is the latest transportation demand model developed and maintained by TransLink. The model contains two road networks (2011 and 2045), and is based on land use assumptions consistent with Metro Vancouver's Regional Growth Strategy. | Existing Conditions | Part B – Effects, Section 5.1.2.3, pages 5.1-8 to 5.1-21 |
| | | <p>The following legislation provides the regulatory context for management of transportation infrastructure (as a proxy for traffic) in south-west B.C.:</p> <ul style="list-style-type: none"> • Transportation Act [SBC 2004] Chapter 44 • South Coast British Columbia Transportation Authority Act [SBC 1998] Chapter 30 <p>In addition to the above legislation, the Ministry of Transportation and Infrastructure's Guidelines for Tolling (MOTI, 2003) would apply to the tolling of the new bridge.</p> | | Part B – Effects, Section 5.1.2.2, pages 5.1-7 to 5.1-8 |

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| | | Description of existing conditions and assessment of potential Project-related effects on traffic use will be presented in Section 6.1.2 of the Application. Technical volumes providing details on traffic modelling will be included in Section 16 (Appendices) of the Application. | Potential Effects Technical Volume - Air Quality Study | Part B – Effects, Section 5.1.3, pages 5.1-21 to 5.1-24 Section 16.4, |
| Section 5.1.3 Page 65 | Potential Effects | <p>The Application will identify potential effects of the Project on traffic in a manner consistent with Section 3.4 Potential Effects of the AIR.</p> <p>Anticipated interactions of Project components and activities with traffic include:</p> <ul style="list-style-type: none"> • Temporary change in traffic flow, and potential detours and infrequent lane closures within the Project alignment during the construction phase. • Anticipated change in traffic flow along the Project corridor during the operational phase of the Project, and consequent change in traffic-related emissions and noise as discussed in Sections 4.9 and 4.10. <p>Potential effects on construction phase traffic will include an assessment of potential congestion on Highway 99 and the directly adjacent local road networks.</p> <p>Potential effects on operational phase traffic will be supported by traffic forecasting that describes traffic conditions on key links of the Highway 99 corridor, for opening day (2022) and to 2045, with respect to conditions with and without the Project.</p> | Potential Effects | Part B – Effects, Section 5.1.3, pages 5.1-21 to 5.1-24 |
| Section 5.1.4 Page 66 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to traffic in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 5.1.4, pages 5.1-24 to 5.1-27 |
| Section 5.1.5 Page 66 | Residual Effects and their Significance | <p>If any residual effect on traffic is identified, it will be described in sufficient detail to support the assessment of potential effects on the following ICs and ultimate receptor VCs:</p> <ul style="list-style-type: none"> ▫ Human health ▫ Air quality ▫ Atmospheric noise ▫ Land use ▫ Terrestrial wildlife | Residual Effects and their Significance | Part B – Effects, Section 5.1-5, pages 5.1-27 to 5.1-34 |

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| Section 5.1.6 Page 66 | Cumulative Effects and their Significance | <p>If a residual effect on traffic is identified, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will describe it in sufficient detail to support the cumulative effects assessment of the following ICs and VCs: <ul style="list-style-type: none"> ▫ Human health ▫ Air quality ▫ Atmospheric noise ▫ Land use ▫ Terrestrial wildlife | Cumulative Effects and their Significance | Part B – Effects, Section 5.1-6, pages 5.1-34 to 5.1-35 |
| Section 5.1.7 Page 67 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | | Part B – Effects, Section 5.1-7, page 5.1-35 |
| Section 5.2 Page 67 | Marine Use | <p>Marine use will be assessed as a VC with the following sub-components:</p> <ul style="list-style-type: none"> ▫ Commercial navigation ▫ Recreational navigation ▫ Navigation for commercial, recreational, and Aboriginal (CRA) fisheries. | Methodology | Part B – Effects, Section 5.2.1.2, pages 5.2-2 to 5.2-3 |
| | | <p>The following indicators are proposed for describing existing conditions and potential Project related effects on marine use:</p> <ul style="list-style-type: none"> ▫ Marine traffic frequency and volume ▫ Accessibility of waterways for navigation | Methodology | Part B – Effects, Section 5.2.1.2, pages 5.2-2 to 5.2-3 |
| Section 5.2.1 Page 67 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to marine use, including maps (Figure 5.2-1 Marine Use Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Methodology | Part B – Effects, Section 5.2.1.2, pages 5.2-2 to 5.2-3 |

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| Section 5.2.2 Page 68 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 5.2.2, pages 5.2-7 to 5-2.27 |
| | | The following general approach has been adopted for collection of baseline information on marine use. • Desktop assessment on navigation conducted for the Project to identify: - Physical characteristics and navigability of the lower Fraser River. - Current and future marine and water-dependent land uses. | Baseline Data Collection | Part B – Effects, Section 5.2.2.1, pages 5.2-7 to 5-2.10 |
| | | The following legislation provides the regulatory context for management of marine use in B.C.: • Navigation Protection Act, R.S.C. 1987, c. N-22 • Fisheries Act, R.S.C. 1985, c. F-14 • Canada Marine Act, S.C. 1998, c. 10 • Canada Shipping Act, 2001, S.C. 2001, c. 26 In addition to the above, Port of Vancouver’s Project and Environmental Review Process may apply to marine activity within Port of Vancouver’s jurisdiction. | Regulatory Context | Part B – Effects, Section 5.2.2.2, pages 5.2-10 to 5.2-12 |
| | | Description of existing conditions and assessment of potential Project-related effects on marine use will be presented in the main body of the Application. The need for a separate technical report on marine use is not anticipated. | Existing Conditions | Part B – Effects, Section 5.2.2, pages 5.2-7 to 5-2.27 |
| Section 5.2.3 Page 69 | Potential Effects | The Application will identify potential effects of the Project on marine use in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 5.2.3, pages 5.2-27 to 5.2-32 |
| Section 5.2.4 Page 69 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to marine use in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 5.2.4, page 5.2-32 to 5.2-35 |
| Section 5.2.5 Page 69 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 5.2.5, pages 5.2-35 to 5.2-40 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 5.2.5, pages 5.2-35 to 5.2-40 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 5.2.6 Page 70 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects and their Significance | Part B – Effects, Section 5.2.6, page 5.2-40 |
| Section 5.2.7 Page 70 | Follow-up Strategy | If a residual effect or cumulative effect has been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 5.2.7, page 5.2-40 |
| Section 5.3 Page 70 | Land Use | <p>Land use will be assessed as a VC with the following sub-components:</p> <ul style="list-style-type: none"> ▫ Land use ▫ Regional growth <p>The Application will include a detailed rationale for the selection of the above subcomponents.</p> <p>Land use will be assessed using the following indicators to describe existing conditions and potential Project related effects:</p> <ul style="list-style-type: none"> ▫ Land Use: <ul style="list-style-type: none"> ▫ Consistency with land use plans and designations ▫ Compatibility with adjacent or proximal land uses ▫ Spatial area (ha) of change in existing land uses ▫ Disturbance to existing land uses from Project-related construction or operation activities: <ul style="list-style-type: none"> ▫ Residential, commercial, and industrial uses ▫ Recreational use of Deas Island Regional Park ▫ Regional Growth <ul style="list-style-type: none"> ▫ Change in regional population growth and distribution ▫ Change in non-residential land (industrial and commercial) development and distribution | Land Use, Methodology | Part B – Effects, Section 5.3.1.2, pages 5.3-2 to 5.3-3 |
| Section 5.3.1 Page 71 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to land use, including maps (Figure 5.3-1 Land Use Subcomponent Local and Regional Assessment Areas and Figure 5.3-2 Regional Growth Subcomponent Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 5.3.1.3, pages 5.3-3 to 5.3-7 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 5.3.2 Page 72 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 5.3.2, pages 5.3-7 to 5.3-44 |
| | | The following general approach has been adopted for collection of baseline information on land use: <ul style="list-style-type: none"> • Review of the Official Community Plans of Richmond, Surrey and Delta, Port Metro Vancouver’s 2014 Land Use Plan, Metro Vancouver’s Regional Growth Strategy, and TransLink’s 2014 Base Plan and Outlook. • Review of land ownership and Crown land tenures in provincial databases. • Review of community planning documents and bylaws. • Analysis of information gathered through the public and stakeholder consultation process. • Review of satellite images, air photos and agricultural baseline studies to determine existing land uses. • Review of relevant traditional ecological knowledge provided by Aboriginal Groups. | | Part B – Effects, Section 5.3.2.1, page 5.3-8 |
| | | The following legislation provides the regulatory context for management of land use in the Lower Mainland: <ul style="list-style-type: none"> • Canada Marine Act, S.C. 1998, c. 10 • Agricultural Land Commission Act, S.B.C. 2002, c. 36 • Land Act, R.S.B.C. 1996, c. 245 • Wildlife Act, R.S.B.C. 1996, c. 488 • Community Charter, S.B.C. 2003, c. 26 • Local Government Act, R.S.B.C. 1996, c. 323 | | Part B – Effects, Section 5.3.2.2, page 5.3-9 |
| | | Description of existing conditions and assessment of potential Project-related effects on land use will be presented in the main body of the Application. | | Part B – Effects, Section 5.3, pages 5.3-1 to 5.3-70 |
| Section 5.3.3 Page 73 | Potential Effects | The Application will identify potential effects of the Project on land use in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 5.3.3, pages 5.3-45 to 5.3-58 |
| Section 5.3.4 Page 73 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to land use in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 5.3.4, pages 5.3-58 to 5.3-59 |

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| Section 5.3.5 Page 73 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Characterization of Residual Effects | Part B – Effects, Section 5.3.5.1, pages 5.3-54 to 5.3-69 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Likelihood of Residual Effects Proponent's Determination of Significance Confidence and Risk | Part B – Effects, Section 5.3.5.2, page 5.3-66 Part B – Effects, Section 5.3.5.3, page 5.3-67 to 5.3-68 Part B – Effects, Section 5.3.5.4, pages 5.3-68 to 5.3-69 |
| Section 5.3.6 Page 74 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects | Part B – Effects, Section 5.3.6, page 5.3-69 to 5.3-70 |
| Section 5.3.7 Page 74 | Follow-up Strategy | Where a residual effect and/or cumulative effect have been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 5.3.7, page 5.3-65 |
| Section 5.4 Page 74 | Agricultural Use | <p>Agricultural use will be assessed as a VC with the following sub-components:</p> <ul style="list-style-type: none"> ▫ Land in the Agricultural Land Reserve (ALR) ▫ Irrigation and drainage ▫ Farm infrastructure and operations | Methodology | Part B – Effects, Section 5.4.1.2, page 5.4-2. |
| Section 5.4 Page 74 | Agricultural Use | <p>The following indicators are proposed for describing existing conditions and potential Project related effects on agricultural use:</p> <ul style="list-style-type: none"> ▫ Change in ALR land by capability class ▫ Change in irrigation and drainage systems ▫ Change in farm operations | Methodology | Part B – Effects, Section 5.4.1.2, pages 5.4-2 to 5.4-3 |

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| Section 5.4.1 Page 75 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to agricultural use, including maps (Figure 5.4-1 Agricultural Use Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 5.4.1.3, pages 5.4-3 to 5.4-7 |
| Section 5.4.2 Page 76 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 5.4.2, pages 5.4-7 to 5.4-24 |
| | | The following general approach has been adopted for collection of baseline information on agricultural use <ul style="list-style-type: none"> • Review of area plans and official community plans; agricultural land, soil, climate capability, and topographic maps; aerial photographs; and data files. • Mapping and spatial analysis of ALR boundaries, the Project alignment, and legal property boundary information • Field studies and interviews with farmers and relevant stakeholders | Baseline Data Collection | Part B - Effects, Section 5.4.2.1, pages 5.4-7 to 5.4-9 |
| | | The following legislation provides the regulatory context for management of agricultural land in B.C.: <ul style="list-style-type: none"> • Agricultural Land Commission Act, S.B.C. 2002, c. 36, and the associated Agricultural Land Reserve Use, Subdivision and Procedure Regulation, B.C. Reg. 171/2002 • Agricultural Land Commission Amendment Act, 2014, Bill 24 – 2014 • Farm Practices Protection (Right to Farm) Act, R.S.B.C. 1996, c. 131 • Environmental Management Act, Agricultural Waste Control Regulation, B.C. Reg. 131/92 In addition to the above, the Official Community Plans (OCPs) of Richmond, Delta, and Surrey, and the related agricultural plans and policies apply to agricultural use within those municipalities | Regulatory Context | Part B - Effects, Section 5.4.2.2, pages 5.4-9 to 5.4-11 |
| | | Description of existing conditions and assessment of potential Project-related effects on agricultural use will be presented in the main body of the Application. The need for a separate technical report on agricultural use is not anticipated | Existing Conditions | Part B - Effects, Section 5.4.2, pages 5.4-7 to 5.4-24 |
| Section 5.4.3 Page 76 | Potential Effects | The Application will identify potential effects of the Project on agricultural use in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 5.4.3, pages 5.4-24 to 5.4-35 |
| Section 5.4.4 Page 77 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to agricultural use in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 5.4.4, pages 5.4-35 to 5.4-41 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 5.4.5 Page 77 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 5.4.5, pages 5.4-41 to 5.4-48 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 5.4.5, pages 5.4-41 to 5.4-48 |
| Section 5.4.6 Page 77 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects | Part B Effects, Section 5.4.6, page 5.4-48 |
| Section 5.4.7 Page 77 | Follow-up Strategy | Where a residual effect and/or cumulative effect have been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B Effects, Section 5.4.7, pages 5.4-48 to 5.4-49 |
| Section 5.5 Page 78 | Visual Quality | <p>Visual quality will be assessed as a VC using the following indicator to describe existing conditions and potential Project related effects:</p> <ul style="list-style-type: none"> ▫ Change in visual quality from sensitive locations. | Methodology | Part B – Effects, Section 5.5.1.2, pages 5.5-2 |
| Section 5.5.1 Page 78 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to visual resources, including maps (Figure 5.5-1 Visual Quality Local Assessment Area), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 5.5.1.3, pages 5.5-3 to 5.5-5 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 5.5.2 Page 79 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 5.5.2, pages 5.5-4 to 5.5-20 |
| | | The following general approach has been adopted for collection of baseline information on visual quality <ul style="list-style-type: none"> Literature review to identify any management objectives for visual quality that may be in place and appropriate analysis methods for the Project, and determine visual sensitivity relevant to the assessment area Field surveys to characterize existing visual conditions at select viewpoints identified based on local knowledge and experience, with consideration to residential and recreational areas (e.g., municipal parks) | Baseline Data Collection | Part B - Effects, Section 5.5.3.1, pages 5.5-5 to 5.5-9 |
| | | In B.C., Visual Quality Objectives are established through the <i>Government Action Regulation</i> , B.C. Reg. 582/2004 under the <i>Forest and Range Practices Act</i> , S.B.C., 2002, c. 69. Visual Quality Objectives identify levels of scenic quality based on physical characteristics and social considerations for a given area. No provincially-designated scenic areas are located in the visual quality assessment area for the Project | Regulatory Conditions | Part B - Effects, Section 5.5.2.2, pages 5.5-9 to 5.5-10 |
| | | Description of existing conditions and assessment of potential Project-related effects on visual quality will be presented in the main body of the Application. The need for a separate technical report on visual quality is not anticipated | Existing Conditions | Part B - Effects, Section 5.5.3, pages 5.5-4 to 5.5-20 |
| Section 5.5.3 Page 80 | Potential Effects | The Application will identify potential effects of the Project on visual resources in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 5.5.4, pages 5.5-20 to 5.5-32 |
| Section 5.5.4 Page 80 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to visual resources in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 5.5.5, page 5.5-33 |
| Section 5.5.5 Page 80 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 5.5.6, pages 5.5-33 to 5.5-40 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 5.5.6, pages 5.5-33 to 5.5-40 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 5.5.6 Page 80 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects and their Significance | Part B – Effects, Section 5.5.7, pages 5.5-40 5.5-42 |
| Section 5.5.7 Page 81 | Follow-up Strategy | Where a residual effect and/or cumulative effect have been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 5.5.8, page 5.5-42 |
| Section 6.0 Page 82 | Heritage Effects Assessment | The Application will include an assessment of heritage VCs identified in the AIR. The assessment will be conducted in accordance with the methodology specified in Section 3.0 Assessment Methodology of the AIR and reported using the organizational structure demonstrated in Section 4.0 Environmental Effects Assessment of the AIR. | Heritage | Part B – Effects, Section 6.0, pages 6.1-1 to 6.1-23 |
| Section 6.1 Page 82 | Heritage Resources | <p>Heritage resources will be assessed as a VC using the following indicators to describe existing conditions and potential Project related effects:</p> <ul style="list-style-type: none"> ▫ Disturbance of archaeological sites, objects, and features ▫ Disturbance of historical sites, objects, and features that are subject to protection under the <i>Heritage Conservation Act</i>, R.S.B.C 1996 (HCA) ▫ Changes in level of accessibility to archaeological sites, objects, and features ▫ Changes in level of accessibility to historical sites, objects, and features that are subject to protection under the HCA | Assessment Context | Part B – Effects, Section 6.1.1.1, pages 6.1-1 to 6.1-2 |
| Section 6.1.1 Page 82 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to heritage resources, including maps (Figure 6.1-1 Heritage Resources Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 6.1.1.2, pages 6.1-2 to 6.1-5 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 6.1.2 Page 83 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 6.1.2, pages 6.1-5 to 6.1-22 |
| | | The following general approach has been adopted for collection of baseline information on heritage resources: <ul style="list-style-type: none"> • Compilation of baseline data through external sources, including consultation with Aboriginal Groups, research institutions, museums, and government agencies such as B.C. Archaeology Branch. • Identification of previously recorded heritage sites through the Provincial Heritage Register and a review of existing archaeological, ethnographic and historical literature relevant to the assessment area • Field inventory to identify, record, and assess heritage sites in areas identified through literature review as having the highest archaeological potential within the assessment area | Baseline Data Collection | Part B - Effects, Section 6.1.2.1, pages 6.1-5 to 6.1-11 |
| | | The following legislation provides the regulatory context for management of heritage resources in B.C.: <ul style="list-style-type: none"> • Environmental Assessment Act, S.B.C. 2002, c. 43 • Heritage Conservation Act, R.S.B.C 1996, Chapter 187 | Regulatory Context | Part B - Effects, Section 6.1.2.2, page 6.1-12 to 6.1-13 |
| | | Many B.C. Aboriginal Groups have developed their own heritage policies and permitting systems. In general, the scope of these policies reflects a desire to have some oversight of archaeological research in each Aboriginal Group's territory so that specific cultural protocols are observed, particularly as they relate to human remains and spiritual locations (Mason 2013). The following Aboriginal Groups are known to have heritage policies and permitting systems that are relevant to the Project area: Kwantlen First Nation, Musqueam Indian Band, Squamish Nation, Stó:lō Nation, and Tsleil-Waututh Nation. | Regulatory Context | Part B - Effects, Section 6.1.2.2, page 6.1-13 |
| | | The following technical report will not be appended to the Application but will be provided to technical working group members as appropriate: <ul style="list-style-type: none"> • Heritage Resources Assessment Technical Report | N/A | N/A |
| Section 6.1.3 Page 84 | Potential Effects | The Application will identify potential effects of the Project on heritage resources in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 6.1.3, page 6.1-23 |
| Section 6.1.4 Page 84 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to heritage resources in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 6.1.4, pages 6.1-22 to 6.1-23 to 6.1-24 |
| Section 6.1.5 Page 84 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 6.1.5, page 6.1-24 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 6.1.5, page 6.1-24 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 6.1.6 Page 85 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent's significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent's Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects and their Significance | Part B – Effects, Section 6.1.6, page 6.1-24 |
| Section 6.1.7 Page 85 | Follow-up Strategy | Where a residual effect and/or cumulative effect have been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 6.1.7, page 6.1-25 |
| Section 7.0 Page 86 | Health Effects Assessment | The Application will include an assessment of health VCs identified in the AIR. The assessment will be conducted in accordance with the methodology specified in Section 3.0 Assessment Methodology of the AIR and reported using the organizational structure demonstrated in Section 4.0 Environmental Effects Assessment of the AIR. | Human Health | Part B – Effects, Section 7.0 |
| | | The following has been identified as the health VC for the assessment of Project-related effects: <ul style="list-style-type: none"> ▫ Human health | Human Health | Part B – Effects, Section 7.1, page 7.1-1 |
| | | In addition to assessing human health as a VC, the Application will provide an overview of how the Health Impact Assessment (HIA) framework has been applied in the context of the Project and the Application. | Health Impact Assessment | Part B – Effects, Section 7.2, |
| Section 7.1 Page 86 | Human Health | Human health will be assessed as a VC with the following sub-components: <ul style="list-style-type: none"> ▫ Health effects linked to changes in air quality ▫ Health effects linked to noise and vibration exposure | Methodology | Part B – Effects, Section 7.1.1.2, pages 7.1-2 to 7.1-4 |
| | | The following indicators are proposed for describing existing conditions and potential Project related effects on human health: <ul style="list-style-type: none"> ▫ Health effects linked to air quality: <ul style="list-style-type: none"> ▫ Acute inhalation risk quotient. ▫ Chronic inhalation risk quotient. ▫ Chronic risk quotient for multi-media exposures. ▫ Health effects linked to noise <ul style="list-style-type: none"> ▫ Annoyance associated with highway noise during operations (as measured by the expected percent of community that is “highly annoyed” (%HA) as a result of noise exposure). ▫ Sleep disturbance. ▫ Ability to maintain adequate speech comprehension. ▫ Annoyance associated with ground-borne vibration. | Methodology | Part B – Effects, Section 7.1.1.2, pages 7.1-3 to 7.1-4 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 7.1.1 Page 87 | Context and Boundaries | The Application will identify the spatial, temporal, administrative and technical study area boundaries, as applicable to human health, including maps (Figure 7.1-1 Human Health Risk Assessment Local and Regional Assessment Areas), in a manner consistent with Section 3.2 Assessment Boundaries of the AIR. | Assessment Boundaries | Part B – Effects, Section 7.1.1.3, pages 7.1-5 to 7.1-7 |
| Section 7.1.2 Page 88 | Existing Conditions | The Application will summarize existing conditions in a manner consistent with Section 3.3 Existing Conditions of the AIR. | Existing Conditions | Part B – Effects, Section 7.1.2, pages 7.1-7 to 7.1-11 |
| | | The following general approach has been adopted for collection of baseline information on human health: • Review of the results of Project-related studies on air quality and noise, previous consultant reports, and relevant documents from international, federal and provincial governments and other agencies that describe how existing ambient air quality and noise relate to human health conditions within and along the Project alignment. | Existing Conditions | Part B - Effects, Section 7.1.2.1, pages 7.1-7 to 7.1-8 |
| | | Various regulatory and public agencies have oversight of air quality health issues, including the B.C. Ministry of Environment, Metro Vancouver, and the B.C. Ministry of Health, particularly as represented by the Vancouver Coastal Health and Fraser Valley Health authorities | Existing Conditions | Part B - Effects, Section 7.1.2.2, page 7.1-8 |
| | | Guidelines for community health developed by the World Health Organization (WHO 1999) and Health Canada's guidance on evaluating human health effects of noise in environmental assessment (HC 2011) are relevant to the assessment of noise-related human health effects of the Project. | Existing Conditions | Part B - Effects, Section 7.1.2.2, page 7.1-9 |
| | | The following technical reports will be appended to the Application to support the human health effects assessment: ▫ Human Health Risk Assessment: Air Quality ▫ Human Health Risk Assessment: Atmospheric Noise | Human Health Risk Assessment: Air Quality Human Health Risk Assessment: Atmospheric Noise | Part B – Effects, Section 7.1; Section 7.1 Appendix B and Appendix C Part B – Effects, Section 7.1 |
| Section 7.1.3 Page 89 | Potential Effects | The Application will identify potential effects of the Project on human health in a manner consistent with Section 3.4 Potential Effects of the AIR. | Potential Effects | Part B – Effects, Section 7.1.3, pages 7.1-11 to 7.1-17 |
| Section 7.1.4 Page 89 | Mitigation Measures | The Application will identify measures to avoid, manage or otherwise mitigate potential adverse effects to human health in a manner consistent with Section 3.5 Mitigation Measures of the AIR. Relevant management plans will be referenced, and linkages to other sections in the Application will be identified. | Mitigation Measures | Part B – Effects, Section 7.1.4, pages 7.1-17 to 7.1-19 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 7.1.5 Page 89 | Residual Effects and their Significance | Where an adverse residual effect is identified, the Application will characterize the residual effect based on the context, magnitude, extent, duration, reversibility, and frequency as described in Section 3.6 Characterization of Residual Effects of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 7.1.5, pages 7.1-19 to 7.1-20 |
| | | Where an adverse residual effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Residual Effects and their Significance | Part B – Effects, Section 7.1.5, pages 7.1-19 to 7.1-20 |
| Section 7.1.6 Page 89 | Cumulative Effects and their Significance | <p>If a residual effect is identified, unless stated otherwise by EAO, the Application will:</p> <ul style="list-style-type: none"> ▫ Determine whether any cumulative interactions between residual effects of the proposed Project and the potential residual effects of other developments, based on the preliminary list of past, present and reasonably foreseeable developments provided in the AIR, are likely to occur, consistent with Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities of the AIR. ▫ Conduct a cumulative effects assessment consistent with Section 3.10.2 Conducting a Cumulative Effects Assessment of the AIR. ▫ Identify any additional mitigation measures, consistent with Section 3.5 Mitigation Measures of the AIR. ▫ Where an adverse residual cumulative effect is identified, the Application will also describe the likelihood, Proponent’s significance determination and predictive confidence, in accordance with Sections 3.7 Likelihood, 3.8 Proponent’s Determination of Significance and 3.9 Confidence and Risk of the AIR. | Cumulative Effects and their Significance | Part B – Effects, Section 7.1.6 page 7.1-20 |
| Section 7.1.7 Page 90 | Follow-up Strategy | Where a residual effect and/or cumulative effect have been identified, the Application will include a description of a follow-up strategy that is consistent with Section 3.11 Follow-up Strategy of the AIR. | Follow-up Strategy | Part B – Effects, Section 7.1.7, page 7.1-20 |
| Section 7.2 Page 90 | Health Impact Assessment | <p>The health effects assessment section of the Application will provide a summary of the findings of a health impact assessment (HIA) that is being completed for the Project. The Application will include:</p> <ul style="list-style-type: none"> ▫ A discussion on how the results of the HIA support Project planning and are integrated into the Application ▫ General overview of the HIA process ▫ Methodology supporting the HIA for the Project ▫ A summary of the results of the HIA, including key findings and recommendations | Health Impact Assessment | Part B – Effects, Section 7.2, pages 7.1-20 to 7.1-36 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 8.0 Page 91 | Accidents and Malfunctions | <p>The Application will include the following:</p> <ul style="list-style-type: none"> ▫ Identification of potential accidents and malfunctions that may occur during Project construction and operation, such as: <ul style="list-style-type: none"> ▫ Release or spill of contaminants such as hydrocarbon fuels, lubricants, concrete from marine or land-based vehicle, machinery, or equipment during construction, including during Tunnel decommissioning. ▫ Structural failure of a culvert, ditch, detention pond, or sediment containment infrastructure during construction. ▫ Damage to utilities during construction (e.g., inadvertent contact with buried natural gas pipes, water mains). ▫ Marine vehicle collisions and unintended obstruction to navigation ▫ Potential failure of Project components during operation. ▫ The overall methodology for assessing the potential risk of an event (likelihood and consequence). ▫ Definitions of each category of likelihood. ▫ Definitions for each category of consequence. ▫ An assessment of the likelihood of the event occurring, based on historical trends and predictive models. ▫ Identification of proposed measures to reduce the likelihood of the event. ▫ Assessment of consequence of the event, in a manner consistent with the direct effects assessment. ▫ Identification of measures to mitigate the consequences to valued components. ▫ Conclusions on the potential risk (likelihood multiplied by consequence) of the accident or malfunction. | Accidents and Malfunctions | Part B – Effects, Section 8.0, pages 8.1-1 to 8.4-21 |
| Section 9.0 Page 92 | Effects of the Environment on the Project | <p>The Application will include:</p> <ul style="list-style-type: none"> ▫ The environmental factors deemed to have possible consequences on the proposed project, including, but not necessarily limited to, consideration of natural hazards such as: <ul style="list-style-type: none"> ▫ Climate change, including temperature rise, precipitation, and sea-level rise ▫ Extreme weather and weather-related events (e.g., heavy precipitation, extreme temperatures, and wind) ▫ Seismic events ▫ Erosion and scour of river channels ▫ Fire ▫ Flood events ▫ A description of any changes or effects on the proposed Project that may be caused by the above- mentioned environmental factors. ▫ The likelihood and consequence of the changes or effects to relevant VCs. ▫ Practical mitigation measures, including design strategies and environmental contingency plans, to avoid or minimize the likelihood and consequence of the effects of the environment on the proposed Project. ▫ A conclusion about the potential risk of an effect of the environment on the proposed Project and to relevant VCs. | Effects of the Environment on the Project | Part B – Effects, Section 9.0, pages 9.1-1 to 9.6-15 |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 10.1 Page 94 | Aboriginal Interests | <p>The Aboriginal Groups discussed in this section will include those identified on Schedule B of the Section 11 Order, as follows:</p> <ul style="list-style-type: none"> ▫ Cowichan Tribes ▫ Halalt First Nation ▫ Katzie First Nation ▫ Kwantlen First Nation ▫ Lake Cowichan First Nation ▫ Lyackson First Nation ▫ Musqueam Indian Band ▫ Penelakut First Nation <ul style="list-style-type: none"> ▫ Hwlitsum ▫ Semiahmoo First Nation ▫ Squamish Nation ▫ Stz'uminus First Nation ▫ Tsawwassen First Nation ▫ Tseil-Waututh Nation | Aboriginal Interests | Part C – Aboriginal Consultation, Section 10.1, page 10.1-2 |
| Section 10.1.1 Page 94 | Background Information | <p>For each Aboriginal Group identified, the Application will provide:</p> <ul style="list-style-type: none"> ▫ A description of the Aboriginal Interests of each group identified through secondary research techniques or provided directly through consultation activities (Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern). ▫ A description of the background information on each Aboriginal Group's language, governance, economy and reserves. | Issue Summary Table | Part C – Aboriginal Consultation, Section 10.1., page 10.1-4 to 10.1-20; Section 10.1.3.2 pages 10.1-89 to 10.1-156 |
| | | <ul style="list-style-type: none"> ▫ Maps that identifies Indian Reserves and Aboriginal communities, for the Aboriginal Groups and the Project location (Figures 10-2 to 10-10 of the application). | Aboriginal Consultation | Part C – Aboriginal Consultation, Section 10.0, Appendix A - Figures |
| Section 10.1.2 Page 95 | Consultation Activities | <p>For each Aboriginal Group identified in Section 10.1, the Application will include:</p> <ul style="list-style-type: none"> ▫ A summary of past and planned consultation activities. | Consultation Activities | Part C – Aboriginal Consultation, Section 10.1.2, pages 10.1-21 to 10.1-81; Appendix B Aboriginal Consultation Report |
| | | <ul style="list-style-type: none"> ▫ A summary of proposed changes to the Aboriginal Consultation Plan resulting from the Aboriginal Group's feedback, or experience from consultation to date, including any such changes which have been implemented. | Feedback and Proposed Changes to the Aboriginal Consultation Plan | Part C – Aboriginal Consultation, Section 10.1.2.3, pages 10.1-25 to 10.1-26; Appendix B Aboriginal Consultation Report 2 |
| | | <ul style="list-style-type: none"> ▫ A summary of the key issues and concerns raised by Aboriginal Groups relevant to the environmental assessment, the Proponent's responses to those issues and concerns, and the status of resolution. | Issue Summary Table | Part C – Aboriginal Consultation, Section |

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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| | | | | 10.3, pages 10.3-151 to 10.3-248 |
| Section 10.1.3 Page 95 | Aboriginal Interests Assessment | For each Aboriginal Group identified in Section 10.1, this section of the Application will provide: <ul style="list-style-type: none"> Traditional Ecological Knowledge and Traditional Land Use information, as available from Aboriginal Groups or publicly available sources, with a description of how Traditional Ecological Knowledge (TEK) and Traditional Land Use Studies (TLUS) information was gathered and incorporated into the assessment of impacts of the proposed Project on Aboriginal Interests. | Traditional Use, Traditional Knowledge & Other Studies | Part C – Aboriginal Consultation, Section 10.1.2.7, pages 10.1-24 to 10.1-25 |
| | | <ul style="list-style-type: none"> A description of potential adverse effects of the proposed Project on Aboriginal Interests, which will consider the findings of the VC chapters in the Application that are relevant to Aboriginal Interests, including cumulative effects and follow up strategies identified for those VCs (per the methodology outlined in sections 3.10 Cumulative Effects Assessment and 3.11 Follow Up Strategy). | Potential Effects | Part C – Aboriginal Consultation, Section 10.1.3.3, pages 10.1-157 to 10.1-180; Section 10.1.3.8, pages 10.1-185 to 10.1-254 |
| | | <ul style="list-style-type: none"> A description or summary of mitigation measures to avoid or reduce potential adverse effects on Aboriginal Interests consistent with Section 3.5 Mitigation Measures of the AIR. | Mitigation Measures | Part C – Aboriginal Consultation, Section 10.1.3.4, pages 10.1-180 to 10.1-184 |
| | | <ul style="list-style-type: none"> A characterization of the residual adverse effects on Aboriginal Interests after mitigation using the methodology described in Sections 3.6 Characterization of Residual Effects, 3.7 Likelihood, and 3.9 Confidence and Risk of the AIR and incorporating the findings of the VC chapters in the Application that is relevant to Aboriginal interests. | Residual Effects | Part C – Aboriginal Consultation, Section 10.1.3.5, page 10.1-184 |
| | | <ul style="list-style-type: none"> A summary of any outstanding Aboriginal Interests issues identified by Aboriginal Groups. | Outstanding Aboriginal Interests Issues Raised by Aboriginal Groups | Part C – Aboriginal Consultation, Section 10.1.3.6, page 10.1-184 |
| | | <ul style="list-style-type: none"> A summary of publically available arrangements or agreements reached between the proponent and Aboriginal Groups. | Publicly Available Project Arrangements or Agreements with Aboriginal Groups | Part C – Aboriginal Consultation, Section 10.1.3.7, page 10.1-184 to 10.1-185 |
| Section 10.2 Page 96 | Others Matters of Concern to Aboriginal Groups | The Application will include: <ul style="list-style-type: none"> A list of other matters of concern raised by Aboriginal Groups with respect to potential environmental, economic, social, heritage and health effects of the proposed Project, which have not already been considered in the discussion about Aboriginal Interests. | Other Matters of Concern to Aboriginal Groups | Part C – Aboriginal Consultation, Section 10.2, pages 10.2-254 to 10.2-258 |
| | | <ul style="list-style-type: none"> A description (or summary if described elsewhere in the Application) of the mitigation measures to address potential effects on other matters of concern to Aboriginal Groups. | Other Matters of Concern to Aboriginal Groups | Part C – Aboriginal Consultation, Section 10.2, pages 10.2-254 to 10.2-258 |
| | | <ul style="list-style-type: none"> A characterization of the residual adverse effects after mitigation, in a manner consistent with assessment methodology in the AIR. | Residual Effects to Other | Part C – Aboriginal |

| Application Information Requirements | | | Application | |
|--------------------------------------|---------------------|--|---|---|
| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| | | | Matters of Concern | Consultation, Section 10.2.1, page 10.2-258 |
| | | <ul style="list-style-type: none"> ▫ A description of how these matters of concern have been addressed from the perspective of the Aboriginal Groups and the Proponent. | Residual Effects to Other Matters of Concern | Part C – Aboriginal Consultation, Section 10.2.1, page 10.2-258 |
| Section 10.3 Page 96 | Issue Summary Table | <p>The Application will include:</p> <ul style="list-style-type: none"> ▫ A Summary Table that identifies Aboriginal Interests or other matters of concern to Aboriginal Groups that may be impacted by the proposed Project, and the measures to avoid, mitigate or otherwise manage the effect | Issue Summary Table | Part C – Aboriginal Consultation, Section 10.3 pages 258-344; Appendices C-P, Overview Tables |
| | | <ul style="list-style-type: none"> ▫ An appended Aboriginal Consultation Report, which contains comments received from Aboriginal Groups regarding this section of the Application. ▫ The Application will include both quantitative and qualitative information, as appropriate, when summarizing consultation activities. | Issue Summary Table | Part C – Aboriginal Consultation, Appendix B , Aboriginal Consultation Report 2 |
| Section 11.0 Page 99 | Public Consultation | <p>The Application will include a report on the results of implementation of the approved Public Consultation Plan including:</p> <ul style="list-style-type: none"> ▫ Background information: <ul style="list-style-type: none"> ▫ Identification of local governments, residents, property owners, and other rights holders who are potentially impacted by the proposed Project ▫ Maps of local government boundaries, private land, tenures/authorizations, or residences with respect to the proposed Project ▫ Background information about each potentially affected municipality and/or stakeholder group | Background Information | Part D – Public Consultation, Section 11.1, pages 11.1-1 to 11.1-19 |
| | | <p>The Application will include:</p> <ul style="list-style-type: none"> ▫ A summary of the past and planned public consultation activities ▫ A summary of any proposed changes to the approved Public Consultation Plan as a result of feedback from local governments, stakeholders or individuals, or experience from consultation to date ▫ A description of the key issues raised by the public that are relevant to the EA, the responses to those issues, and the status of their resolution | Summary of Past and Planned Consultation Activities | Part D – Public Consultation, Section 11.2, pages 11.2-20 to 11.2-41 |
| | | <p>The Application will include a summary table (Table 11.2-3 Key Areas of Interest for Public and Stakeholders) that identifies concerns raised by the public and the measures taken or proposed to avoid, reduce or mitigate those impacts.</p> | Summary of Public Feedback and Proponent Responses | Part D - Public Consultation, Section 11.2.3.5, Table 11.2-3, pages 11.2-34 to 11.2-41 |

| Application Information Requirements | | | Application | |
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| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 12.0 Page 101 | Management Plans | <p>The Application will include:</p> <p>A list of Management Plans for all phases of the proposed Project, including but not limited to:</p> <ul style="list-style-type: none"> ▫ Construction Environmental Monitoring Plan ▫ Air Quality and Dust Control Management Plan ▫ Agricultural Management Plan ▫ Archaeological and Heritage Resources Management Plan ▫ Contaminated Sites and Sediment Management Plan ▫ Emergency Response and Spill Contingency Plan ▫ Erosion and Sediment Control Plan ▫ Fish and Fish Habitat Management Plan ▫ Marine Mammal Management Plan ▫ Noise Management Plan ▫ Terrestrial Vegetation and Wildlife Management Plan ▫ Waste Management Plan ▫ Construction Traffic Management Plan ▫ Marine Access Management Plan ▫ Health and Safety Plan ▫ Operation Environmental Management Plan | Management Plans | Part E – Management Plans, Section 12.0, pages 12.1-1 to 12.5-17 |
| | | <p>A comprehensive description of the contents of each Management Plan, including the identification of any mitigation measures described in previous sections that will be included within the plans.</p> | Management Plans | Part E - Management Plans, Section 12.0, pages 12.1-1 to 12.5-17 |
| Section 13.0 Page 102 | Monitoring and Follow-up Programs | <p>The Application will include:</p> <ul style="list-style-type: none"> ▫ A description of the monitoring and follow-up programs the Proponent will implement, including their activities, objectives, and reporting. An Environmental Monitoring Plan will be developed to guide implementation of Project-related environmental management plans and associated monitoring programs, which are anticipated to include, but not be limited to: ▫ Air quality monitoring program ▫ Atmospheric noise monitoring program ▫ Water quality monitoring program ▫ Underwater noise monitoring program ▫ Wildlife monitoring program ▫ Fish and fish habitat monitoring program | Monitoring and Follow-up Programs | Part E – Monitoring and Follow-up Programs, Section 13.0, pages 13.2-1 to 13.2-4 |
| | | <ul style="list-style-type: none"> ▫ Reporting structure as identified within the environmental management plans, monitoring plans and EA Certificate Conditions | Compliance Monitoring and Reporting | Part E – Monitoring and Follow-up Programs, Section 13.2, pages 13.2-1 to 13.2-4 |

| Application Information Requirements | | | Application | |
|--------------------------------------|--------------------------------|---|--|---|
| AIR Section and Page No. | AIR Section Title | AIR Section Language | Application Section Title | Application Volume, Section, Sub-Section, Page No. |
| Section 14.0 Page 104 | Conclusions | The Application will: <ul style="list-style-type: none"> Provide the Proponent's conclusions regarding the potential for significant adverse effects on VCs from the Project. Request an EA Certificate for the proposed Project. | Conclusions | Part F – Conclusions, Section 14.0, pages 14.1-1 to 14.1-2 |
| Section 14.1 Page 104 | Summary of Residual Effects | The Application will summarize all potential residual effects, including cumulative residual effects, in a table format that depicts the potential effect, project phases, project activity or physical work linked to the effect, proposed mitigation and significance of effect on VCs. | Summary of Residual and Cumulative Effects | Part F – Conclusions, Section 14.1, pages 14.1-2 to 14.1-4 |
| Section 14.2 Page 104 | Summary of Mitigation Measures | The Application will include a table (Table 14.2-1 Proposed Mitigation Measures) that identifies the proposed measures to mitigate potential impacts to VCs as shown in Table 4 of the AIR. This information provides the foundation for the development of a Table of Conditions for the proposed Project, which would be appended to an EA Certificate, should one be issued. | Summary of Mitigation Measures | Part F – Conclusions, Section 14.2, pages 14.2-5 to 14.2-11 |
| Section 15.0 Page 105 | Reference Material | The Proponent will provide a list of reference material used in developing the Application. | Reference Material | Part F – Reference Material, Section 15.0, page 15-1 |
| Section 16.0 Page 107 | Appendices | The Application will include all appendices referenced in the Application. Information prepared by professionals and provided under their professional seal will be identified in the Application and the related sealed studies will be included in an Appendix. | Appendices | Part F – Appendices, Section 16.0 |

APPLICATION SUMMARY

Project Overview

The British Columbia (B.C.) Ministry of Transportation and Infrastructure (Ministry) is proposing the George Massey Tunnel Replacement Project (Project) to address current safety and congestion challenges, meet forecast population and employment growth, and ensure Highway 99 continues to serve regional, provincial, and national transportation needs.

Located on the Highway 99 corridor, the George Massey Tunnel (Tunnel) is an important link in the regional and provincial transportation system, carrying an average of 80,000 vehicles each day. It is a vital goods movement route that fuels our national, provincial, and regional economies, and is the main access route for businesses in City of Richmond (Richmond), Corporation of Delta (Delta), City of Surrey (Surrey), and Tsawwassen First Nation (TFN).

The Tunnel provides an essential link between the municipalities of Richmond and Delta, and connects to gateways such as the Vancouver International Airport (YVR), Douglas (Peace Arch) and Pacific Highway Canada–United States border crossings, BC Ferries' Tsawwassen terminal, Deltaport, and Boundary Bay Regional Airport.

The Project is designed to reduce congestion and improve travel times and reliability for commuters, transit, commercial vehicles, and tourists; improve safety; provide new travel options for cyclists and pedestrians; and provide capacity for improved transit. Proposed works include:

- Replacing the Tunnel with a new bridge spanning the Fraser River South Arm and Deas Island.
- Replacing the existing Westminster Highway, Steveston Highway, and Highway 17A interchanges.
- Widening Highway 99 to accommodate dedicated transit/high occupancy vehicle (HOV) lanes.
- Constructing integrated transit stops, dedicated ramps, and other transit-priority measures.
- Providing multi-use pathways on the bridge for cyclists and pedestrians.
- Decommissioning the Tunnel.

Environmental Assessment Process

The Project is being reviewed under Part 5 and Part 8 of the *Reviewable Projects Regulation* of the B.C. *Environmental Assessment Act* (B.C. *EAA*) because of the area of foreshore and submerged land likely to be disturbed during Tunnel decommissioning (i.e., greater than 2 ha) and the continuous distance over which extra lanes will be added to the existing public highway (i.e., greater than 20 km).

The B.C. Environmental Assessment Office (EAO) issued an Order under section 10 of B.C. *EAA* for the Project, on Dec 16, 2015, indicating the Project requires an environmental assessment, and an Order under section 11 of B.C. *EAA*, on January 7, 2016, describing the requirements for public consultation on the Project Description and Key Areas of Study document. A subsequent order under section 11 of B.C. *EAA* was issued on March 7, 2016, which described the scope of the Project and the scope of the assessment under B.C. *EAA*.

While the Project does not trigger a federal review under the *Canadian Environmental Assessment Act, 2012*, federal involvement in the Project will include consultation with Fisheries and Oceans Canada, Environment and Climate Change Canada, Transport Canada, and the Vancouver Fraser Port Authority, and issuance of a permit, approval, or authorization from these agencies as applicable.

Consultation

Since September 2012, the Ministry has been conducting technical analyses, raising awareness about the Project, engaging interested parties in dialogue, and responding to Project-related enquiries. Input obtained through these consultation and engagement processes has assisted in:

- Identifying the new bridge and associated highway improvements as the most appropriate approach to meeting Project objectives.
- Identifying complementary improvements that will support more sustainable modes of transportation in the Highway 99 corridor including transit, HOV, cycling and walking.
- Identifying environmental, socio-economic, health and heritage values to be considered and addressed during Project planning, environmental assessment, construction, and operation.

Project-related consultation has provided valuable insights from a broad range of organizations and individuals, including Aboriginal Groups, municipalities, Metro Vancouver, TransLink, the agricultural community, first responders, recreational groups, local businesses, local residents, cyclists, environmental groups, marine users, and other interested individuals.

Public Consultation Activities To Date

Ministry-led Consultation

The Ministry undertook three phases of Project consultation, each of which included open houses complete with display boards, discussion guides, and feedback forms:

- **Phase 1 Consultation: Understanding the Need** (November/December 2012) – Conducted early in the Project’s planning process, this phase of consultation sought input to gain a better understanding of travel needs and community considerations for developing replacement options. Congestion relief and economic growth were identified as the most important factors when considering solutions for the Tunnel. Doing nothing was not viewed as an option. This input was used to help develop a draft project scope and potential replacement scenarios.
- **Phase 2 Consultation: Exploring the Options** (March/April 2013) – Sought input on five potential replacement scenarios, which were developed in consideration of Phase 1 input, and the criteria to evaluate these scenarios. During this phase, participants indicated a preference for a new bridge along the existing Highway 99 corridor. They also wanted the Ministry to make sure the new crossing includes improvements for transit, cyclists and pedestrians.
- **Phase 3 Consultation: Project Definition Report** (December 2015/January 2016) – Sought input on the Project Definition Report including the proposed Project scope, Project success measures, funding options, and traffic management during construction. Input from the Phase 3 consultation was used to finalize the Project scope and support development of the Application.

Public communication measures have included the following:

- **Project Office, Website and Telephone Information Line:** A Project website (www.masseytunnel.ca) and a Project-related electronic database (e-database) were established in November 2012 to provide information about the Project, and a Project Office with full-time community relations staff was opened in Richmond in January 2014.
- **Stakeholder Outreach:** The Ministry has engaged in a variety of additional outreach activities with key stakeholders. This has involved over 100 presentations on request to business and community groups; and extensive meetings with key stakeholder groups to gather input in support of developing conceptual designs for the new crossing, including more than 85 meetings with City of Richmond and Corporation of Delta staff, and more than 30 meetings with Metro Vancouver staff.
- **Advertising and Media Relations:** The Ministry maintains an ongoing and open dialogue with the media, including interviews with the Minister of Transportation and Infrastructure, the Executive Project Director, and other Project spokespersons.

Pre-Application EA Consultation

As part of the pre-Application phase of the environmental assessment, the EAO held a public comment period from January 15, 2016 to February 15, 2016 that sought input on the Project Description and Key Areas of Study document for the Project. Two open houses, led by EAO, were held in support of the 31-day public comment period: on January 26, 2016 in Richmond and January 27, 2016 in Delta. Project and EAO staff and the Ministry's technical experts were present to answer questions on the Project. Following the public comment period, the Ministry provided responses to all questions raised, and these responses were posted on the provincial electronic Project Information Centre (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_home.html). Another 30-day public comment period led by the BC EAO will be held during the review of the Application. The Ministry will be required to respond to comments received at that time.

Aboriginal Consultation Activities To Date

Two phases of consultation with Aboriginal Groups that may be affected by the Project or that have Aboriginal Interests within the Project alignment, included those as set out on the section 11 Order, are complete: initial consultation (January 2013 to December 2015) and pre-Application consultation (December 2015 to July 2016).

The primary objective of the Ministry's Aboriginal consultation program is to maintain and, where possible, enhance respectful, positive, and productive relationships with Aboriginal Groups while meeting all applicable legal, policy, and regulatory requirements in relation to the Project. Additional objectives include providing opportunities for Aboriginal Groups to provide meaningful input for consideration in the environmental assessment and permitting processes and undertaking consultation with Aboriginal Groups in accordance with the Project's Aboriginal Consultation Plan. The Ministry provided participation funding in response to requests by all Schedule B Aboriginal Groups during initial Project-related discussions for funding to support participation in the Project review process, and undertook the appropriate planning and discussions with Aboriginal Groups.

To date, more than 80 meetings have taken place with Aboriginal Groups involved with the Project. The Ministry will continue to work with Schedule B Aboriginal Groups during the Application Review Phase to further refine community-specific consultation activities. Post Environmental Assessment Certificate (EAC) consultation will continue from issuance of the EAC to the date when all Project-related permits have been issued.

Environmental Effects Assessment Method

The Application follows a standard approach to selecting appropriate valued components (VCs) and assessing the Project's effects on each VC, consistent with EAO guidance. Any residual environmental effects of the Project are characterized using specific criteria (context, magnitude, geographic extent, duration, frequency and reversibility) that are defined for each VC (described in detail in the Application). The significance of Project-specific residual effects is determined for each VC using relevant thresholds, regulatory standards, or professional judgment. The significance of the Project's contribution to cumulative effects, in combination with other past, present or future projects and activities, is also assessed, where relevant.

The following VCs were selected for assessing Project-related effects:

- Environmental
 - Fish and fish habitat
 - At-risk amphibians
 - Marine mammals
 - Vegetation
 - Terrestrial wildlife
- Socio-economic
 - Land use
 - Marine use
 - Agricultural use
 - Visual quality
- Heritage
 - Heritage resources
- Health
 - Human health

In cases where potential Project-related effects on a component are part of a longer effects pathway, those components were classified as intermediate components (ICs) and studied to support the assessment of Project-related effects on the ultimate receptor VC. The following components were assessed as ICs:

- River hydraulics and river morphology
- Surface water and sediment quality
- Underwater noise
- Air quality
- Atmospheric noise
- Traffic

Key Conclusions

Key findings of the assessments conducted on each of the selected VCs and ICs are discussed.

River Hydraulics and River Morphology

Potential Project-related effects on river hydraulics and river morphology considered in the assessment include changes in water levels, velocities, and flow patterns (hydraulics) and subsequent influence on sedimentation and erosion (morphology). River hydraulics and river morphology was assessed as an IC to support the assessment of potential effects of the Project on fish and fish habitat, marine mammals, and marine use. Key findings of this assessment are presented below:

- The proposed bridge will have a clear-span over the Fraser River South Arm, which avoids potential changes to river hydraulics or river morphology resulting from the new structure.
- The Fraser River South Arm is dynamic with scour in the order of several meters during freshet and migrating sand dunes with heights of up to four metres.
- Removal of the Tunnel is not expected to result in changes in water level or affect flow splits between the main channel and nearby channels.
- Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.

- Tunnel removal is expected to result in temporary bed lowering between the Tunnel and the Lulu Island–Delta watermain; however, with monitoring and mitigation, no effect on the watermain is expected.
- Measures proposed to mitigate potential effects on the Lulu Island-Delta watermain include early engagement and coordination with Metro Vancouver, as well as riverbed monitoring and procedures for priority scour protection repairs if required.
- No Project-related long-term residual effects or cumulative effects on river hydraulics or river morphology are expected.

Sediment and Water Quality

Potential Project-related effects on sediment and water quality considered in the assessment include temporary increases in turbidity as a result of construction activities, including installation of bridge foundations along the edge of Deas Slough, Tunnel removal, and decommissioning of the Deas Slough Bridge. Sediment and water quality was assessed as an IC to support assessment of potential Project-related effects on fish and fish habitat, marine mammals, vegetation, and at-risk amphibians. Key findings of the assessment are presented below:

- The new bridge will have a clear-span, which reduces potential Project-related effects on sediment and water quality in the Fraser River South Arm.
- Minor, temporary increases in turbidity in the Fraser River South Arm, as compared with baseline conditions, are expected during Tunnel decommissioning.
- No appreciable change in water quality related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated.
- Applying mitigation, including timing windows for undertaking in-stream works, will avoid or minimize potential effects of Project-related changes in water quality on fish and fish habitat.
- Elements of the Project design, including the use of biofiltration ponds, will provide a benefit to ambient water and sediment quality in the Fraser River by improving the level of treatment of surface runoff from Highway 99.
- No Project-related post-construction residual effects or cumulative effects on sediment and water quality are expected.

Underwater Noise

The Project involves in-water or near-shore construction activities such as pile driving, soil stabilization, and Tunnel removal that have the potential to influence underwater noise levels in the Fraser River South and Deas Slough, which could affect fish and marine mammals in these waters. Underwater noise was assessed as an IC to support the assessment of fish and fish habitat and marine mammals. Key findings of this assessment are summarized below:

- The Project area is highly developed and existing underwater noise levels in the Fraser River, dominated by noise from vessels transiting the river, are relatively high.
- The proposed bridge will have a clear-span over the Fraser River and Deas Slough, minimizing instream works and the potential for underwater noise effects associated with construction.
- Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Underwater noise can be mitigated effectively by scheduling construction activities in a manner that minimizes potential effects.
- Applying mitigation, including underwater noise monitoring and management during construction, will minimize the potential for Project-related changes in underwater noise conditions to affect fish or marine mammals.
- No post-construction residual effects or cumulative effects on underwater noise conditions are expected.

Fish and Fish Habitat

The Fraser River South Arm, tidal sloughs, and upland watercourses support a range of fisheries values. The Ministry has taken steps during Project planning and design, including proposing a clear span structure across the Fraser River South Arm and no direct run-off from the bridge to the river, to avoid or minimize Project-related impacts on fish and fish habitat. Potential effects on fish and fish habitat include those related to potential changes in water quality, underwater noise, and riparian and aquatic habitat as a result of Project-related construction activities.

Key findings of the assessment of the assessment of potential Project-related effects on fish and fish habitat are summarized below:

- The small area of fish habitat affected by the Project will be offset by proposed habitat enhancements, including restoring Green Slough to its historic alignment, resulting in a net environmental benefit for fish and fish habitat.

- Mitigation, including timing windows for undertaking in-stream works and other measures outlined in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed.
- Given the disturbed nature of much of the Project alignment, revegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by:
 - Improvements to local water quality through Project-related improvements in stormwater management.
 - Removal of non-native species.
 - Replanting with species that provide habitat value for fish and wildlife.
- Adherence to prescribed least-risk timing windows and implementation of standard industry practices and mitigation measures will effectively minimize effects on fish in the Project area such that there is no anticipated effect on population integrity.
- No overlap or interaction of Potential Project-related effects with effects of other projects or activities is expected; thus no cumulative effects are anticipated.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

At-risk Amphibians

The Project is located primarily within the existing, previously disturbed Highway 99 right-of-way, and suitable habitat within the Project alignment is limited. Potential effects on at-risk amphibians include those related to potential changes in water quality in upland watercourses.

Key findings of the Project-related at-risk amphibian assessment include the following:

- At-risk amphibians were not detected within the Project alignment during field studies undertaken in 2014 and 2015. The potential for at-risk amphibians to occur within the Project alignment is low.
- Applying mitigation, including least-risk timing windows, and adherence to standard practices for undertaking in-stream works and highway maintenance activities, will ensure that potential Project-related effects on at-risk amphibians are addressed.
- No Project-related residual or cumulative effects on at-risk amphibians are expected.

Marine Mammals

Marine mammals, specifically harbour seals and sea lions, are known to use marine areas within and adjacent to the Project alignment. Other species of conservation interest, including southern resident killer whales, do not occur in the Fraser River. Potential Project-related effects on marine mammals are primarily associated with underwater noise during in-stream construction activities, including Tunnel decommissioning. Key findings of the assessment of potential Project-related effects on marine mammals are summarized below:

- Underwater noise in the Fraser River South Arm from existing sources currently exceed thresholds for disturbance to marine mammals approximately 20% of the time.
- The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.
- Best management practices will be applied to activities such as impact pile driving to ensure sound thresholds for the protection of marine mammals are adhered to. Applying such measures to mitigate and monitor Project-related underwater noise will ensure that potential effects on marine mammals are effectively addressed.
- Project-related construction activities are not anticipated to result in population-level effects to marine mammals, including species at risk, and no residual effects on marine mammals are anticipated.
- No Project-related residual or cumulative effects on marine mammals are expected.

Vegetation

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development. There are, however, small portions of the Project alignment that support native vegetation, and an assessment of potential Project-related effects on vegetation was undertaken. An overview of the key findings of this assessment is provided below:

- The Project alignment has limited potential to support terrestrial and wetland plant species and ecosystems, including those considered to be (provincially) at-risk.
- Project components and activities will be primarily located within the existing Highway 99 ROW, where the vegetation consists mainly of grassy, mowed verges.
- No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.
- Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily a cattail marsh and estuary marsh, which occurs in the vicinity of the Project.

- Creating comparable habitat within the Project alignment will offset the unavoidable potential Project-related effect, which is limited to a small reduction in area of the cattail marsh that overlaps with Project components.
- Applying best practices such as flagging of at-risk ecosystems to avoid encroachment during construction and replanting of disturbed areas with native species will ensure that Project-related effects on vegetation are effectively addressed.
- With the application of mitigation, no Project-related residual or cumulative effects on vegetation are expected.

Terrestrial Wildlife

Terrestrial wildlife along Highway 99 consists primarily of common species of raptors, riverine birds, and small mammals. Potential effects on terrestrial wildlife, including construction-related effects on habitat, and disturbance effects and collision risk during the operational phase, were assessed. Key findings of this assessment are summarized below:

- Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge.
- No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.
- The application of best practices during future stages of design and construction will largely avoid or mitigate Project-related effects on wildlife and wildlife habitat.
- Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed.
- Installation of flight deflectors such as hedgerows at appropriate locations along the highway will mitigate potential Project-related collision risk for barn owls.
- Nesting opportunities provided by the new bridge will offset the loss of barn swallow nesting habitat due to removal of the Deas Slough Bridge.
- No significant Project-related residual effects or cumulative effects on terrestrial wildlife are expected.

Air Quality

Recent and projected trends in regional air quality in the Lower Fraser Valley indicate that, for most parameters, air quality has improved as a result of reductions in emissions from vehicles as new emission control technologies are phased in. This trend in improvements in air quality are expected to continue in the future, with or without the Project; however, Project-related reduction in idling due to congestion and consequent reduction in emissions, as well as better dispersion of vehicle emissions from the bridge are anticipated to result in further improvement in air quality.

Key findings of the Project-related air quality assessment are summarized below:

- Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include:
 - A 35 % reduction in particulate matter emissions, as compared with a 14 % reduction without the Project.
 - A 47 % reduction in volatile organic compound (VOC) emissions, as compared with a 40 % reduction without the Project.
- No exceedances of the current most-stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.
- The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.
- Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.
- Construction-related effects on air quality will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation infrastructure projects in the Lower Mainland.
- Potential effect of Project-related construction on air quality are expected to be low in magnitude, and confined to active construction areas. All effects will be temporary, of short-duration, and fully reversible.
- No Project-related post-construction residual effects or cumulative effects on air quality are expected.

Atmospheric Noise

Ambient noise levels in the Project area are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Trains, aircraft, marine, and agricultural activities also contribute to ambient noise in and around the Project area. However, there are areas along the corridor where noise conditions will change as a result of Project-related construction and operation. Key findings of the assessment of such potential Project-related changes are summarized below:

- Construction-related noise can be addressed by applying mitigation and best practices, including the following, that have proven to be effective on other recent transportation infrastructure projects in the Lower Mainland:
 - Equipment and activity restrictions to minimize noise emissions.

- Noise monitoring program.
- Processes for community communication, engagement, and adaptive management.
- Residual effects during construction will be temporary and vary from low to high depending on the distance from the construction site and nature of construction activity. Effects will be short-term during construction of interchanges etc., and of moderate term during pile installation for the new bridge. All construction-related effects on atmospheric noise will be temporary and fully reversible.
- Appropriate mitigation measures will be implemented at select locations to address Project-related change in noise levels during operation.
- With the application of mitigation, ambient noise levels during operation are expected to be lower than current levels—on average by 4 dBA at residences and 1.5 dBA at schools and places of worship.
- Noise levels at parks adjacent to the Project, including Deas Island Regional Park, are expected to increase by varying degrees dependent on the distance from the highway, but will generally remain below levels that warrant mitigation consideration for residential and institutional use.
- No cumulative changes of readily measurable or perceptible magnitude are predicted within the Project alignment.

Traffic

The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. Changes in traffic conditions, during construction and operation, have been estimated to support the assessment of potential effects on terrestrial wildlife, air quality, atmospheric noise, land use, and human health. Key findings of this assessment are summarized below:

- Impacts on traffic during Project construction will be minimized through the implementation of recognized mitigation measures and best management practices.
- Temporary, localized changes in traffic volume, mode share, and travel time and reliability can be anticipated during construction as construction-related traffic interacts with regular flows. These low to moderate magnitude changes could occur frequently during construction, and are expected to be short to moderate term in duration. All construction-related effects are fully reversible.
- During operations, the Project will provide travel time savings of 25-35 minutes per day for commuters, improve safety with a forecast 35% reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling.

- As proposed, Project-related improvements, which include better travel mode options, and tolling will help moderate traffic growth while effectively serving forecast demand at the crossing.
- The Project will have a positive effect on future traffic conditions along the Highway 99 corridor.

Marine Use

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, sorting and booming, as well as commercial, recreational and aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place in the vicinity of the Project.

Key findings of the assessment of Project-related effects on marine include the following:

- The proposed clear span crossing of the Fraser River will avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span, improving navigation in and out of the slough.
- Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.
- Working with Aboriginal Groups and key stakeholders to develop a Marine Access Management Plan will mitigate temporary impacts to marine use associated with Project construction.
- Key mitigation considerations to ensure marine use activities can continue in a safe manner during Project construction include:
 - Communications protocols to establish and advise of in-stream construction activities.
 - Lighting and marking for safe navigation.
 - Establishing navigation protection zones during construction to avoid or minimize impacts on marine use.
- Potential construction-related residual effects of the Project on marine use are considered to be low to moderate in magnitude, local in extent, short-term in duration, occasional in frequency, and reversible.
- Temporary residual effects of Project construction on marine use are not considered significant.
- No overlap or interaction of Potential Project-related effects with effects of other projects or activities is expected; thus no cumulative effects are anticipated.
- Project-related changes are expected to have a positive effect on marine use in Deas Slough during the operational phase.

Land Use

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta. Key findings of the land use assessment are summarized below:

- The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way.
- Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill.
- The Project is consistent with local and regional land use plans, will support denser, land-intensive, high-quality forms of development along the Highway 99 corridor, consistent with such plans.
- The Project is not anticipated to affect the planned distribution of regional population and employment growth predicted in Metro Vancouver's regional growth strategy, overall regional population growth and distribution or current trends in industrial land use and development.
- Once the new bridge becomes operational, the recreational experience on adjacent land is expected to change due to:
 - Improved connectivity across Deas Island Regional Park resulting from removal of the Tunnel portals.
 - Improvements in local air quality, Deas Island shoreline restoration and revegetation of areas that currently support highway infrastructure.
 - Shading adjacent to the bridge, overhead noise, and changes in local viewscales.
- The Project will not result in changes to existing land use beyond the small amounts of land that are required outside of the existing right-of-way.
- Potential temporary effects on existing land use during construction will be addressed by developing and implementing a Construction Traffic Management Plan.
- No significant Project-related residual effects or cumulative effects on land use are expected.

Agricultural Use

Agriculture is the predominant use of land adjacent to the Highway 99 ROW in Richmond and Delta. Agricultural land borders about two thirds of the Project alignment. Potential Project-related effects on agricultural use include requirements for agricultural land as well as indirect effects, such as changes in drainage and other farm infrastructure. Key findings of the Project-related agricultural use assessment are presented below:

- The Project has been designed to accommodate all proposed works predominantly within the Highway 99 ROW, minimizing the need for land acquisitions to the extent possible.
- The Ministry has identified suitable land parcels that will be made available for agricultural use to offset the acquisition of small portions of farmland for the Project. These parcels are located adjacent to existing farm fields and can be restored to comparable land capability, enhancing their agricultural potential.
- Project-related offsetting is expected to result in a net gain of land for agricultural use.
- The Project is expected to result in potential changes to the boundaries of a small number of farms. Potential effects associated with these changes will be mitigated through measures such as parcel consolidation and using elevated guideways to minimize land requirements.
- Agricultural operations along the Project alignment are expected to benefit from Project-related improvements to irrigation and drainage systems as well as increased reliability in getting agricultural goods to market.
- Potential residual effects of the Project are limited to changes in parcel boundaries of three farm fields. These effects can be largely offset by consolidating the parcels with adjacent properties such that the parcels can continue to be farmed.
- No overlap or interaction of Project-related residual effect with effects of other projects or activities is expected; thus, no cumulative effects are expected.
- No significant Project-related residual effects or cumulative effects on agricultural use are expected.

Visual Quality

The new bridge will add visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges has the potential to change visual conditions at these locations. Key findings of the assessment of potential Project-related effects on visual quality are presented below:

- At distances greater than one kilometre, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers.

- Vegetated buffers will minimize visual effects to residential developments within close proximity to the bridge in Delta.
- Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.
- After the implementation of mitigation measures, residual changes in conditions are predicted at a small number of viewpoints located in the immediate vicinity of the new bridge.
- Overall, the new bridge is expected to result in changes in visual conditions that are moderate in magnitude and site-specific in extent.
- No overlap or interaction of Potential Project-related effects with effects of other projects or activities is expected; thus no cumulative effects are anticipated.
- No significant Project-related residual effects or cumulative effects on visual quality are expected.

Heritage Resources

The Project is located in an area where substantial historical development has occurred and the majority of the local assessment area is characterized as having low archaeological potential.

Key findings of Project-related assessment of heritage resources are summarized below:

- The Project is located in an area where substantial historical development has occurred, and the majority of the Project alignment is characterized as having low archaeological potential.
- No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.
- The development and implementation of an Archaeological and Heritage Resources Management Plan, which will include a chance-find procedure, will avoid impacts to previously unknown or unidentified heritage resources that may be encountered during Project construction and operation.
- No Project-related residual effects or cumulative effects on heritage resources are expected.

Human Health

A human health risk assessment (HHRA) was used to support the assessment of health. The HHRA focused on health considerations associated with Project-related changes in air quality and noise conditions. The Ministry also undertook a health impact assessment (HIA) to evaluate the influence of the Project on broader determinants of human health. Key findings of studies related to health are summarized below:

- Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health.
- Implementing mitigation measures to address traffic-related noise during Project operation will avoid increases in human health risk, and in some cases will result in improvements over current conditions.
- Proven mitigation measures, effectively used during the construction of projects such as the South Fraser Perimeter Road and Port Mann/Highway 1 Improvement project, will be implemented to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
- The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options.
- The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased opportunities for active and public transportation, improved traffic safety, improved connectivity and access, improved emergency response, and economic development opportunities.
- Future Project-related engagement with Aboriginal Groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.
- Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations and emergency response.
- With the application of mitigation, no Project-related adverse effects or cumulative effects on human health are expected.

Accidents and Malfunctions

The primary environmental effect that could result from accidents and malfunctions that may occur during Project-related construction and operation would be the release of deleterious substances into terrestrial or aquatic habitats. Mitigation measures, including Project design, implementation of a Construction Environmental Management Plan, and contingency measures (e.g., spill prevention and emergency response training, erosion control), will minimize the potential for adverse effects resulting from accidents and malfunctions.

Effects of the Environment on the Project

Natural events with the potential to affect the Project (e.g., damage to highway and bridge infrastructure), lead to traffic closures and adversely affect environmental components include erosion and scour, extreme weather, flooding, seismic events, and climate change. The Project will be designed, constructed, and operated in a manner that addresses potential adverse effects of climate change, including temperature rise, increased precipitation, and sea-level rise, on Project components. Adherence to appropriate engineering design standards will ensure that potential effects of the environment on the bridge and highway improvements will not affect safety or functionality.

Aboriginal Consultation

Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.

Mitigation measures to address potential Project-related effects on ICs and VCs associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.

In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an EAC. Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests, and potential project agreements.

Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.

Conclusion

The proposed Project is being advanced in order to address substantial traffic and safety challenges in the Highway 99 corridor that affect the efficient movement of people and goods within the region. Addressing these challenges will result in a number of economic, environmental, social and health benefits including:

- Travel time and reliability improvements for all users
- Improvements in local air quality
- Reductions in vehicle collisions and safety risk
- Improvements in access and mobility for local agricultural operations
- Improvements in access to transit, carpooling, and active modes of transportation
- Economic benefits including employment and economic growth

In addition to addressing traffic challenges in the Highway 99 corridor, the Project represents an opportunity to enhance environmental values that have been affected by previous development including restoration of Green Slough to its historic alignment and enhancements to habitat in Deas Slough.

The environmental assessment undertaken for the Project identified other environmental and socio-community values that may potentially be affected by Project construction and operation. Where applicable, steps have been taken during Project planning to avoid such effects. Additional mitigation during Project design, construction, and operation is proposed to address potential adverse effects. After mitigation implementation, including potential offsetting strategies and monitoring programs, the Ministry has assessed that Project construction and operation will not result in significant adverse effects.

Acronyms and Abbreviations

| Term | Description |
|-------------|--|
| 2-D | two-dimensional |
| AADT | annual average daily traffic |
| AANDC | Aboriginal Affairs and Northern Development Canada |
| AAOR | average automobile occupancy rate |
| AAQC | Ambient Air Quality Criteria (for Ontario) |
| AAQO | Ambient Air Quality Objectives (for Alberta) |
| AAWDT | annual average weekday traffic |
| AAWET | annual average weekend traffic |
| ADCP | Acoustic Doppler current-profiler |
| ADT | average daily traffic |
| AENV | Alberta Environment |
| AFB | Alex Fraser Bridge |
| AIR | Application Information Requirements |
| AIS | alien invasive species |
| ALC | Agricultural Land Commission |
| ALR | Agricultural Land Reserve |
| ALRT | advanced light rapid transit |
| AMAR | autonomous multi-channel acoustic recorder |
| AOA | archaeological overview assessment |
| Application | Application for an Environmental Assessment Certificate under the B.C. <i>Environmental Assessment Act</i> |
| AQHI | Air Quality Health Index |
| AQMP | air quality management plan |
| ARB | Air Resource Board |
| ARDSA | Agri-Food Regional Development Subsidiary Agreement |
| ASIR | Age-standardized incidence rate |
| ASMR | Age-standardized mortality rate |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| AWCR | Agricultural Waste Control Regulation |
| B.C. | British Columbia |
| BAM | baseline adjustment method |

| Term | Description |
|-----------------|--|
| BCEAA | British Columbia <i>Environmental Assessment Act</i> |
| BCHCA | British Columbia <i>Heritage Conservation Act</i> |
| BCMCA | British Columbia Marine Conservation Analysis |
| BCR | BC Railway Company Ltd. |
| BCTC | British Columbia Treaty Commission |
| BCWQG | British Columbia Water Quality Guidelines |
| BEC | Biogeoclimatic Ecosystem Classification |
| BIEAP | Burrard Inlet Environmental Action Program |
| BLIER | Base Level Industrial Emission Requirement |
| BMP | best management practices |
| BNSF | Burlington Northern Santa Fe Railway |
| c/mvk | collisions per million vehicle kilometres |
| CAC | criteria air contaminant |
| CCIP | Container Capacity Improvement Program (Port of Vancouver) |
| CCME | Canadian Council of Ministers of the Environment |
| CDC | Conservation Data Centre |
| CEA Agency | Canadian Environmental Assessment Agency |
| CEAA 2012 | <i>Canadian Environmental Assessment Act, 2012</i> |
| CEMP | Construction Environmental Management Plan |
| CEPA 1999 | <i>Canadian Environmental Protection Act, 1999</i> |
| CEQG | Canadian Environmental Quality Guidelines |
| CF | continuous frequency |
| CH ₄ | Methane |
| CHBDC | Canadian Highway Bridge Design Code |
| CHS | Canadian Hydrographic Service |
| CMD | climatic moisture deficit |
| CMHC | Canada Mortgage and Housing Corporation |
| CMN | Community Mapping Network |
| CN Rail | Canadian National Railway |
| CNG | compressed natural gas |
| CO | carbon monoxide |
| CO ₂ | carbon dioxide |

| Term | Description |
|--------------------|---|
| CO ₂ -e | carbon dioxide equivalent |
| COPC | chemicals or contaminants of potential concern |
| COPD | chronic obstructive pulmonary disease |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| CPI | Consumer Price Index |
| CRA | commercial, recreational, and Aboriginal |
| CRB | concrete roadside barrier |
| CSA | Canadian Standards Association |
| CSR | <i>Contaminated Sites Regulation</i> |
| CTA | Canadian Transportation Agency |
| CTMP | Construction Traffic Management Plan |
| CWS | Canadian Wildlife Service |
| CZBB | Boundary Bay Airport |
| dB | Decibel |
| dBA | A-weighted decibel |
| DFO | Fisheries and Oceans Canada |
| DHV | design hourly volume |
| DIEP | Delta Irrigation and Enhancement Project |
| DNA | deoxyribonucleic acid |
| DO | dissolved oxygen |
| DPM | diesel particulate matter |
| DWT | dead-weight tonne |
| EA | environmental assessment |
| EAC | Environmental Assessment Certificate |
| EAO | Environmental Assessment Office |
| EC | Environment and Climate Change Canada |
| eDNA | environmental DNA |
| EIA | environmental impact assessment |
| EIS | environmental impact statement |
| EMME2 | bilingual acronym for multimodal equilibrium/équilibre multimodal |
| EMP | environmental management plan |
| EPH | extractable petroleum hydrocarbons |

| Term | Description |
|-------------|---|
| ESA | environmentally sensitive area |
| FAL | freshwater aquatic life |
| FF | frequent frequency |
| FFT | fast Fourier transform |
| FHWA | U.S. Federal Highway Administration |
| FHWG | U.S. Fisheries Hydroacoustic Working Group |
| FISS | Fisheries Information Summary System |
| FPHLCC | First Peoples' Heritage, Language and Culture Council |
| FPPA | <i>Farm Practices Protection Act</i> |
| FPWGAQ | Federal Provincial Working Group on Air Quality |
| FREMP | Fraser River Estuary Management Program |
| FRL | Fraser River Lowland |
| <i>FRPA</i> | <i>Forest and Range Protection Act</i> |
| FTA | U.S. Federal Transit Administration |
| FTE | Full –time equivalent |
| FWRAM | Full Waveform Range-dependent Acoustic Model |
| GDP | gross domestic product |
| GHG | greenhouse gas |
| GIF | ground inspection form |
| GIS | geographic information system |
| GPS | global positioning system |
| GSC | Geological Survey of Canada |
| GVRD | Greater Vancouver Regional District |
| GWP | Global Warming Potential |
| HA | highly annoyed |
| HC | Health Canada |
| <i>HCA</i> | <i>Heritage Conservation Act</i> |
| HE | high likelihood of effect |
| Hemmera | Hemmera Envirochem Inc. |
| HFC | Hydrofluorocarbon |
| HHRA | Human Health Risk Assessment |
| HIA | Health Impact Assessment |

| Term | Description |
|-------------|---|
| HM | high magnitude |
| HOV | high-occupancy vehicle |
| HT | hearing threshold |
| Hz | Hertz |
| IARC | International Agency for Research on Cancer |
| IC | intermediate component |
| IISD | International Institute for Sustainable Development |
| ILRR | Integrated Land and Resource Registry |
| IPCC | International Panel for Climate Change |
| ISCMV | Invasive Species Council of Metro Vancouver |
| ISO | International Standardization Organization |
| ISQG | interim sediment quality guidelines |
| ITS | Intelligent Transportation System |
| IUCN | International Union for Conservation of Nature |
| KG | kilograms |
| KM | kilometres |
| LAA | local assessment area |
| LFR | lower Fraser River |
| LFV | lower Fraser Valley |
| L_n | nth percentile exceedance level |
| LNG | liquefied natural gas |
| LSA | local study area |
| MAFF | B.C. Ministry of Agriculture, Food and Fisheries |
| MAMP | Marine Access Management Plan |
| MARR | B.C. Ministry of Aboriginal Relations and Reconciliation |
| <i>MBCA</i> | <i>Migratory Birds Convention Act</i> |
| MCRD | B.C. Ministry of Community and Regional Development |
| MELP | B.C. Ministry of Environment, Lands and Parks |
| FLNR | B.C. Ministry of Forests, Lands and Natural Resource Operations |
| Ministry | B.C. Ministry of Transportation and Infrastructure |
| <i>MMR</i> | <i>Marine Mammal Regulations</i> |
| MOE | B.C. Ministry of Environment |

| Term | Description |
|------------------|--|
| MONM | Marine Operations Noise Model |
| MoTI | Ministry of Transportation and Infrastructure |
| MOVES | Motor Vehicle Emissions Simulator |
| MPDCA | British Columbia Marine and Pile Driving Contractors Association |
| MPOI | maximum point of impingement |
| MRN | major road network |
| MV | Metro Vancouver |
| MWLAP | B.C. Ministry of Water, Lands and Parks |
| N ₂ O | nitrous oxide |
| NAAQS | National Ambient Air Quality Standards (U.S.) |
| NAPS | National Air Pollution Surveillance |
| NEI | National Emissions Inventory |
| NH ₃ | Ammonia |
| NHC | Northwest Hydraulic Consultants Ltd. |
| NM | negligible magnitude |
| NMFS | National Marine Fisheries Service (U.S.) |
| NO | nitric oxide |
| NO ₂ | nitrogen dioxide |
| NO _x | A generic term for the mono-nitrogen oxides NO and NO ₂ |
| <i>NPA</i> | <i>Navigation Protection Act</i> |
| NPP | Navigation Protection Program |
| NRC | National Research Council Canada |
| NRC | United States National Research Council |
| NTU | nephelometric turbidity units |
| NWA | National Wildlife Area |
| NWAFC | Northwest and Alaska Fisheries Center |
| O ₃ | Ozone |
| OC | organic carbon |
| OCP | Official Community Plan |
| OEMP | Operations Environmental Management Plan |
| OLM | Ozone Limiting Method |
| PAH | polycyclic aromatic hydrocarbon |

| Term | Description |
|-------------------|--|
| PCB | polychlorinated biphenal |
| PCIC | Pacific Climate Impacts Consortium |
| PCR | polymerase chain reaction |
| PEP | Provincial Emergency Program |
| PET | potential evapotranspiration |
| PFCs | Perfluorocarbons |
| PIEVC | Public Infrastructure Engineering Vulnerability Committee |
| PIT | Project interaction table |
| PM | particulate matter |
| PM ₁₀ | inhalable particulate matter; particulate matter of 10 microns or less in diameter |
| PM _{2.5} | particulate matter of 2.5 microns or less in diameter, also referred to as respirable particulate matter |
| PSD | particle size distribution |
| PTS | permanent threshold shift |
| PWGSC | Public Works and Government Services Canada |
| PoV | Port of Vancouver |
| PY | Person year |
| QEP | Qualified Environmental Professional |
| qPCA | quantitative polymerase chain reaction |
| QRP | qualified registered professional |
| R.S.B.C. | Revised Statute of British Columbia |
| R.S.C. | Revised Statute of Canada |
| RAA | regional assessment area |
| RFP | request for proposal |
| RFQ | request for qualification |
| RGS | Regional Growth Strategy |
| RISC | Resource Inventory Standards Committee |
| ROW | right-of-way |
| RQ | risk quotient |
| RSA | regional study area |
| RTM | Regional Transportation Model |
| RTS | Regional Transportation Strategy |

| Term | Description |
|-----------------|---|
| RVP | Reid vapour pressure |
| S.B.C. | Statute of British Columbia |
| S.C. | Statute of Canada |
| SARA | <i>Species at Risk Act</i> |
| SCBC | Stewardship Centre for British Columbia |
| SD | standard deviation |
| SDG | Steer Davies Gleave |
| SE | specific effect |
| SEL | sound exposure level |
| SF ₆ | sulphur hexafluoride |
| SFPR | South Fraser Perimeter Road |
| SI | International System of Units |
| SL | source level |
| SO ₂ | sulphur dioxide |
| SOG | Strait of Georgia |
| SO _x | sulphur oxide |
| SPL | sound pressure level |
| SQG | Sediment quality guidelines |
| SRKW | southern resident killer whale |
| SSP | sound speed profile |
| TC | Transport Canada |
| TDM | transportation demand management |
| TEK | Traditional Ecological Knowledge |
| TEM | terrestrial ecosystem mapping |
| TEU | twenty-foot equivalent unit |
| TK | traditional knowledge |
| TLUS | Traditional Land Use Studies |
| TNM | traffic noise model |
| TOC | total organic carbon |
| TSP | total suspended particulates |
| TSS | total suspended solids |
| TTS | temporary threshold shift |

| Term | Description |
|-------------|---|
| TU | traditional use |
| TV | Technical Volume |
| Tunnel | George Massey Tunnel |
| U.S. | United States |
| U.S. EPA | United States Environmental Protection Agency |
| UTM | Universal Transverse Mercator geographic coordinate system |
| VAFFC | Vancouver Airport Fuel Facilities Corporation |
| VC | valued component |
| VFPA | Vancouver Fraser Port Authority |
| VHT | vehicle hours traveled |
| VKT | vehicle kilometres traveled |
| VLI | Visual Landscape Inventory |
| VOC | volatile organic compound |
| VQ | visual quality |
| VQC | visual quality class |
| VSC | visual sensitivity class |
| WAL | Wakefield Acoustics Ltd. |
| WARS | Wildlife Accident Reporting System |
| WCEL | West Coast Environmental Law |
| WHO | World Health Organization |
| WMA | wildlife management area |
| WQG | water quality guideline |
| WRAP | Western Regional Air Partnership |
| WRF-NMM | Weather Research and Forecasting Nonhydrostatic Mesoscale Model |
| YVR | Vancouver International Airport |

Symbols and Units of Measure

| Term | Description |
|-------------------|-------------------------------------|
| 3-D | three-dimensional |
| °C | degrees Celcius |
| dS/m | deci-Siemens per metre |
| H | hour |
| Ha | hectare |
| Hz | hertz |
| kg | kilogram |
| kHz | kilohertz |
| km | kilometre |
| km ² | square kilometres |
| km/h | kilometres per hour |
| Kts | knots |
| L | litre |
| M | metre |
| m ³ | cubic metre |
| Min | minute |
| ml | millilitre |
| ms | millisecond |
| ppb | parts per billion |
| ppm | parts per million |
| ppt | parts per thousand |
| rms | root-mean-square |
| s | second |
| μ | micron or micrometre |
| μg/m ³ | microgram per cubic metre |
| μPa | micropascal (derived pressure unit) |
| μS/cm | microsiemens per centimeter |
| VkmT | vehicle kilometres travelled |

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Part A – Introduction

1.0 Overview of Proposed Project and Proponent

Introduction

The British Columbia (B.C.) Ministry of Transportation and Infrastructure (Ministry) is proposing the George Massey Tunnel Replacement Project (Project) to address current safety and congestion challenges, meet forecast population and employment growth, and ensure Highway 99 continues to serve regional, provincial, and national transportation needs.

The proposed Project involves replacing the George Massey Tunnel (Tunnel) with a new bridge spanning the Fraser River South Arm and Deas Island, decommissioning the Tunnel, and improving Highway 99 between Bridgeport Road in Richmond and Highway 91 in Delta.

The purpose of this section of the Application is to provide information to support the assessment of the proposed Project, including:

- Information on the Project Proponent.
- The Project purpose and rationale, including overview of key Project drivers.
- Detailed information on key Project elements, including activities to be undertaken to facilitate construction and operation of the Project.
- Additional Project planning considerations including: overview of the proposed tolling framework, cost estimates for construction and operations, and business case for the Project.
- A summary of social, economic and environmental benefits that will result from the Project.

Project Proponent

The Project proponent is the B.C. Ministry of Transportation and Infrastructure, and if the Project is approved, an Environmental Assessment Certificate (EAC) will be awarded to and held by the Ministry. The Ministry plans transportation networks, provides transportation services and infrastructure, develops and implements transportation policies, and administers related acts and regulations. The Ministry opens up B.C. through innovative, forward-thinking strategies that move people and goods safely, and fuel the provincial economy. Improvement of vital infrastructure is a key goal, along with enhancing the competitiveness of B.C.'s transportation industries, reducing transportation-related greenhouse gas emissions and providing B.C. with a safe and reliable highway system.

Name of Proponent: B.C. Ministry of Transportation and Infrastructure

Primary Contact: Geoff Freer

Title: Executive Project Director

Address: 2030 – 11662 Steveston Highway
Richmond, B.C. V7A 1N6

Telephone: 1-855-562-7739

Email: masseytunnel@gov.bc.ca

Project Website: <https://engage.gov.bc.ca/masseytunnel/>

An environmental assessment team developed this Application for an EAC under the B.C. *Environmental Assessment Act*, led by the following team members:

- Malcolm Smith, Environmental Director
- Bindu Chembrakkalathil, Environmental Assessment Manager

Technical information within this Application has been developed with the input of discipline leads with expertise in relevant disciplines as summarized in **Table 1-1**.

Table 1-1 Environmental Assessment Discipline Leads

| Application Section Number | Responsible Team Member and Qualifications | Role on Project/Area of Technical Expertise |
|--------------------------------------|---|--|
| 2.0, 11.0 | Pamela Ryan, B.Com. (TLOG) | Communications and Public Consultation |
| 4.1 | Matt Gellis, P.Eng. | River Hydrology and Morphology |
| 4.2, 7.1 | Doug Bright, Ph.D., R.P.Bio., P.Biol. | Human Health and Water Quality and Sediment |
| 4.3 | Alex MacGillivray, M.Sc. | Underwater Noise |
| 4.4 | Jim Roberts, R.P.Bio. | Fish and Aquatics |
| 4.5 | Jared Hobbs, M.Sc., R.P.Bio. | At Risk Amphibians |
| 4.6 | Sonya Meier, M.Sc., R.P.Bio. | Marine Mammals |
| 4.7, 4.8 | Charlie Palmer, M.Sc., P.Biol., R.P.Bio. | Vegetation and Wildlife |
| 4.9 | Alex Schutte, B.Sc. | Air Quality |
| 4.10 | Clair Wakefield, M.A.Sc., P. Eng. | Atmospheric Noise |
| 5.1 | Neil Valsangkar, M.Sc., P. Eng. | Traffic |
| 5.2 | Joost Meyboom, Dr.sc.tech., P.Eng. | Marine Use |
| 5.3 | Ruth Hardy, M.Sc., P.Ag. | Land Use |
| 5.4 | Hugh Hamilton, Ph.D., P.Ag. | Agriculture |
| 5.5 | Warren Nimchuck, RPF, B.Sc. | Visual Resources |
| 6.1 | Andrew Mason, MA, RPCA | Heritage Resources |
| 7.0 | Doug Bright, PhD, R.P.Bio., P. Biol. | Health |
| 10.1.2 | Jemma Scoble, M.A.Sc. | Aboriginal Consultation |
| 10.1 (except 10.1.2) 10.2 10.3 | Monica Karpiak, M.A., RPCA | Traditional Use/Aboriginal Interests |

1.1 Description of Proposed Project

1.1.1 Project Purpose

Located on the Highway 99 corridor, the Tunnel is an important link in the regional and provincial transportation system, carrying an average of 80,000 vehicles each day. It is a vital people and goods movement route that fuels our national, provincial, and regional economies and a key access point for businesses in City of Richmond (Richmond), City of Surrey (Surrey), Corporation of Delta (Delta), and Tsawwassen First Nation.

The Tunnel provides an essential link between the municipalities of Delta and Richmond, and connects to key gateways such as Vancouver International Airport (YVR), Peace Arch and Pacific Canada-U.S. border crossings, BC Ferries Tsawwassen terminal, Deltaport, and Boundary Bay Airport.

Figure 1.1-1 provides an overview of the general Project alignment within the Lower Mainland. **Figure 10.1-1** in **Section 10** presents a summary of Halkomelem place names, in the vicinity of the Project.

George Massey Tunnel Replacement Project – PART A
 OVERVIEW OF PROPOSED PROJECT PROPONENT DESCRIPTION

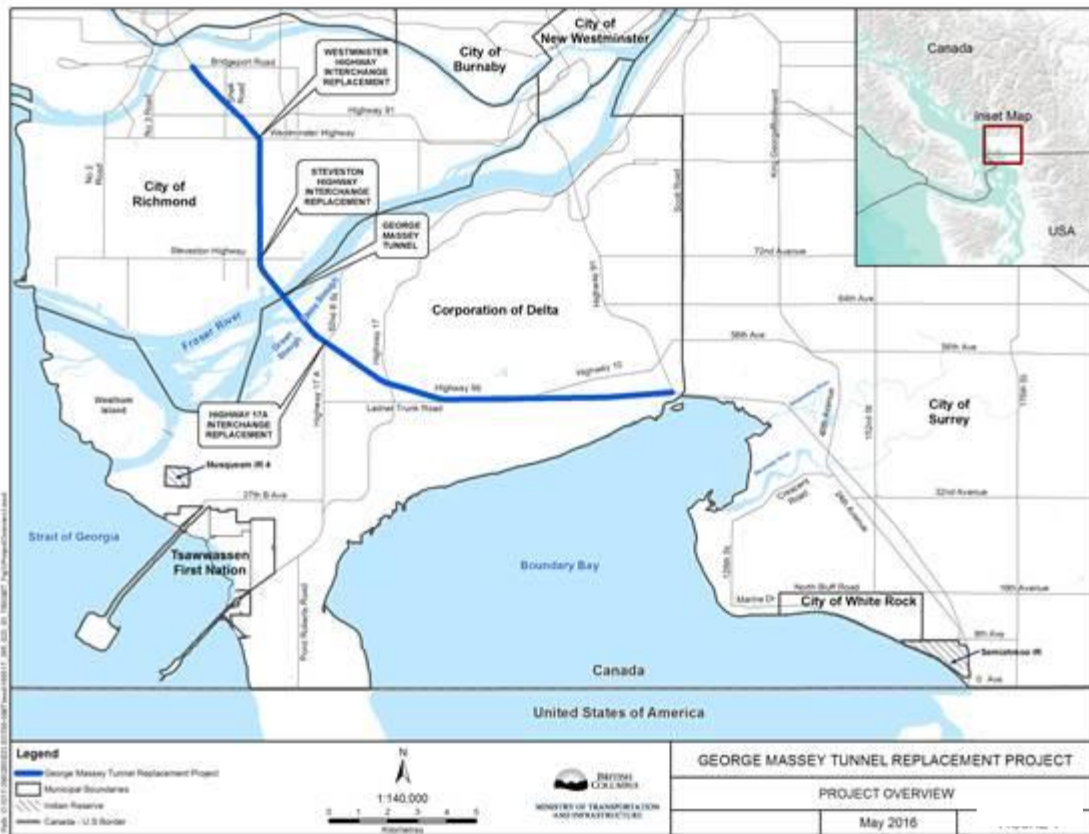


Figure 1.1-1 Project Context Map

Since the Tunnel opened in 1959, greater Vancouver’s population and economy have grown, and its population is forecast to continue to increase by more than one million people over the next 30 years. Without improvements to this crossing, economic growth and regional liveability will be constrained by congestion and increasing travel times for commuters, goods movers, commercial and other traffic.

With growing concerns about safety and traffic congestion in and near the Tunnel, in 2012 the Government of B.C. commenced a study of options to address these issues.

An extensive public and stakeholder consultation process in the fall of 2012 (Phase 1) and spring of 2013 (Phase 2) informed the development of six key Project goals:

- **Improve safety:** Improve traffic and seismic safety, as well as emergency-response capabilities.
- **Reduce congestion:** Improve travel times and reliability for all users.

- **Support trade and commerce:** Improve access to local businesses and gateway facilities and improve travel time reliability for goods movers and service providers.
- **Support increased transit on the Highway 99 corridor:** Provide dedicated transit/high-occupancy vehicle (HOV) lanes on the new bridge will improve travel time reliability and add capacity for long-term transit improvements.
- **Support options for pedestrians and cyclists:** Provide multi-use pathways on the new bridge to connect cycling and pedestrian corridors in Richmond and Delta.
- **Enhance the environment:** Enhance the environment under the new bridge and in the Project right-of-way (ROW) on Deas Island.

Based on the Ministry's mandate, technical analysis and results of consultations, a new bridge to replace the Tunnel emerged as the preferred solution, and in September 2013, was carried forward for development.

The Project is strategically important not only to assist in fulfilling the Ministry's mandate, but also to support the mandates and objectives of many other transportation agencies. These include local, regional and national/international bodies with responsibilities in transit, air, marine, rail, road and inter-modal operations, with respect to both passenger traffic and goods movement.

The Project has been developed in consideration of national, provincial, regional and local economic, transportation and land use plans, including the following:

National Plans

- Asia-Pacific Gateway and Corridor Initiative (2006)
- Building Canada plan (2007)
- Economic Action Plan (2014)
- Port 2050 (2010) Port Metro Vancouver's Land Use Plan Update (2014)

Provincial Plans

- Pacific Gateway Transportation Strategy (2012–2020)
- BC Jobs Plan (2011)
- B.C. on the Move: A 10-Year Transportation Plan, Government of British Columbia, 2015

Regional Plans

- Metro Vancouver's Regional Growth Strategy(2011)

- TransLink's Regional Transportation Strategy (2013)
- Corporation of Delta's Official Community Plan (2012)
- City of Richmond's Official Community Plan (2012)
- City of Surrey's Official Community Plan (2013)
- City of White Rock's Official Community Plan (2008)
- Tsawwassen First Nation's Land Use Plan (2009)

1.1.2 Project Development History

The need for added capacity at the George Massey Tunnel crossing has been identified a number of times over past decades and numerous technical and planning studies that have informed the development of the proposed Project have been undertaken during this period. The purpose of this section is to provide an overview of recent, as well as historic technical and planning work that has been considered in the development of the proposed Project. All of the documents noted below, plus an extensive list of additional technical and planning documents, can be found at www.masseytunnel.ca.

As early as 1989, the Freedom to Move plan developed by the Greater Vancouver Transportation Task Force (1989) recommended that the Tunnel be expanded by 2001 in order to address congestion issues and improve the regional transportation network. Building on this, in 1991 the Ministry of Transportation commissioned the George Massey Tunnel Expansion Planning Study (Ward Consulting Group 1991) which explored five options and recommended new tunnel capacity at the existing crossing for the short term, and a new 72nd Street/No. 8 Road crossing for the long term.

In 1993, A Long-Range Transportation Plan for Greater Vancouver: Transport 2021 Report (Greater Vancouver Regional District 1993) that was developed in support of developing the Livable Region Strategic Plan (Greater Vancouver Regional District 1999), identified the need for additional capacity across the north and south arms of the Fraser River. Following the Transport 2021 report, in 1995 the Ministry of Transportation commissioned the Fraser River North and South Arm Crossing Study (Reid Crowther and Partners Ltd. and Ward Consulting Group 1995) which considered 12 options including expanding the Oak Street Bridge to five lanes, adding a new tube at the existing George Massey Tunnel, upgrading Highway 99 between Highway 17 and the Oak Street Bridge, and constructing a new crossing at Tree Island between Highway 91 in Richmond and Marine Way in Burnaby.

The various concepts presented in both the 1991 and 1995 studies, in addition to technical work to address seismic challenges associated with the Tunnel and studies supporting rapid bus and

HOV improvements on the Highway 99 corridor between 2008 and 2011, informed the development of the conceptual design presented in **Section 16.1 Reference Concept**.

In its provincial transportation strategy, “B.C. on the Move” (March 2015), the Ministry has confirmed the Project as a Priority for Action to improve highway safety, capacity and reliability – addressing one of the region’s worst congestion points.

In the context of recent work to support the planning of the George Massey Tunnel Replacement Project, a range of technical and planning studies were conducted between 2012 and 2015. These studies cover a range of areas and disciplines including geotechnical, costing, project risk, procurement and traffic studies. Summaries of key studies undertaken are provided below.

1.1.2.1 Traffic Studies

George Massey Tunnel Replacement Project Analysis of OD Survey Data

This report documents the methodology and findings of the Origin-Destination (OD) surveys conducted in October and November, 2013 (Delcan 2015a).

George Massey Tunnel Replacement Project Analysis of OD Survey Data Fall 2014

This report documents the methodology and findings of the OD surveys conducted in October and November, 2014 (Delcan 2015b).

George Massey Tunnel Replacement Project Collision Data Analysis

The purpose of this document is to outline the methodologies and assumptions used in the analysis, and present the findings (Delcan 2015c).

George Massey Tunnel Replacement Project Traffic Data Collection Report Fall 2014

This report summarizes data collected during October of 2014. The report builds on and complements initial data collection activities that were conducted during the summer and fall of 2013, spring of 2014, and summer of 2014 (B.C. MOTI 2015a).

George Massey Tunnel Replacement Project Traffic Data Collection Report Spring 2014

This report documents the traffic data collected in April, 2014 on Highways 99, 91, 17, 17A and 10. The information includes: vehicle count data (from permanent count stations; short count stations; manual counts; and, tube counts); vehicle occupancy survey data; and, corridor travel times. The report builds on the initial data collection activities that were conducted during fall and summer 2013 (B.C. MOTI 2015b).

George Massey Tunnel Replacement Project Traffic Data Collection Report Summer 2014

This report documents the traffic data collected in August, 2014 on Highways 99, 91, 17, 17A and 10. The information includes: vehicle count data (from permanent count stations; short count stations; manual counts; and, tube counts); vehicle queue observations; and, corridor travel times. The report builds on initial data collection activities that were conducted during the summer fall of 2013 and spring of 2014 (B.C. MOTI 2015c).

George Massey Tunnel Replacement Project Traffic Data Collection Report Summer & Fall 2013

This report documents the traffic surveys completed and vehicle count data collected in August, October and November, 2013 on Highways 99, 91, 17, and 10. The information includes: traffic count data (from permanent count stations; short count stations; manual counts; signal controllers; and, tube counts); origin-destination survey data; vehicle queue observations; vehicle occupancy survey data; corridor travel times; transit ridership survey data; bike shuttle counts; and collision data. The purpose of this report is to document the planning and assumptions involved with each traffic data collection activity and consolidate and organize the data collected by the traffic data collection program (B.C. MOTI 2015d).

George Massey Tunnel Replacement Project Traffic Data Overview

The purpose of this report is to provide an overview of the traffic information collected and the assessment undertaken to support the development of the George Massey Tunnel Replacement Project. It also serves as a technical reference document through the inclusion of appendices with facts, figures, and records of source documentation (B.C. MOTI 2015e).

1.1.2.2 Planning Studies

George Massey Tunnel Replacement Project Business Case

This study establishes the need for improvements and how the Project will contribute to the objectives and strategies to improve transportation infrastructure in Metro Vancouver (B.C. MOTI 2015f).

Capital Cost Estimate Report George Massey Tunnel Replacement Project

This report details the conceptual capital cost estimate for the Project, including design & construction, bid development, owner's costs, IDC, contingency, and risk (B.C. MOTI 2015g).

Massey Tunnel Financial Model

This report summarizes inputs to the financial modelling for value for money comparison of the Design Build and Design Build Finance Operate Maintain Rehabilitate delivery models (B.C. MOTI 2015h).

Operations, Maintenance and Rehabilitation Base Cost Estimate Report George Massey Tunnel Replacement Project

This report provides an assessment of costs for operational maintenance and rehabilitation services anticipated over both the operating term and service life including assumptions relating to: service life, tolling operations, inflation and contingency (B.C. MOTI 2015i).

Procurement Options Report George Massey Tunnel Replacement Project: Identification and Assessment of Procurement Options for Detailed Business Case Analysis

This analysis identifies procurement alternatives for the Project and narrows to two preferred options (a traditional Design Build and a Design Build Finance Operate Maintain Rehabilitate partnership model), for input to detailed analysis in the Business Case (B.C. MOTI 2015j).

George Massey Tunnel Replacement Project Risk Report

This report documents the risk assessment process for the Project including: overview of approach, risk identification and allocation between Province and Contractor, risk management strategies, assessment and quantification methodology for input to Business Case (B.C. MOTI 2015k).

George Massey Tunnel Replacement Project Evaluation of Crossing Scenarios

This report evaluates five potential crossing scenarios for the Project as identified in “Planning for the Future Phase 2: Exploring the Options Consultation Discussion Guide” (B.C. MOTI 2013). This report identifies “New Replacement Bridge on Highway 99 corridor” as the preferred solution (MMK Consulting Inc. 2014).

George Massey Tunnel Replacement Project Conceptual Highway and Interchange Design Summary Report

The purpose of this report is to document the basis for the conceptual designs of the five potential crossing scenarios, the assumptions made, the work completed and resulting findings, and any key actions required for future design development of the concepts (CH2M Hill Canada Limited 2014).

1.1.2.3 Geotechnical Studies

Basic Field Data Report George Massey Tunnel Replacement

This report presents the basic results of a geotechnical site investigation program conducted from January 15th to May 29th, 2014 at the George Massey Tunnel. The program consisted of 18 Cone Penetration Tests (CPT), 34 Seismic Cone Penetration Tests (SCPT), and one Downhole Seismic Test (DHS) (ConeTec Investigations Ltd. 2014a).

Downhole Seismic Field Data Report George Massey Tunnel Replacement Project

This document contains the test data for downhole seismic testing (ConeTec Investigations Ltd. 2014b).

Geotechnical Data Report George Massey Tunnel Replacement Project

This report documents the results of a geotechnical investigation carried out between November 2013 and January 2014, which included a site description, project description, geotechnical scope of work, review of available information, and results of a geotechnical investigation. The data collected from two boreholes drilled near the north and south tunnel portals (Golder Associates Ltd. 2014a).

Geotechnical Data Report - Highway 99 and Interchanges George Massey Tunnel Replacement Project

This report documents the results of the geotechnical investigation carried out along the existing Highway 99 corridor between Westminster Highway in Richmond and Highway 17A in Delta, BC, during January and February, 2015 (Golder Associates Ltd. 2015a).

Geotechnical Data Report - Steveston Highway Interchange and Green Slough George Massey Tunnel Replacement Project

This report documents the results of the geotechnical investigation carried out along the existing Highway 99 corridor between Steveston Highway in Richmond and River Road at Green Slough in Delta, BC, during September and October, 2015 (Golder Associates Ltd. 2015b).

Geotechnical Data Report - Test Pile Site George Massey Tunnel Replacement Project

This report presents the results of a geotechnical investigation and laboratory testing at the proposed test pile location adjacent to the existing south portal of the George Massey Tunnel on the east side of Highway 99 in January 2015 (Golder Associates Ltd. 2015c).

Supplemental Geotechnical Laboratory Testing George Massey Tunnel Replacement Project, Richmond & Delta, BC

This document provides the results of supplemental laboratory testing carried out on samples collected during geotechnical investigation, between November 2013 and January 2014 (report dated April 2014) (Golder Associates Ltd. 2014b).

1.1.3 Project Rationale

The following section provides an overview of the key drivers that support the rationale for the Project, including: importance of the Tunnel in the regional transportation network, historic trends in population and traffic growth on the Highway 99 corridor, current conditions including congestion, future regional growth in population and traffic demand, and public support that has been identified through Project consultation and engagement.

1.1.3.1 Importance of the Tunnel

The Tunnel provides the main road connection between the municipalities of Delta and Richmond, and Highway 99 is the primary travel route between Delta, Surrey, White Rock, and Tsawwassen First Nation to the south, and Richmond and Vancouver to the north. In its current configuration, the Tunnel serves a wide range of users, including auto and transit commuters and other local traffic, light and heavy commercial truck traffic, travellers to and from the U.S., and other visitors to the region.

Highway 99 and the Tunnel serve as a key link to several major international transportation gateways, including the Deltaport container terminal at Roberts Bank, Vancouver International Airport (YVR), and the Pacific Highway and Douglas (Peace Arch) Canada-U.S. border crossings leading to and from the U.S. interstate highway system. The Tunnel also provides a key connection to BC Ferries services between Tsawwassen, Vancouver Island and the Southern Gulf Islands, and a highway link to Boundary Bay Regional Airport.

1.1.3.2 Historic Population and Traffic Trends

Highway 99 communities adjacent to the Tunnel have experienced strong population growth for decades. As illustrated in **Figure 1.1-2** below, the combined population of Richmond, Surrey, Delta, and White Rock doubled between 1986 and 2011, from 400,000 to 800,000.

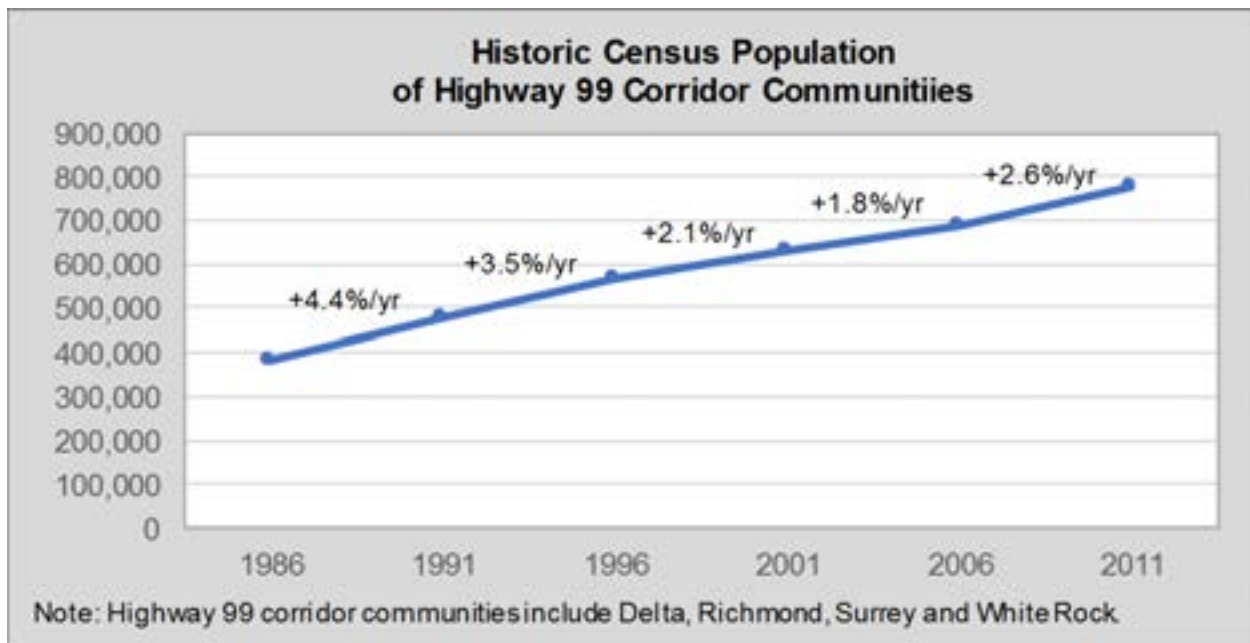


Figure 1.1-2 Historic Census Population of Highway 99 Corridor Communities (Statistics Canada 2016)

To help serve greater Vancouver's growing population, the six-lane Alex Fraser Bridge opened upstream from the Tunnel in 1986. This bridge and the Highway 91 corridor have provided a similar-distance alternate route for the significant portion of traffic travelling between South Surrey/White Rock and much of Vancouver, Burnaby, and Richmond.

The opening of the Alex Fraser Bridge initially led to some congestion relief at the Tunnel; however, traffic levels at the Tunnel continued to grow with population and employment, reaching a daily average of 80,000 vehicles by the early 1990s, resulting in major morning and afternoon congestion periods in both directions.

From the early 1990s to the early 2010s, the Alex Fraser Bridge absorbed virtually all of the growth in Richmond and Delta cross-river traffic realizing steadily increased volumes while volume trends at the Tunnel generally remained flat. For the two crossings combined, the average traffic growth rate between 2003 and 2013 was 0.64 % per year. **Figure 1.1-3** presents historic annual average daily traffic volumes from 1989 to 2013.

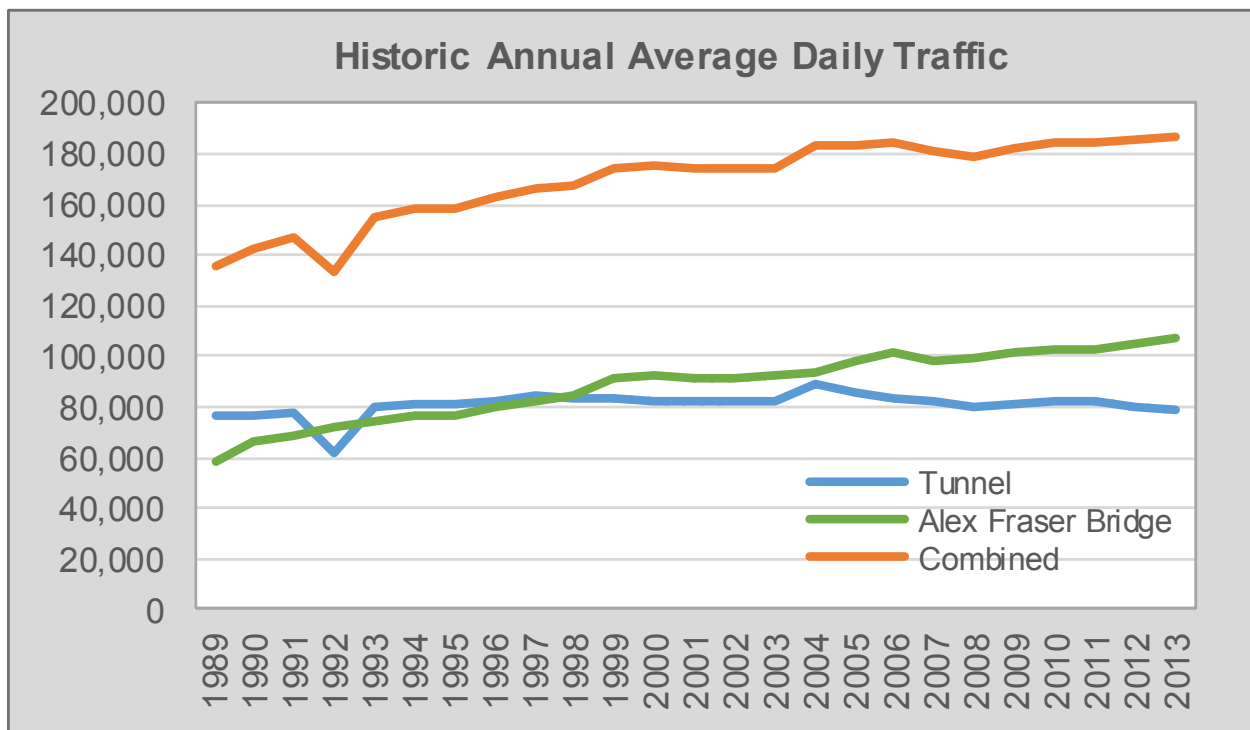


Figure 1.1-3 Historic Annual Average Daily Traffic (B.C. MOTI 2015a)

1.1.3.3 Current Congestion Patterns at the Tunnel and at the Alex Fraser Bridge

During the morning and afternoon rush periods, drivers using the Tunnel experience substantial congestion in both directions. For the three lanes of northbound morning and southbound afternoon traffic, the average peak delay time is eight minutes northbound in the morning, in addition to eight minutes southbound in the afternoon, for a daily total of 16 minutes. For the single lane of counter flow traffic, peak traffic delay times are even higher: eight minutes

southbound in the morning, in addition to 18 minutes northbound in the afternoon, for a daily total of 26 minutes. When there is a crash or vehicle breakdown, these queues, and resulting delay times, can be much longer.

Traffic volumes also approach capacity during regular two-lane operations on weekdays and on weekends, where even a minor traffic incident can lead to substantial congestion delays. Holiday weekends are particularly congested, with highly variable and unpredictable travel times.

With the Alex Fraser Bridge absorbing most of the demand, its traffic levels have grown substantially over the past two decades. This bridge is now at capacity in rush hour, with limited ability to accommodate additional traffic volumes. Congestion delays for morning northbound and afternoon southbound traffic are now greater at Alex Fraser Bridge than at the Tunnel, especially for morning northbound traffic.

The following two graphs (Figure 1.1-4 and Figure 1.1-5) illustrate northbound and southbound weekday congestion patterns, by time of day, at the Tunnel and the Alex Fraser Bridge.

Section 5.1 Traffic provides a detailed description of current and future traffic conditions in the Project area.

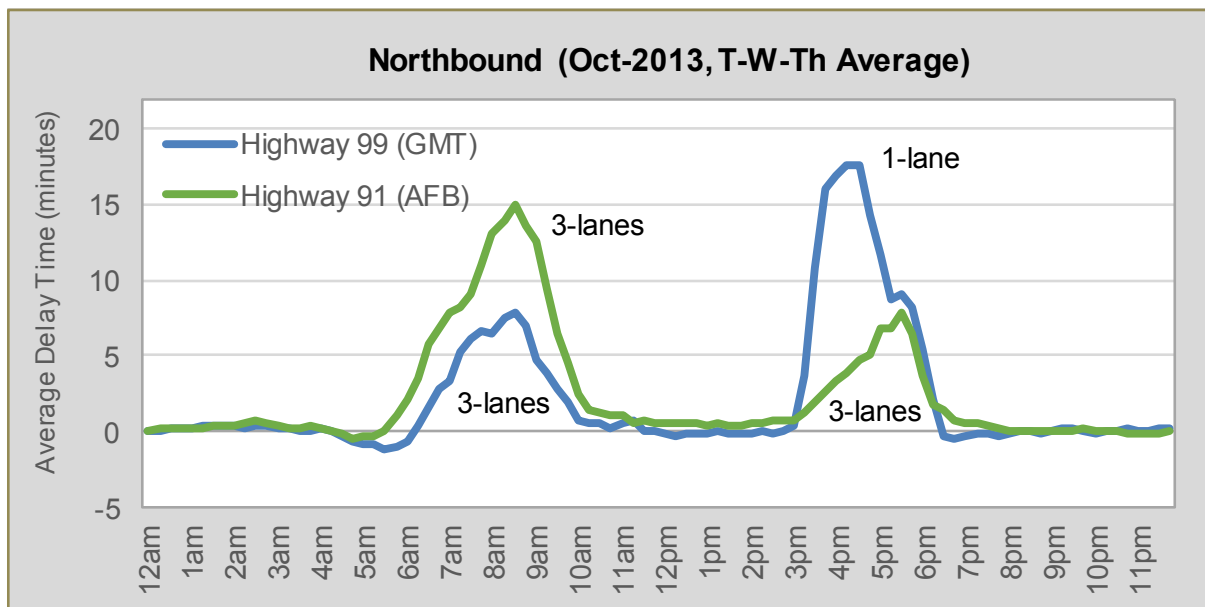


Figure 1.1-4 Northbound Highway 99 and Highway 91 Traffic Delay Time (2013) (B.C. MOTI 2016)

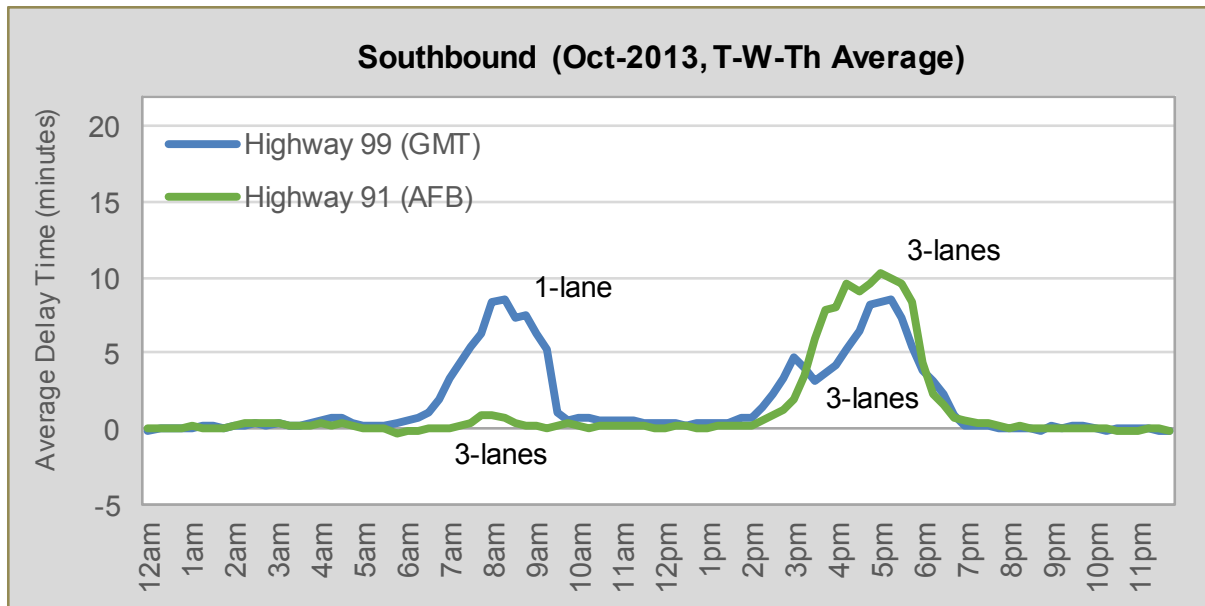


Figure 1.1-5 Southbound Highway 99 and Highway 91 Traffic Delay Time (2013) (B.C. MOTI 2016)

Future increases in cross-river traffic volumes are forecast at both the Tunnel and the Alex Fraser Bridge, and will result in increasing congestion at both locations. As with current conditions within the corridor, the nature of such congestion is variable and unpredictable throughout the day.

1.1.3.4 Future Growth in Population and Traffic Volumes

The Greater Vancouver Regional District (Metro Vancouver) regional growth strategy *Metro 2040: Shaping our Future (Metro 2040)* projects an increase of more than 60 per cent from 2006 numbers in population and employment in Richmond, Surrey, and Delta by 2041, representing an average annual growth rate of more than 1.4 per cent per year (Metro Vancouver 2015).

With respect to future traffic volumes, forecasts based on TransLink’s Regional Transportation Model (RTM) (2013) predict that under continued Tunnel operation, daily traffic volumes at the Tunnel will increase from 79,000 to 97,000 between 2013 and 2045, which represents an average growth rate of 0.64 per cent per year. This forecast traffic growth rate, while less than half of the projected population growth rate, is consistent with the actual growth in combined Tunnel and Alex Fraser Bridge traffic between 2003 and 2013 (see **Table 1.1-1** below).

Table 1.1-1 Projected Population, Employment, and Traffic Growth

| Projected Growth | Recent Census Year | Target Year | Average Annual Growth |
|--|--------------------|-------------|-----------------------|
| Population and Employment ¹ | 2006 | 2041 | |
| Population | 714,400 | 1,203,000 | 1.50% |
| Employment | 335,240 | 558,800 | 1.47% |
| George Massey Traffic Growth | 2013 | 2045 | |
| Annual Average Daily Traffic (AADT) ² | 79,000 | 97,000 | 0.64% |

Note: ¹ For Richmond, Delta, Tsawwassen, Surrey, and White Rock.

² Source: Metro Vancouver's Regional Growth Strategy (2015)

1.1.3.5 Future Travel Time Delays under Continued Tunnel Operation

As indicated in **Figure 1.1-4** and **Figure 1.1-5** above, one-way travel time delays averaging eight to 18 minutes are routinely experienced in both directions, during both the morning and afternoon peak periods. Peak period round-trips delay times are currently 16 to 26 minutes, depending on direction.

Looking ahead, given the current high levels of congestion at the Tunnel, even the RTM-predicted moderate annual traffic growth rate will result in significant increases in future congestion levels.

Based on a detailed analysis of current and forecast traffic patterns, and assuming 0.6 per cent average annual traffic growth, round-trip delay times for peak-period travellers under continued Tunnel operation are forecast to increase to between 27 to 39 minutes (depending on direction) in 2021, and 99 to 105 minutes in 2045 (**Table 1.1-2**).

Table 1.1-2 Current and Future Weekday Congestion Delays under Continued Tunnel Operation

| Traffic Direction | Weekday Congestion Delays | | |
|---------------------------------|---------------------------|---------|----------|
| | 2013 | 2021 | 2045 |
| Peak direction delays (3 lanes) | | | |
| Northbound AM weekdays | 8 min. | 11 min. | 32 min. |
| Southbound PM weekdays | 8 min. | 16 min. | 67 min. |
| Combined | 16 min. | 27 min. | 99 min. |
| Counterflow delays (1 lane) | | | |
| Southbound AM weekdays | 8 min. | 16 min. | 41 min. |
| Northbound PM weekdays | 18 min. | 23 min. | 64 min. |
| Combined | 26 min. | 39 min. | 105 min. |

1.1.3.6 Public Support for Replacing the Existing Tunnel

The Ministry's public consultation programs in 2012 and 2013 (**Section 11 Public Consultation**) confirmed strong support for relieving traffic congestion with a new bridge on the existing Highway 99 corridor as soon as possible.

Further details on the rationale for the Project, and the strong levels of public support for it, are contained in the results of public consultation programs, and Project Definition Report (B.C. MOTI 2015a), as posted on the George Massey Tunnel Replacement Project website at www.masseytunnel.ca.

1.1.3.7 Tunnel Decommissioning

When the new bridge is open to traffic, the Tunnel will be decommissioned and the four in-stream segments removed to:

- Eliminate future risk of damage to the new bridge and impact to shipping associated with significant seismic activity;
- Meet Ministry best practice regarding management of obsolete infrastructure; and,
- Provide opportunities to restore important Fraser River habitat.

Removing the in-stream segments of the Tunnel addresses the risks that an earthquake may cause the Tunnel to shift, creating an obstruction in the shipping channel and/or damaging the Fraser River shoreline. Given the importance of the Fraser River as a transportation corridor that supports the national and provincial economies and as a diverse marine ecosystem, the impact of such an occurrence would be significant. As such, leaving the in-stream segments in place presents a long-term liability to the Province.

Removing in-stream Tunnel elements concurrent with the Project also represents the least cost alternative – it would be significantly more expensive and risky to undertake this work at some later date in the future, should it be deemed necessary.

Additionally, obsolete infrastructure degrades over time, so it is standard practice to remove redundant facilities and man-made materials when new infrastructure replaces it. Removing the in-stream segments of the Tunnel will return the river bottom to its natural condition. This also provides the opportunity to backfill the south portal, reconnect the two sides of Deas Island that are currently bisected by the Highway 99 roadway, and re-establish riparian habitat in this area.

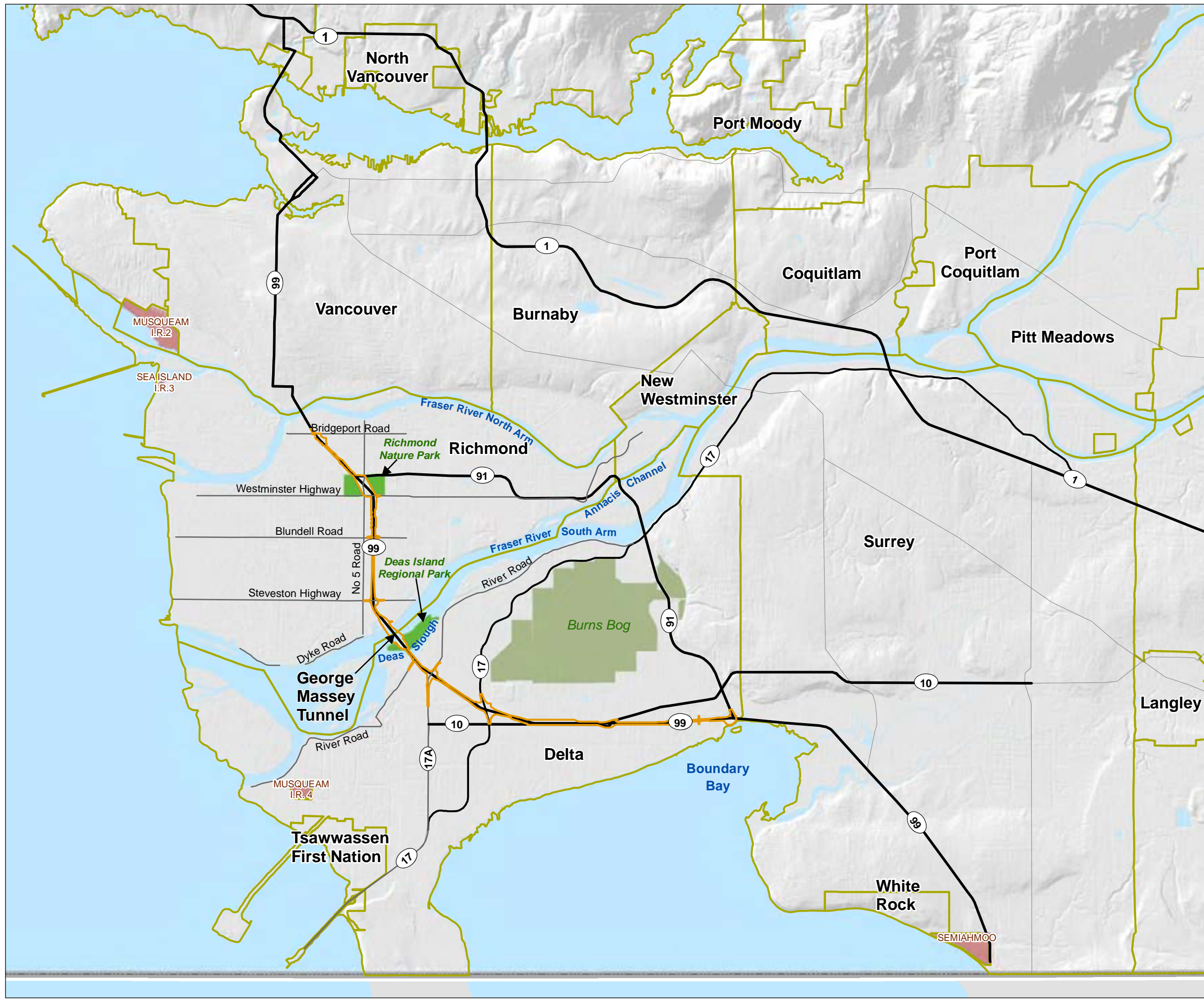
1.1.4 Project Location

The Project is located within the Highway 99 corridor in B.C.'s lower mainland (49° 07'18.36" N and 123° 04'32.32" W) (**Figure 1.1-6**).

The northern extent of the Project is the Bridgeport Road interchange in Richmond. The Project alignment then continues south along the Highway 99 corridor to the new bridge crossing over the Fraser River South Arm. South of the new bridge, the Project continues along the Highway 99 corridor to the Highway 91 interchange in Delta. Federal land in proximity to the Project alignment includes the following:

- Sea Island Indian Reserve No. 3, approximately two kilometres west of the Project .
- Musqueam Indian Reserve No. 4, approximately five kilometres northwest of the Project.
- Semiahmoo Indian Reserve, approximately 12 kilometres southeast of the Project .
- Alaksen National Wildlife Area and George C. Reifel Migratory Bird Sanctuary, which overlaps the Alaksen National Wildlife Area, located approximately seven kilometres west of the Project.
- Department of National Defense, less than one kilometre from the Project.
- Fraser Wharves, managed by the VFPA, is located adjacent to the Project.
- Submerged land in the Fraser River North and Middle Arms, the portion of submerged land under the Fraser River west of Tilbury Island and several parcels of foreshore and upland areas in Richmond and Delta.

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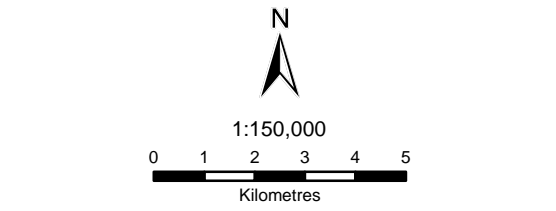


Legend

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

PROJECT LOCATION

| | |
|--------------|------------|
| Figure 1.1-6 | 13/05/2016 |
|--------------|------------|

1.1.4.1 Adjacent Land Use

Land use in areas adjacent to the Highway 99 corridor in Richmond and Delta, in the Newton Area of Surrey, and in the far west and far east portions of Highway 99 through South Surrey is predominantly agricultural. Most of the agricultural land adjacent to the highway falls within the provincial Agricultural Land Reserve.

Along the Project alignment, Highway 99 provides access to, and supports the following:

- Agricultural lands.
- Municipal properties used for local and regional transportation, public services, and educational institutions.
- Parks and recreation.
- Single- and multi-unit residences.
- Religious institutions.
- Retail and commercial/industrial (light and heavy) facilities.

The new bridge will span the Fraser River South Arm and Deas Slough, which are used for commercial, recreational and Aboriginal fishing, port activities, and commercial and recreational marine purposes.

Deas Island Regional Park, located on either side of the Project alignment along the south approach to the Tunnel, provides recreational opportunities including walking trails, picnic areas, and access to recreational boating along Deas Slough.

The Tsawwassen First Nation is located approximately six kilometres southwest of the Project alignment, adjacent to Roberts Bank, between the BC Ferries Tsawwassen Terminal and Deltaport.

1.1.4.2 Land Ownership and Management

The Project is generally within Ministry ROW, including land that is under water, with Vancouver Fraser Port Authority (VFPA) having navigational jurisdiction in the Fraser River. Metro Vancouver owns Deas Island Regional Park, located immediately outside the Project alignment on Deas Island.

The following legislation apply to the use and management of lands within the Project alignment:

- *Canada Marine Act*, S.C. 1998, c. 10, which establishes VFPA's navigation jurisdiction within the Fraser River.
- B.C. *Land Act*, R.S.B.C. 1996, c. 245, which governs the disposition of provincial Crown land.
- *B.C. Agricultural Land Commission Act*, S.B.C. 2002, c. 36, which establishes the provincial Agricultural Land Reserve (ALR) and permitted uses within the ALR
- B.C. Community Charter and *Local Government Act*, R.S.B.C. 1996, c. 323, which establishes the authority for local government planning bylaws
- B.C. *Wildlife Act*, R.S.B.C. 1996, c. 488, which establishes Wildlife Management Areas (WMAs) for conservation purposes

Land use interactions and potential effects on land use are discussed in **Section 5.3** of the Application. The Project is sited largely on provincial Crown land within Richmond and Delta, and straddling the Fraser River South Arm. The majority of the proposed works are located within the highway ROW; however, small portions of land in Delta and Richmond adjacent to the ROW will be required for the Project. Land Ownership is described in more detail in **Section 5.3 Land Use** and shown on **Figure 5.3-3**.

Land within Richmond, Delta, and Surrey is owned by federal, provincial, or local governments; First Nations; or is privately held. The federal government owns the submerged land in the Fraser River North and Middle Arms, the portion of submerged land under the Fraser River west of Tilbury Island, and several parcels of foreshore and upland areas in Richmond and Delta. The Province owns submerged land in the Fraser River South Arm east of Tilbury Island, and the submerged land within the Project alignment. The Province manages tenures for uses within this area. Outside of the Highway 99 ROW, the Province owns some upland parcels and submerged lands adjacent to the Project alignment. Metro Vancouver owns Deas Island Regional Park, which is situated on both sides of the south approach to the Tunnel. Richmond owns three parcels and Delta owns several parcels adjacent to the ROW.

Provincial land holdings within the vicinity of the Project include the BC Ferries fleet maintenance facility (Deas Pacific Marine) in south Richmond, portions of the South Arm Marshes Wildlife Management Area (WMA), and smaller parcels in upland areas of Delta. Ownership of the Burns Bog Ecological Conservancy Area is shared between the Province and a partnership between Metro Vancouver and Delta. The City of Vancouver owns the Vancouver Landfill, situated between Highway 99 and the southwest corner of Burns Bog. Delta owns the

land base for the Boundary Bay Airport, and several parks and recreational corridors. Richmond and Delta own the land base for their respective arterial and local roads, community centres, and public works facilities. The remainder of land, which includes a Canadian National (CN) rail corridor in Richmond and a Burlington Northern Santa Fe rail corridor in Delta, is privately owned.

Tsawwassen First Nation Lands, as defined by the *Tsawwassen First Nation Final Agreement* (2009), are located approximately six kilometres southwest of the Project alignment, adjacent to Roberts Bank. Musqueam Indian Reserve No. 4 is located approximately five kilometres northwest of the Project alignment. Information on First Nation Treaty lands and Indian Reserves is provided in **Section 10 Aboriginal Consultation**.

Support structures for the new bridge will be installed on Deas Island and adjacent to Deas Slough within the Highway 99 corridor, outside of Deas Island Regional Park and the main channel of the south arm of the Fraser River. In Richmond, just south of Rice Mill Road, Highway 99 crosses the CN rail line, which is private land. The Project does not overlap federal lands, First Nation Reserves, or federal or provincial parks or Protected Areas.

1.1.4.3 Asserted Traditional Territories and Treaty Nation Territories

As shown in **Figure 1.1-7**, the Project is entirely or partially located within the following Aboriginal Groups' asserted traditional territories, and/or Treaty Nation territories:

- Cowichan Tribes
- Halalt First Nation
- Katzie First Nation
- Kwantlen First Nation
- Lake Cowichan First Nation
- Lyackson First Nation
- Musqueam Indian Band
- People of the River Referrals Office

- Penelakut Tribe
 - Hwlitsum¹
- Semiahmoo First Nation
- Stz'uminus First Nation
- Squamish Nation
- Tsawwassen First Nation
- Tsleil-Waututh Nation

Further detail on the location of the Project in relation to traditional territories and Treaty Nation territories is provided in **Section 10.0 Aboriginal Consultation**.

¹ This reference to the Hwlitsum is not intended to signify any change in the position that the Province may have taken in other contexts in relation to the duty to consult with this group.



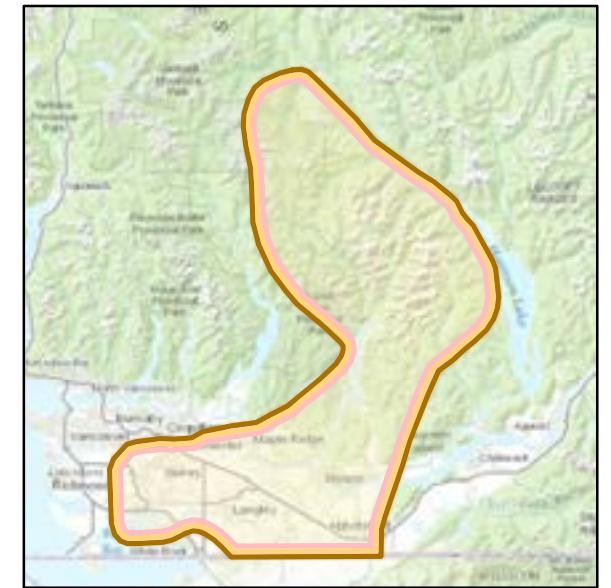
Semiahmoo First Nation Asserted Traditional Territory



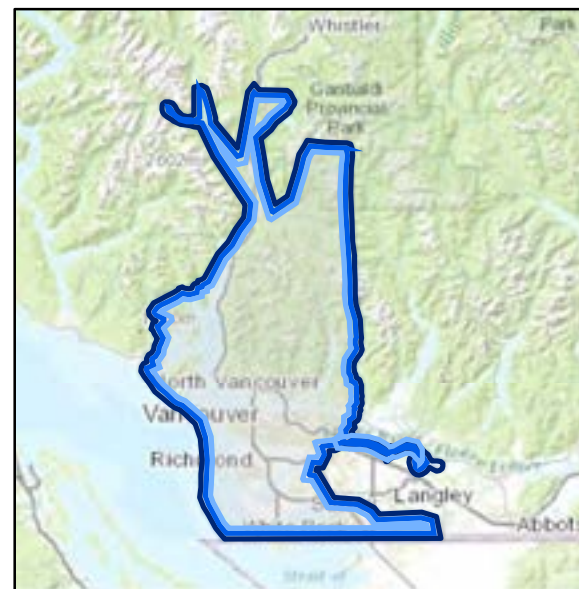
Musqueam First Nation Asserted Traditional Territory



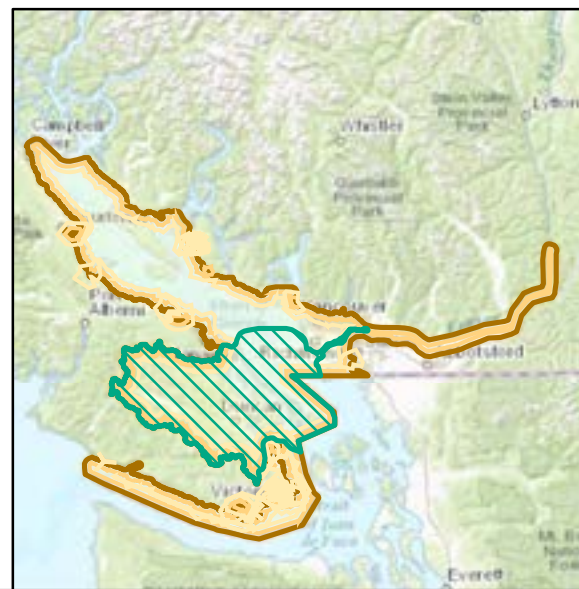
Tsawwassen First Nation Traditional Territory



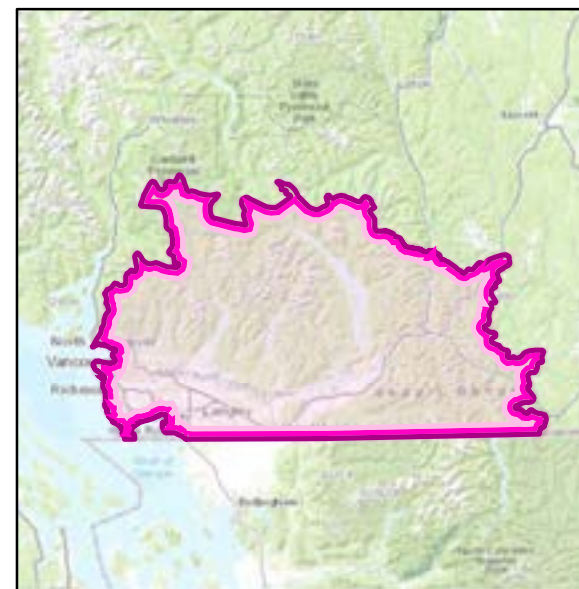
Kwantlen First Nation Asserted Traditional Territory



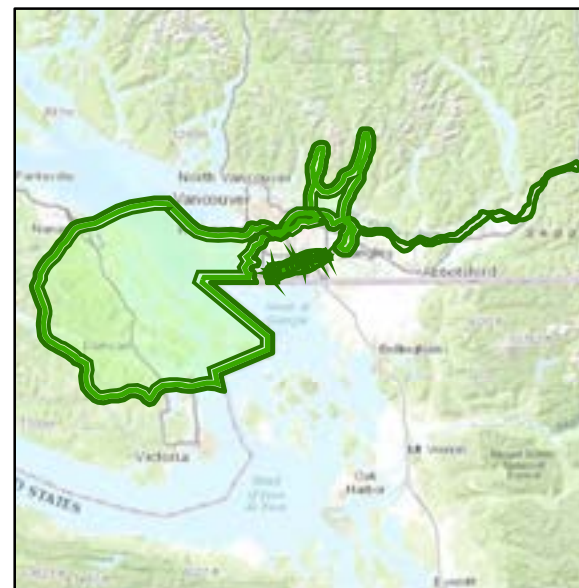
Tsleil-Waututh Nation Asserted Traditional Territory



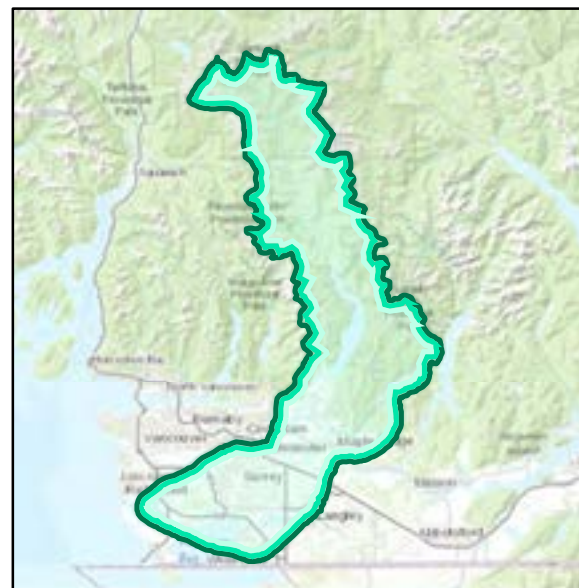
Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory and Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory (green)



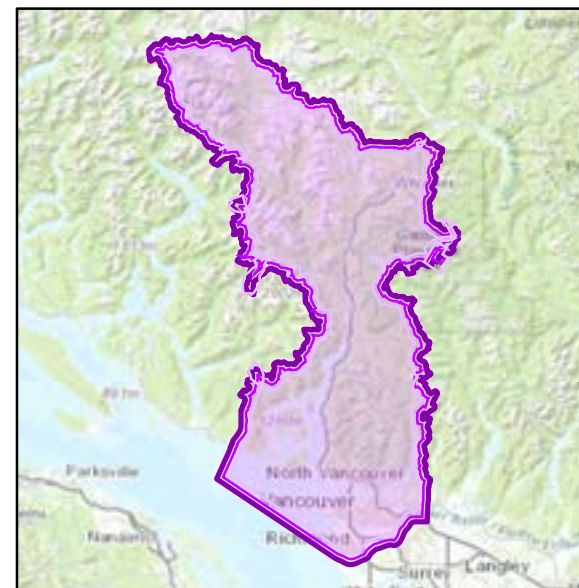
Stó:lo Treaty Association Asserted Traditional Territory



Hwlitsum First Nation Asserted Traditional Territory



Katzie First Nation Asserted Traditional Territory



Squamish Nation Asserted Traditional Territory

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| | |
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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| ASSERTED TRADITIONAL TERRITORIES AND TREATY NATION TERRITORIES | |
| Figure 1.1-7 | 13/05/2016 |

1.1.5 Project Phases and Schedule

The Ministry developed the draft conceptual design for the Project between 2013 and 2015. If an EAC is awarded for the Project, the Ministry intends to start Project construction in 2017, with the new bridge opening in 2022, followed by Tunnel decommissioning.

Major elements of the Project schedule are shown in **Table 1.1-3**. A description of Project activities during the site preparation, construction, and operation and maintenance phases of the Project is provided in **Section 1.1.8**.

The Project is intended as a permanent component of the regional and provincial transportation system, with a 100-year service life for the new bridge. There are no plans to decommission any new Project components in the foreseeable future.

Table 1.1-3 Project Schedule from Draft Conceptual Design to Completion

| Project Phase and Stage | Proposed Schedule |
|--|---|
| Pre-Construction and Site Preparation | |
| EAC Application and Regulatory Review | 2016 |
| Anticipated EA certification | Early 2017 |
| Procurement | 2016 – 2017 |
| Site Preparation | 2017 |
| Construction | |
| Construction of Project components | 2017 – 2022 |
| Tunnel decommissioning | Following opening of the new bridge in 2022 |
| Operation | |
| Operation and Maintenance | Ongoing from 2022 |

1.1.6 Key Project Components

The Project involves constructing a clear span bridge over the Fraser River, highway improvements along Highway 99 from Bridgeport Road in Richmond to Highway 91 in Delta, including improved drainage infrastructure and overpass replacements, replacing three interchanges, incorporating new transit and HOV facilities, providing connections to the municipal cycling/pedestrian path network and decommissioning the Tunnel.

Once commissioned, the Project will become part of the provincial highway system. The Ministry will select a contractor to provide products and services associated with the management, planning, and delivery of construction, operation, maintenance, and rehabilitation activities in accordance with defined Performance Measures.

The Project scope, divided into four sections, is detailed in the Reference Concept included in **Section 16.1**, drawings EA-H-1001 to EA-H-1015, and summarized below.

Section 1 – Bridgeport Road to Westminster Highway

- Construct a dedicated transit road under the Oak Street Bridge between Van Horne Way and Bridgeport Road.
- Provide a dedicated transit connection between Bridgeport Road and Highway 99 along Bridgeport Road and Sea Island Way, connecting to the transit/HOV lanes on Highway 99.
- Match to existing Highway 99 laning at the south abutment of the Oak Street Bridge.
- Construct two new median transit/HOV lanes between Bridgeport Road and Westminster Highway including replacing Cambie Road underpass Shell Road overpass and the Highway 91 westbound to Highway 99 southbound ramp bridge.
- Construct a median barrier on Highway 99 for traffic safety and to support mid-island flood protection in the City of Richmond.
- Improve drainage along Highway 99 including provisions to manage water flow rates, water levels and water quality.
- Replace the Westminster Highway interchange to accommodate all existing connections and improve cyclist/pedestrian connectivity across Highway 99.

Section 2 – Westminster Highway to Steveston Highway

- Widen Highway 99 to allow for two new dedicated median transit/HOV lanes and four general purpose lanes in each direction between Westminster Highway and Steveston Highway including replacing the Blundell Road underpass.
- Upgrade the median barrier on Highway 99 for traffic safety and to support mid-island flood protection in the City of Richmond.
- Improve drainage along Highway 99 including provisions to manage water flow rates, water levels and water quality.
- Replace the Steveston Highway interchange to accommodate all existing traffic movements and provide a new direct connection between Rice Mill Road and Highway 99 to help alleviate congestion at the Steveston Highway/No. 5 Road intersection.

- Provide an integrated median transit/HOV lane transit stop in the Steveston Interchange with connections to bus service on Steveston Highway including safe and convenient walkways, stairs and elevators for pedestrians and cyclists to access the transit stops.
- Provide multi-use pathways at the Steveston Highway interchange for east-west access across Highway 99, north-south access to Rice Mill Road and access to the multi-use pathways on the new bridge.

Section 3 – Steveston Highway to Highway 17A

- Widen Highway 99 to allow for two new dedicated median transit/HOV lanes and four general purpose lanes in each direction between Steveston Highway and Highway 17A.
- Construct a new 10-lane bridge with a clear span over the Fraser River and multi-use pathways for cyclists and pedestrians. The new bridge will be built to accommodate potential future rapid transit and will provide navigational clearances similar to those at the Alex Fraser Bridge.
- Provide connections between the multi-use pathways on the new bridge to Steveston Highway, River Road South and the Millennium Trail.
- Replace the Deas Slough Bridge with the Delta approach to the new bridge. The Delta approach will be significantly higher than the Deas Slough Bridge allowing a wider range of boats to pass underneath.
- Construct a southbound ramp exit for the new bridge connecting to River Road South.
- Provide sufficient clearance at River Road to allow the Corporation of Delta to extend River Road South eastward, improving connectivity between Ladner and North Delta.
- Replace the Highway 17A interchange to accommodate all existing traffic movements.
- Provide an integrated median transit/HOV lane transit stop in the Highway 17A interchange with connections to bus service on Highway 17A including safe and convenient walkways, stairs and elevators for pedestrians and cyclists to access the transit stops.
- Provide multi-use pathways at the Highway 17A Interchange for east-west access across Highway 99 and a connection to the shoulders of Highway 17A and Vassey Road.
- Provide biofiltration ponds to manage stormwater runoff from the road.
- Decommission the Tunnel.

Section 4 – Highway 17A to Highway 91

- Widen Highway 99 to allow for two new dedicated median transit/HOV lanes and additional general purpose lanes between Highway 17A and Highway 91 including replacement of the Matthews underpass at Ladner Trunk Road/Highway 10, and 112th Street underpass.
- Improve drainage along Highway 99 including provisions to manage water flow rates, water levels and water quality.
- Match to the existing cross section of Highway 99 just west of the Highway 91 interchange.

1.1.7 Project Design Considerations

1.1.7.1 General Design Considerations

The following section provides additional detail with respect to the Project generally as well as specific Project elements.

Design

The Project's design of the road elements will meet relevant highway design standards with respect to typical design considerations (e.g., shoulder width, lane width, median width, median placement etc.). The number of lanes reflect the inclusion of dedicated transit/HOV facilities and the anticipated 2045 traffic volumes and operational simulations. Technical analysis confirming the requirement for a 10-lane facility was undertaken and is presented in the George Massey Tunnel Replacement Project Traffic Data Overview Report (Government of B.C. 2015a). A summary of this analysis is provided in **Section 1.4 Assessment of the Project Alternatives**.

The Project roadway design minimizes overall land requirements and provides net benefits to agriculture while ensuring no net loss of agricultural land.

Typical upgraded highway cross sections along the alignment are shown in the **Reference Concept (Section 16.1)**, drawings EA-H-3001 and 3002).

Seismic Design Criteria

The seismic design for the new bridge and associated structures (i.e., interchanges) will be in accordance with the Canadian Highway Bridge Design Code (CSA-S6-14).

The new bridge will be designed to a lifeline standard and as such, site-specific seismic inputs have been developed for the crossing. Seismic inputs are based on real earthquake records from around the world that have been adjusted to reflect conditions in the Lower Mainland. Stringent limits for acceptable post-earthquake damage will be achieved through seismic load performance requirements. Ground improvements (see **Section 1.1.7.5 Construction – Ground Improvements**) will be used to reduce lateral loads on bridge foundation piles and to maintain the integrity of the new bridge foundations.

Climate Change Adaptation

All new projects being planned and constructed by the Ministry require that engineering and design work evaluate and consider vulnerability associated with future climate change and extreme weather events and to include appropriate adaptation measures to mitigate against future consequences over the design life of infrastructure. Design considerations to guide climate change planning are provided in the Ministry's Technical Circular T-06/15 Climate Change and Extreme Weather Event Preparedness and Resilience in Engineering Infrastructure Design (B.C. MOTI 2015b).

Bridge Foundation Design

Extensive geotechnical investigations have been undertaken to establish foundation design parameters for the new bridge. Large-diameter, driven pipe piles would be a conventional solution and piles would be installed to a depth of between 65 m and 85 m. The new bridge will be constructed such that piles, ground improvements, and the foundations for the bridge towers will be located above the high water level, with no permanent works below the high-water level.

Navigational Clearance

The Bridge design, which has been informed through dialogue with VFPA, Transport Canada (TC) and marine users, and will meet the requirements of the *Navigation Protection Act R.S.C., 1985, c. N-22*. Based on guidance from VFPA and TC, the new bridge design will provide for navigation clearances similar to those at the Alex Fraser Bridge. This information will be included as part of applications submitted for approvals required under the *Navigation Protection Act*.

The new bridge navigational clearance is shown in the **Reference Concept (Section 16.1, drawing EA-B-GEN1)**.

Railway Crossings

The Project crosses railways at Shell Road and at Rice Mill Road in Richmond and at the British Columbia Railway Company (B.C. Rail) Overhead in Delta. Impacts at these locations are:

- Shell Road – None; the existing highway bridge over the railway can be removed and replaced with no impact on railway operation.
- Rice Mill Road – CN has a spur line that runs along Rice Mill Road and crosses the Tunnel approaches on a structure. The Tunnel approaches will be backfilled at the completion of the Project.
- B.C. Rail Overhead – None; Highway 99 passes under B.C. Rail between Ladner Trunk Road and 112th Street and modifications Highway 99 can be made with no impact on the railway overhead.

Design and construction of new highway infrastructure adjacent to railways will take into account and comply with the following regulations and codes of practice:

- *Railway Safety Act* and associated regulations.
- *Canadian Transportation Act* and associated regulations.
- American railway engineering and maintenance-of-way manual.
- CN and B.C. Rail design specifications.

Stormwater and Drainage Infrastructure

The Project design provides for existing and anticipated drainage requirements adjacent to the Highway 99 corridor. It also will accommodate stormwater management and treatment along Highway 99, including that generated off the deck of the new bridge.

Stormwater management infrastructure will adhere to best practices in B.C. and will be consistent with the concept of integrated stormwater management. As such, design and construction of the drainage infrastructure will take into account hydrological requirements and habitat values associated with drainage features.

The new drainage infrastructure along Highway 99 will be developed with reference to the following documents:

- B.C. Supplement to TAC Geometric Design Guide, Section 1000 (B.C. MOTI 2007a).
- B.C. Supplement to CAN/CSA-S6-06 (B.C. MOTI 2007b).
- Culverts and Fish Passage Fact Sheet (B.C. Ministry of Transportation 2013).
- Stormwater Planning: A Guidebook for British Columbia (B.C. MOE 2002).

- Best Management Practices (BMP) Guide for Stormwater (Metro Vancouver 1999).
- Stormwater Source Control Guidelines (Metro Vancouver 2005).
- Urban Stormwater Guidelines and BMP for Protection of Fish and Fish Habitat (Fisheries and Oceans Canada 2005).
- Land Development Guidelines for the Protection of Aquatic Habitat (Fisheries and Oceans Canada 1993).
- Drainage Factsheet – Agricultural Drainage Criteria (B.C. Ministry of Agriculture, Food and Fisheries 2002).

The following performance objectives will guide the development of final stormwater management infrastructure designs:

- Provide improvements to infrastructure or alternate flow paths to maintain system water levels at pre-Project levels during a 10-year design storm event and as close as feasible to pre-Project levels during a 100-year design storm event.
- Ensure improvements to drainage features avoid or mitigate flow volume increases to municipal pump stations.
- Incorporate water quality BMPs to treat surface runoff such that overall water quality is maintained or improved by the proposed works.
- Provide water quality treatment upstream of locations where highway runoff discharges into irrigation systems.
- Provide fish-passage features in drainage infrastructure, such as culverts, in fish bearing streams.
- Provide opportunity for environmental enhancement areas to offset environmental impacts of the proposed works.

Based on calculations of the impervious area that will be added as a result of upgrading the existing highway, the increase in additional storm water generated as a result of the Project is anticipated to be small relative to the amount of water draining from the area. Existing drainage standards of Richmond and Delta will inform the final drainage infrastructure designs to ensure that incremental Project-related increases in storm water do not compromise the ability to meet existing drainage requirements and not overwhelm the capacity of existing pump stations.

To minimize the increase in stormwater peak-flow rates generated by the proposed work, stormwater storage facilities, including biofiltration ponds, will be used to limit peak flows to pre-Project levels. These storage facilities will double as water quality treatment facilities. Potential stormwater detention pond locations include space under the new bridge and within the interchange ramp footprints **Table 1.1-4**.

Table 1.1-4 Proposed Storm water Storage Structures

| Storage Structure Location | Type |
|-----------------------------------|-------------|
| Steveston Interchange | Pond |
| New Bridge (Richmond) | Pond |
| New Bridge (Deas Island) | N/A |
| New Bridge (Delta) | Pond |
| Highway 17A Approach | Swale |
| Highway 17A Interchange | Pond |
| Highway 17 Interchange (North) | Pond |
| Highway 17 Interchange (South) | Swale |

To minimize runoff volume increases that would need to be managed through the existing pump stations, bridge runoff will be discharged through gravity outfalls that are independent of the municipalities' pumped systems.

Biofiltration ponds and roadside swales will be used where possible to provide sediment capture and infiltration features that will facilitate improved water quality.

Lighting Design

Functional roadway lighting will be provided on the Highway and at interchanges according to TAC and Ministry standards.

Lighting for the multi-use trails and public spaces will be designed to meet functional, safety and Crime Prevention Through Environmental Design (CPTED) requirements. The type of lighting to be used, and orientation of lighting relative to existing development, will focus on meeting safety requirements while avoiding light spill onto adjacent (non-road) areas. Dark sky objectives will be incorporated.

Navigation lighting for marine users and aircraft will be included on the new bridge.

Heritage Considerations

Recognizing the importance of the Highway 99 corridor in facilitating regional growth and development, the Ministry has undertaken a study to identify historic considerations associated with the Highway 99 corridor. The study will inform efforts to recognize and acknowledge the history of the area and the role of the corridor and Tunnel in its evolution.

1.1.7.2 Alternative Transportation Considerations

In addition to providing capacity to meet future vehicle traffic demand, the Project supports broader transportation choices, including significant measures to encourage greater use of transit, car-pooling, cycling, and walking.

Transit/High Occupancy Vehicles

Recognizing that a key goal of the Project is to support increased transit on the Highway 99 corridor, the Project includes significant improvements to transit infrastructure between the Bridgeport Canada Line Station and Highway 91 in Delta. The new dedicated median transit/HOV lanes over the length of the Project will also provide new opportunities for car-pooling. Specific improvements include:

- 50 lane-kilometres of new dedicated transit/HOV lane in the median of Highway 99 between Bridgeport Road in Richmond and Highway 91 in Delta.
- A dedicated transit road under the Oak Street Bridge to improve connectivity for buses between the Bridgeport Canada Line Station and Highway 99.
- A dedicated transit ramp between Highway 99 and Bridgeport Road to provide safe and reliable access for buses destined to or from Canada Line at Bridgeport Station.
- A dedicated transit ramp at Highway 17A for southbound buses destined for Ladner, Tsawwassen and BC Ferries.
- Transit stops, with stairs and elevator access for pedestrians and cyclists, will be integrated with the median transit/HOV lanes and the interchanges at Steveston Highway and Highway 17A.

The new bridge also is designed to accommodate future rapid transit as population density and transportation demand south of the Fraser increases in the future. Specific design considerations that provide for future rapid transit include:

- Deck configuration that allows the conversion of transit/HOV lanes to rapid transit lanes when needed.
- Grades on the bridge that are appropriate for rapid transit applications.
- Bridge design that accommodates rapid transit loads.

Cycling and Walking

Key links in the municipal pedestrian and cyclist networks across Highway 99 and across the Fraser River will be upgraded as part of the Project as summarized below. Improvements to cycling and pedestrian infrastructure include multi-use pathways on both sides of the new bridge. Interchange improvements will include upgraded pedestrian and cyclist facilities.

In Richmond, Project-related cycling improvements include:

- A multi-use pathway that will connect Odlin Road, a current cycling route in Richmond, with the Shell Road Greenway.
- Multi-use pathways on the proposed overpasses at Westminster Highway and Blundell Road.
- Multi-use pathways at the Steveston Highway interchange that keep cyclists and pedestrians separated from road traffic, while accommodating access between the bridge and the integrated transit stops, and between Steveston Highway and the new bridge and Rice Mill Road.

In Delta, cycling improvements within the Project alignment include:

- A connection between pathways on each side of the new bridge to access the Millennium Trail, River Road and Vasey Road. The connection at River Road will link to the existing cycling access for Highway 17A, and 64th Street in Delta.
- The Highway 17A interchange will include a separated multi-use pathway through the interchange with connections to Highway 17A and 62B Street and the integrated transit stop within the interchange.
- Overpasses at Matthews Interchange and 112 Street will also include multi-use pathways.

From a safety perspective, Project-related cycling improvements provide considerably safer alternatives than existing routes through provision of connections where none exist today and through the emphasis on grade-separated multi-use pathways where practical, especially at the Steveston and Highway 17A interchanges.

Smart Transportation

Recognizing that the Highway 99 corridor is an integral part of the regional road network, the design of the Project will incorporate smart transportation elements to support improved traveller information and efficient operations including incident identification and response.

1.1.7.3 Project Design

The Project description provided in the Application describes a Reference Concept for the Project, including a conceptual level design for key Project elements that are required for the proposed infrastructure to operate efficiently and meet performance objectives.

As discussed in **Section 1.1.8.4**, the Project will be delivered by a Contractor that will be responsible for the final Project design, construction approach, staging, and schedule, as well as operation and maintenance.

The Reference Concept described in this Application reflects a level of design adequate to identify and address significant constraints, evaluate and minimize risk, and limit the potential impacts of the Project. In this context, the extent and nature of environmental effects described in this Application are those that would be anticipated to occur assuming the Reference Concept is developed.

While it is anticipated that this level of detail is sufficient to support the environmental assessment of the Project, the design-build nature of the Project allows for Contractor design refinements, which may include innovative designs or approaches to construction that improve operational performance, reduce construction or operating costs, or avoid or minimize potential effects on environmental or community values.

Such changes, if any, will be limited to those that do not result in Project-related effects over and above those described in the Application and do not extend beyond the defined spatial footprint. With these restrictions, the procurement process provides the opportunity for design improvements during Project delivery while ensuring that the extent and nature of potential Project-related effects presented in this Application are not exceeded.

Changes in a certified project may be undertaken subject to consideration by EAO. Under the *Environmental Assessment Act*, substantive variation from the certified Project Description may trigger the requirement for an amendment to the EAC prior to allowing such works to proceed. The amendment process, which includes an opportunity for stakeholder input, provides a mechanism for considering whether proposed changes in project scope could result in potential adverse effects, and confirming that potential additional effects can be mitigated.

1.1.8 Project Activities by Phase

As required in **Section 1.1** of the Application Information Requirements, the following section provides a description of project activities, supported by figures where appropriate, required to construct the proposed Project.

The Reference Concept (**Section 16.1**) includes figures that show the location, design and dimensions of key physical works, including highway widening and various structural components of the Project including the bridge, interchanges, multi-use paths, staging areas required to support bridge construction, integrated transit infrastructure etc.

Following selection of the private sector partner to deliver the Project, detailed design will proceed and additional information will be available with respect to

- Construction approach and staging for highway improvements including widening and interchange construction
- Pre-Construction and Site Preparation
- Preloading, and aggregate and pre-load materials storage
- Temporary access roads and detours
- Temporary drainage structures
- Erosion and sediment control measures
- Temporary barging facilities
- Temporary lighting
- Establishment of site office(s) and temporary staging and laydown areas

The Contractor's designs will conform to all applicable design criteria, technical requirements and constructability and traffic management considerations as well as special considerations for construction of structures, including deck installation methodologies.

1.1.8.1 Site preparation

Site preparation activities are required to collect design-related data or to make way for construction activities. Site preparation activities typically include the following:

- Surveying – Defining the extent of area where construction works will take place and locate site access roads, temporary detours, utilities and property accesses, and sensitive areas.
- Geotechnical investigations – Assessing existing ground conditions within the Project corridor, including confirmation of pile capacities. Locations where ground improvements are required will be identified through compaction testing and collection of soil core samples.
- Clearing and grubbing – Removing of existing vegetation where required for highway widening and improvement activities. Activities will take place within the right-of-way and will include the removal of organic material and soils that are unsuitable for construction.
- Temporary drainage structures- Establishing of works to maintain existing drainage patterns and manage stormwater runoff within the Project alignment while accommodating temporary access routes and detours.

- Erosion and sediment control measures – Establishing of infrastructure to minimize soil erosion and prevent the release of sediments into water courses during site preparation and other pre-construction activities.
- Staging and laydown areas – Establishing of areas for the staging and/or storage of materials and/or heavy equipment such as cranes and construction materials. Wherever possible, staging and lay-down areas will be placed in previously disturbed areas within the Project alignment.

1.1.8.2 Construction

Temporary Works

Temporary works required to provide temporary access to construction areas include:

- Establishing of access roads and detours – Providing access to construction areas, and isolating construction activities from public traffic. Traffic patterns and property access within the Highway 99 corridor will be maintained throughout the pre-construction and construction phases. A Construction Traffic Management Plan (**Section 12.0 Management Plans**) will be developed to describe the approach to traffic management that will be undertaken during Project construction.
- Temporary lighting – Installing of lighting required to facilitate construction. Community notifications will be undertaken in advance of installation and use of any required nighttime lighting.
- Temporary barging facilities – Establishing temporary barging facilities to facilitate movement of materials and minimize the use of regional and local roads. Barge facilities may be required to assist with the delivery of construction materials. All temporary barge facilities would be removed once no longer required.
- Temporary bridges – Constructing temporary bridges on either side of the existing Deas Slough Bridge to access to Deas Island. These temporary structures will be removed when the bridges are no longer required.

Ground Improvements

Ground improvements are undertaken to minimize settlements and to improve seismic performance. Two ground improvement methods that could be used to support the Project include:

Preloading

Pre-loading is often used to control settlement in areas where there are weak soils. Preloading involves the placement of sand onto the compressible soils, to consolidate underlying material in areas that will support road bed and associated infrastructure. Sand used for pre-load is typically applied in discrete layers to build the amount of load required to achieve the desired level of soil compaction in underlying materials.

Densification

For structures in areas underlain by loose sands prone to liquefaction, ground densification treatment may be required. An example of a ground densification technique is vibro-replacement with stone columns. This technique involves lowering a vibrating probe 20 to 30 m into the ground using water jets and backfilling the cavity created by the probe with clear crushed stone while vibrating to densify the ground and crushed stone.

Highway Widening and Paving

Construction works required to develop proposed highway upgrades include the construction of new lanes within the Highway 99 right-of-way as well as replacement of existing interchanges and over/underpass structures.

General activities that will be undertaken to support highway upgrades include:

Embankment construction

Embankment construction involves removal of unsuitable material and placing of fill or expanded polystyrene (EPS) where there is a requirement to minimize weight. Often embankments are retained by walls to minimize footprint. When walls are not used, the embankment edges slope from the finished to the existing grade at a ratio of 3:1 (i.e., width to height). Slopes are seeded or landscaped in their final configuration. In soft soils, preloads are placed in advance of building the embankment to minimize settlement.

Road base construction

Typical road base preparation for the at-grade sections of the highway will include the following:

- Excavating of unsuitable soils, replacement with suitable material from borrow areas and compacting of the replacement soils
- Establishing of a sub-grade, (the soil surface on which the road will be built) by placing fill on soils that are suitable for construction to achieve the appropriate grade (level) and density (compaction)
- Placing of gravel on the sub-grade, followed by topping with a base-course. The base-course consists of layers of gravel, each of different size.

Paving and line painting

Typically asphaltic concrete, a mixture of liquid asphalt and aggregates in a hot mix solution, is used for road surfaces in B.C. This mixture is prepared off-site and transported to the project where it is applied and rolled to a smooth surface. Asphalt pavement can be produced in a variety of manners to deliver different qualities as required.

Road surfaces will have lane markings in accordance with contract requirements. Lane markings include a reflective component that improves visibility for night driving.

Installation of sign bases, signs, and lighting

Construction signs and new directional signs will be required. Installing highway sign foundations may require excavation and in some cases foundation piles, depending on soil conditions and size of the sign. Sign bases can vary in size; moderate sized excavations and structurally sound foundations are required for large directional signs that span the width of the road, while minor works are required for small signs. Both types of signs will be required at various locations, as dictated by the Ministry specifications.

Interchange and Overpass/Underpass Construction

Interchange and over/underpass construction includes roads, structures, retaining walls and embankments, followed by removal of existing structures once the new structures are in service.

Embankment and road construction for interchanges is the same as for highway widening works.

Construction of interchange structures, overpasses, and underpasses includes undertaking ground improvements, installing foundations, constructing concrete pile caps and piers (substructure), erecting girders, constructing concrete deck (superstructure), and removing existing infrastructure. Ground improvement activities supporting the construction of structures are as described previously. Additional construction activities supporting the development of interchanges and overpasses/ underpasses are described below.

Foundations

Due to the nature of the soft soils along the corridor, many of the new structures will require the use of deep, driven/vibrated or drilled pile foundations. Based on preliminary testing, it is anticipated that the contractor will most likely use driven steel tube piles, which may be partially filled with concrete after driving.

Substructure

Reinforced concrete will most likely be used to construct the concrete piers and abutments. Depending on access to the work site, concrete will be placed using a chute directly from the truck, crane and bucket, or pump truck, or precast concrete will be used.

Superstructure

Interchange and over/underpass superstructures will be constructed with steel girders and/or pre-cast pre-stressed concrete girders and reinforced concrete deck slabs. Girders will likely be lifted into place using one or two cranes or launched from one end of the structure.

After the main superstructure elements (the girders) have been placed, the deck will either be cast in place using conventional formwork or partial depth pre-cast deck slabs will be used as stay-in-place formwork. After the superstructure is complete, compacted backfill will be placed up to the abutments.

Decommissioning existing structures

Many existing structures will be replaced with new structures. Once the new structures are ready, these old structures will be decommissioned. All decommissioned elements, including concrete piers, pre-cast concrete girders, cast-in-place concrete decks and concrete parapets or steel railings will be recycled, or disposed of at an appropriate facility.

The Contractor will provide a decommissioning plan containing specific procedures, including any traffic management plans that may be required to support disassembly and removal. Decommissioning activities will be undertaken in compliance with environmental management plans established for specific demolition works as well as terms and conditions of environmental permits and approvals.

As described in **Section 1.1.8.2**, Project works will be managed to minimize the amount of construction-related waste produced including demolition waste from decommissioned roadway and structures.

New Bridge Construction

The new bridge consists of two parts – the approaches and the river crossing. These will require different construction methods as discussed below.

Approaches

Approach spans will be used to bring the roadway to the elevation required for the river crossing. The approaches will consist of multiple spans constructed using either steel or concrete girders. Approach span construction will include the construction methods discussed in previous sections including:

- Embankment Construction – Embankments will be constructed to a height of approximately eight metres to reduce the length of structure required for the approach spans.
- Foundation construction – Piles will be installed to support the approach spans and soils adjacent to the piled foundations will require densification. On completion of pile driving, the top of the piles are cleaned out and backfilled with concrete.
- Substructure installation – Pile caps will be required to transfer load between the bridge piers and the piles. Pile caps will be cast-in-place reinforced concrete.
- Pier Installation– Piers will be reinforced concrete and could be either precast or cast-in-place. Piers will vary in height from about five metres to more than 50 metres. Pier columns will be sufficiently far apart to allow the existing Highway 99 to continue to operate.
- Superstructure Construction – Construction of the approach span superstructure will be in close proximity to the existing Highway 99 roadway. It is assumed that steel girders will likely be installed using cranes located to the side of the approach spans or by launching them from the abutments. Partial depth precast deck panels would be installed on the steel girders as permanent formwork to allow construction of a cast-in-place concrete deck.

River Crossing

The river crossing will consist of tower foundations, towers, a clear span over the Fraser River, and a backspan on each side of the river to balance the main span. Construction methodologies of these elements are described below.

- Tower Foundations – Tower foundations will be similar to those for the approach spans with approximately 100 large diameter pipe piles required per tower. Stone columns may be required around each pile group to address potential liquefaction.
- Towers – Towers hold the main span's cables and will be in the order of 205 metres tall as measured from existing grade. Towers will be constructed of reinforced concrete. A tower crane mounted on the pile caps will likely be installed to facilitate tower construction.

- Main span – A cable-supported main span of approximately 660 metres is anticipated with the main span deck consisting of a fabricated steel box with either a steel plate deck or a concrete deck. Complete deck sections would be delivered to site by barge and hoisted into place.
- Backspans – Backspans could be either a continuation of the approach spans or similar to the mainspan configuration. If similar to the mainspan configuration temporary works and specialized heavy lifting equipment will be required to transfer deck segments from a barge to shore.

Sequencing and Staging of Bridge Construction

Sequencing and staging of bridge construction will be influenced by the Contractor's construction approach and will be determined in concert with design activities. **Section 16.1 Reference Concept** includes a draft construction staging methodology for the main crossing north and south approaches (**Figures 16.1.1-S-SK01 to SK06** and **16.1.1-N-SK01 to SK06**) that depicts the work to be undertaken and a potential staging approach. The Contractor will provide plans for all elements of the Project including; temporary facilities, detours, staging & laydown areas, etc., that will be finalized through the design submission and review procedures established in the contract.

All staging locations are anticipated to be contained within the Project right-of-way and specific locations will be confirmed once the design of the physical works are finalized. It is expected that over the construction phase of the Project, some staging areas will shift once certain work activities are completed and traffic is relocated. This is similar to the experience on the Port Mann/Highway1 Improvement Project, particularly at interchange locations.

Tunnel Decommissioning

When the new bridge is open to traffic, the Tunnel will be removed. Decommissioning will involve the following activities:

- Removing the central four segments of the Tunnel
- Flooding the remaining two Tunnel segments
- Backfilling the Tunnel approaches
- Removing the ventilation shafts and associated above ground enclosures

The Tunnel consists of the following elements:

- **North and south approach structures** – Structures that allow Highway 99 to transition from above ground to below to access the north and south tunnel portals.
- **North and south portals and ventilation buildings** – Located on the dike on the north bank of the Fraser River and on Deas Island, respectively, these structures provide the transition between the onshore approach structures and the Tunnel segments. These structures also house the electrical and mechanical systems for the pumps and fans used for water and air circulation in the Tunnel.
- **Tunnel Segments** – The Tunnel consists of six, 104 m long segments that form an immersed tube under the Fraser River. The Tunnel was constructed by floating the segments to site where they were lowered into a dredged channel, connected together and then ballasted with a combination of concrete in the Tunnel and riprap on top of the Tunnel.

Key Tunnel dimensions and characteristics of the Tunnel are shown on **Figure 1.1-8**.

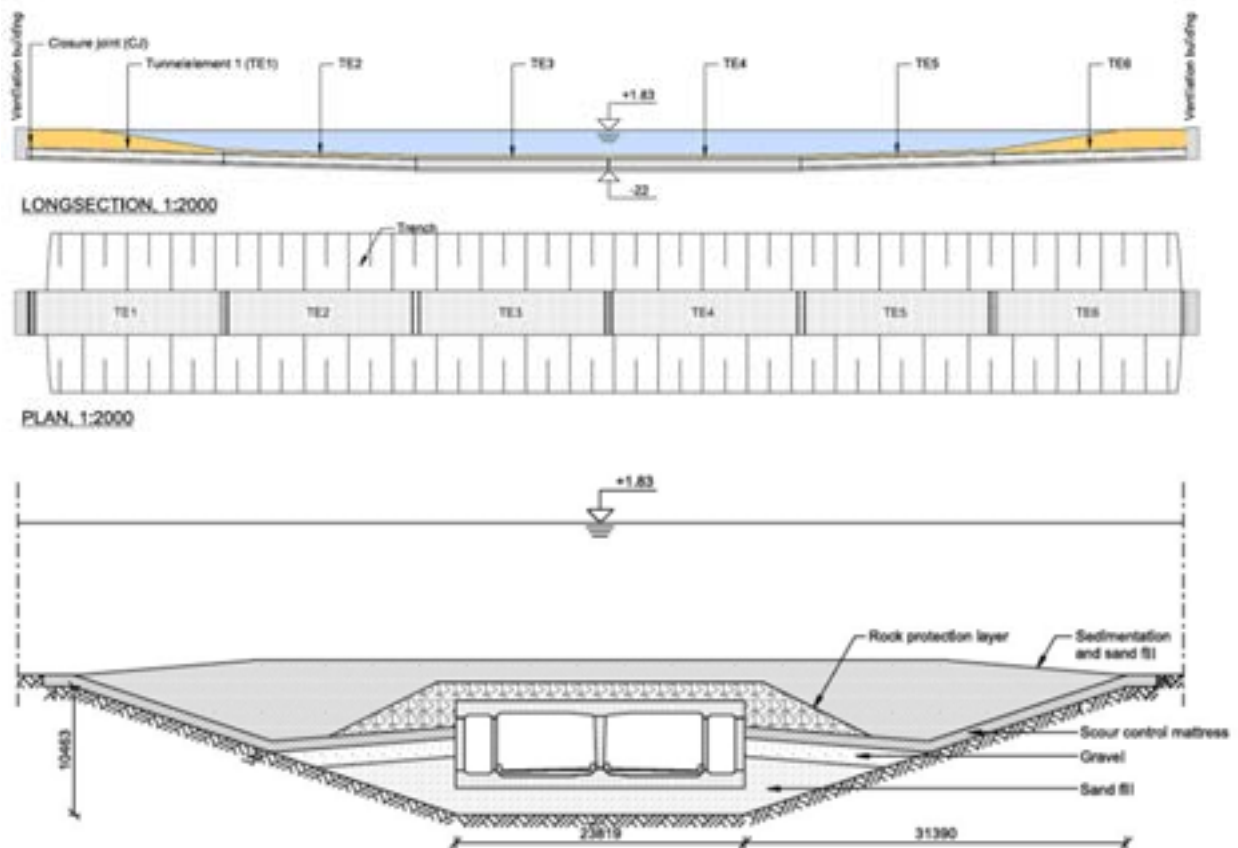


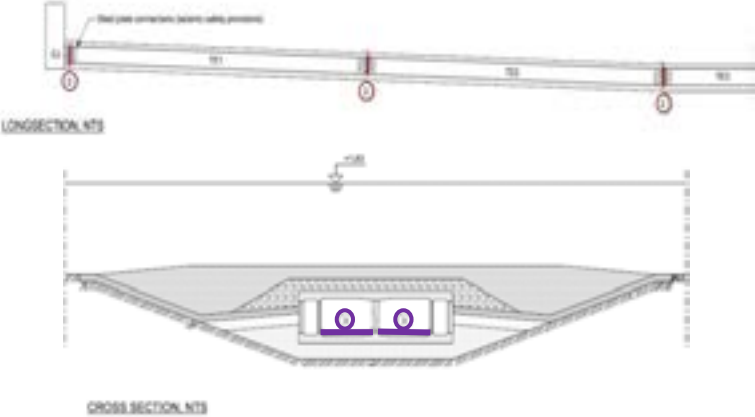
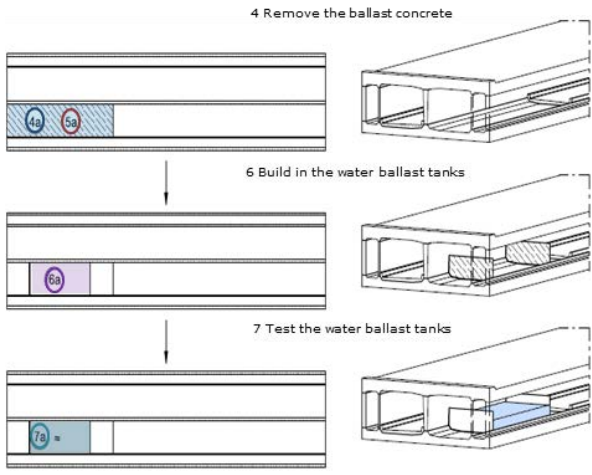
Figure 1.1-8 Tunnel Dimensions and Cross Section

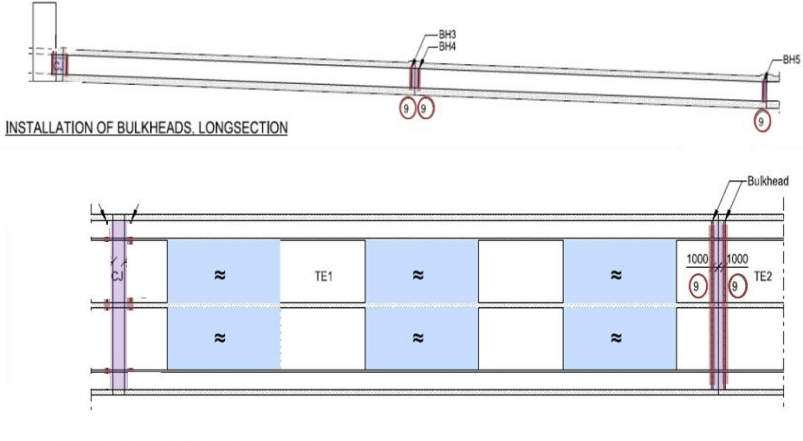
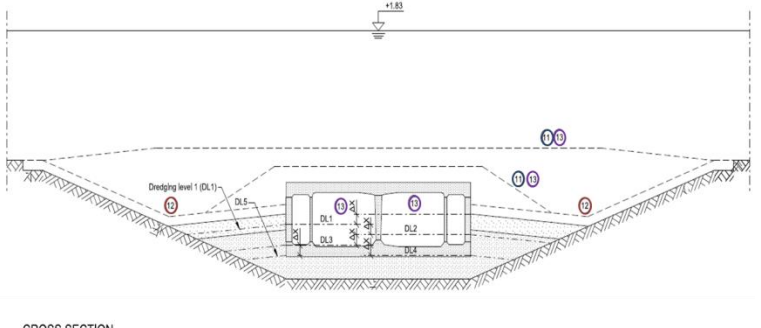
Tunnel decommissioning will involve the sequential removal of instream Tunnel elements and their protective covering by reversing the immersion process that was used to construct the Tunnel. To protect the environment and minimize impacts to marine users during decommissioning, the following requirements will be in effect:

- Maintain navigation in the Fraser River South Arm during Tunnel decommissioning.
- Use BMPs and comply with regulatory requirements, including those related to construction timing windows, notifications, specific mitigation measures.
- Maintain long-term stability and hydrology of the Fraser River South Arm, including water and sediment flow regimes and local ecological conditions.

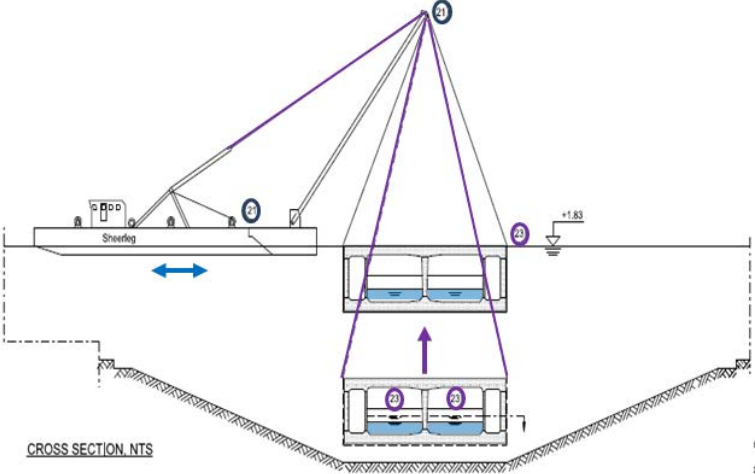
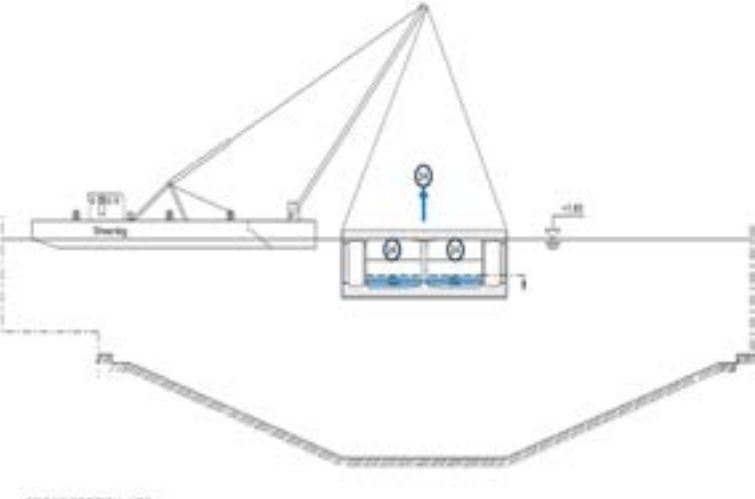
Tunnel decommissioning will be completed within the appropriate construction windows. The Reference Concept for Tunnel decommissioning currently assumes that the four Tunnel elements will be removed over the course of one construction season (i.e., between freshets) and during a window where effects on fish and marine mammals are minimized (**Section 4.4 Fish and Fish Habitat** and **Section 4.6 Marine Mammals**). The process for removing the tunnel segments is outlined in **Table 1.1-5**.

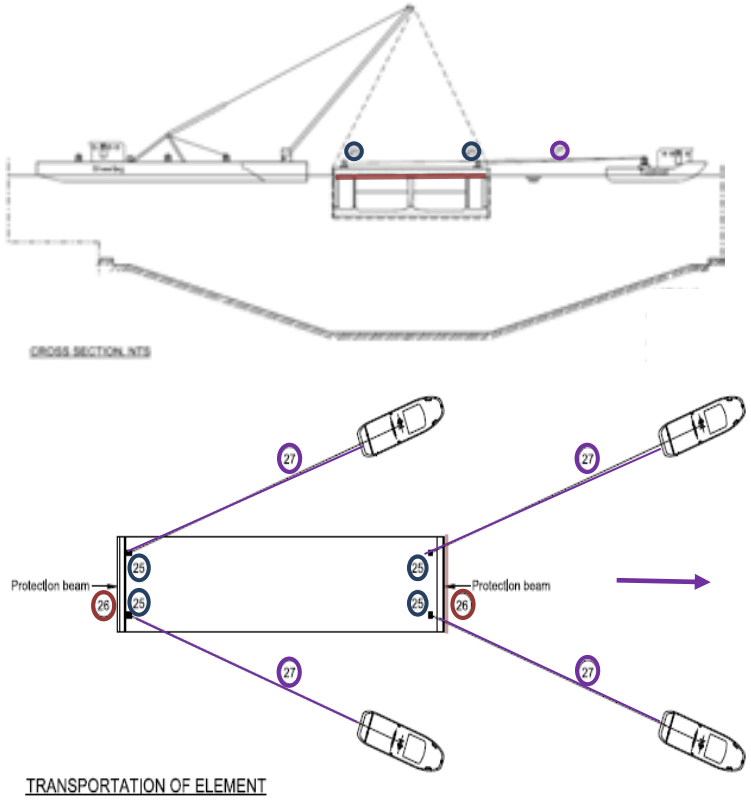
Table 1.1-5 Proposed Sequence of Tunnel Decommissioning Activities

| Decommissioning Activity | Details |
|--|--|
| <p>Permanently close the Tunnel</p> <ol style="list-style-type: none"> 1. Close Tunnel and remove utilities 2. Remove Stage 1 Seismic Retrofit Works 3. Mill asphalt |  <p>The diagrams show the tunnel's internal structure. The 'LONG SECTION, NTS' shows a perspective view of the tunnel with three circular markers labeled '0' along its length. A note above it reads 'Ballast concrete before utility removal'. The 'CROSS SECTION, NTS' shows a top-down view of the tunnel's trapezoidal shape with two circular ballast tanks highlighted in purple at the bottom center.</p> |
| <p>Install ballast tanks</p> <ol style="list-style-type: none"> 4. Mill ballast concrete 5. Clean inside of Tunnel 6. Install water ballast tanks 7. Test ballast tanks |  <p>The sequence shows three stages of installation: <ol style="list-style-type: none"> 4 Remove the ballast concrete: A diagram shows the removal of concrete from the tunnel floor, with markers '4a' and '5a' indicating the area. 6 Build in the water ballast tanks: A diagram shows the installation of a ballast tank, with marker '6a' indicating its position. 7 Test the water ballast tanks: A diagram shows the tank being filled with water, with marker '7a' indicating the water level. </p> <p>SEQUENCE FOR INSTALLING WATER BALLAST TANKS</p> |

| Decommissioning Activity | Details |
|--|---|
| <p>Install bulkheads</p> <ol style="list-style-type: none"> 8. Remove electrical and mechanical equipment 9. Build bulkheads between tunnel segments 10. Pressure test bulkheads |  <p>INSTALLATION OF BULKHEADS, LONGSECTION</p> <p>INSTALLATION OF BULKHEADS, PLAN</p> |
| <p>Remove concrete mattress</p> <ol style="list-style-type: none"> 11. Remove river sediments, riprap, locking fill 12. Remove concrete mattress 13. Remove sand under the Tunnel to break suction |  <p>CROSS SECTION</p> |

| Decommissioning Activity | Details |
|--|---------|
| <p>Install anchors</p> <ol style="list-style-type: none"> 14. Install anchor points for removal 15. Fill space in the closure joint with water 16. Mechanically remove the closure joint 17. Remove the immersion joint as far as the water seal and install provision for jacking elements apart 18. Visual confirmation that element is free | |
| <p>Install cables</p> <ol style="list-style-type: none"> 19. Complete removal of material under the Tunnel segment 20. Install cables under the Tunnel segment | |

| Decommissioning Activity | Details |
|---|--|
| <p>Initiate segment removal</p> <ul style="list-style-type: none"> 21. Position cables for removing segment 22. Connect hydraulic jacks and release segment 23. Lift segment to surface |  |
| <p>Float segments</p> <ul style="list-style-type: none"> 24. Pump ballast tanks to allow segment to float |  |

| Decommissioning Activity | Details |
|---|--|
| <p>Transport segments</p> <ul style="list-style-type: none">25. Prepare element for transport26. Install necessary protection for bulkheads27. Connect element to tug transport off site for recycling |  <p>The diagrams illustrate the process of transporting a tunnel segment. The top diagram, labeled 'GROSS SECTION, NTS', shows a cross-section of a tunnel with a segment being prepared. The bottom diagram, labeled 'TRANSPORTATION OF ELEMENT', shows the segment being moved by four tugboats. The segment is supported by four points, each labeled with a circled '27'. Protection beams, labeled with a circled '26', are installed at both ends of the segment. The segment is shown moving to the right, as indicated by a purple arrow.</p> |

Tunnel segments will be removed sequentially starting at either the north or south side. Shipping will be maintained during removal operations although reducing the navigation to temporarily be one-directional may be required. Back filling after the Tunnel segments have been removed will occur naturally and is anticipated to take about approximately seven months (**Section 4.1 River Hydraulics and River Morphology**). The Metro Vancouver watermain downstream of the Tunnel will be monitored against baseline measurements and additional scour protection will be provided if required.

The approaches to the Tunnel consist of concrete retaining walls with a thick concrete floor. These structures will be left in place and backfilled with clean soil material.

The ventilation buildings located between the Tunnel approaches and the instream segments are concrete structures that are approximately 15 metres below existing grade. After removing all non-structural elements and cleaning, the ventilation building in Richmond will be backfilled and incorporated into a strengthened dike on the Richmond side of the river. Consideration will be given to incorporating the ventilation building on Deas Island into an interpretive area to acknowledge the history of the Highway 99 corridor and the Tunnel.

Ancillary Construction Activities

In addition to the activities associated with specific project phases described in previous sections, the following activities are also associated with the construction of the Project.

Staging Areas

Laydown areas will be required during construction for staging of equipment and storage/preparation of construction materials. Laydown areas will be used for temporary storage of construction or demolition materials such as gravel and pre-cast concrete sections, and for assembly of culverts, formwork and reinforcing steel construction. These areas may also be used for site offices, workshops, equipment storage and other related uses.

Previously developed and disturbed areas within the highway right-of-way are available for staging purposes. The Contractor will confirm the number and location of required staging areas based on the detailed Project design and construction staging plan.

Areas within the right-of-way to be used for staging areas will be managed in accordance with Environmental Management Plans including the Construction EMP (CEMP) (**Section 12.0 Management Plans**). When Project construction is complete, any land used for staging areas and not required for permanent Project infrastructure will be restored to its pre-construction condition. In this context, the use of lands within the right-of-way for staging areas is not expected to result in environmental effects over and above those described in the effects assessment sections (**Part B – Assessment of Environmental, Economic, Social, Heritage, and Health Effects**) of the Application.

The Contractor will be responsible for obtaining required permits and approvals for any additional staging areas on lands other than those within the highway ROW, prior to initiating such works.

Utilities Relocation

Utilities within the right-of-way are under a permit from the Ministry. During Project planning to date, the Ministry has met with all potentially affected permit holders to identify utilities that may need to be relocated or protected.

With the exception of those no longer in use, all utilities located within or immediately adjacent to the ROW will be relocated or protected prior to, or during construction. Potentially affected utilities include water, sanitary sewer, gas, telecommunications, and electrical transmission and distribution lines (overhead and underground).

Utilities owned by BC Hydro, BritishColumbia Transmission Corporation (BCTC), Fortis BC, Kinder Morgan, Shaw Communications Inc., TELUS Communications Company, municipalities and others, are located within the Highway 99 corridor. B.C. Hydro is currently taking steps to relocate the existing 230 kv lines that run parallel to Highway 99 and pass through the Tunnel.

Metro Vancouver's Lulu Island-Delta water main that crosses the south arm of the Fraser River downstream of the Tunnel is not directly adjacent to the Project works and will not need to be relocated. **Section 4.1 River Hydraulics and River Morphology** assesses potential effects to this utility as a result of Tunnel decommissioning and presents mitigation that will be undertaken to avoid effects on this infrastructure.

Given the current stage of Project design, detailed utility relocation requirements are yet to be finalized. As part of confirming the final design of the Project, the Contractor will work with utility companies to identify and address utility relocations and avoid service disruptions and associated costs during construction.

Aggregate and Pre-Load Materials

Aggregate will be required for roadbed construction and the manufacture of concrete for bridge construction. It is assumed that aggregates will be sourced from existing pits and quarries within the region and not through development of new aggregate quarries.

Pre-load material required to support ground improvement will also be obtained through existing sources and vendors and no project-specific works will be undertaken to obtain pre-load materials.

Concrete and Asphalt Production Facilities

Concrete and asphalt will be required for Project construction. While there are a number of facilities in proximity to the corridor that are capable of supplying these materials, it is possible that the final design and construction methodology may include the development of concrete and/or asphalt production facilities within the Project area. Such facilities may be established to help reduce the volume and impacts of construction traffic on local and regional roads, and to expedite the construction schedule.

Areas within the ROW to be used for concrete or asphalt production will be managed in accordance with EMPs including the CEMP (**Section 12.0 Management Plans**). When Project construction is complete, land used for concrete or asphalt production and not required for permanent project infrastructure, will be rehabilitated in a manner consistent with its condition prior to its use for concrete or asphalt production. In this context, the use of lands within the right-of-way for this purpose is not expected to result in environmental effects over and above those described in the effects assessment sections (**Part B – Assessment of Environmental, Economic, Social, Heritage, and Health Effects**) of the Application.

In the event that such facilities are required, details regarding their location and operating requirements, including provision of material input and any environmental permit requirements, will be the responsibility of the Contractor, and will be addressed as part of the final design and construction planning.

Waste Disposal

The Project will be managed to minimize the amount of construction-related waste produced. Construction waste includes demolition waste from decommissioning of roadway and structures and excavated material that cannot be used as fill material along the alignment.

Costs and other constraints associated with conventional waste disposal encourage contractors to re-use or recycle waste material. For example, a variety of technologies are available for recycling pavement. Concrete rubble can be crushed and re-used for road base and other applications and reinforcing bars can be separated and salvaged. Contractors will be able to re-use excavated material for applications such as pre-loading and filling, either at locations along the alignment or at off-site construction projects.

Where disposal of waste is necessary, such activities will be conducted in accordance with the *Environmental Management Act*. Construction waste management procedures and approaches to be followed during construction will be described in the CEMP (**Section 12.0 Management Plans**).

The Project, as currently contemplated, is not expected to involve activities that may require a Disposal At Sea Permit pursuant to the Disposal at Sea provisions of the *Canadian Environmental Protection Act*, 1999, c.33. If the need for disposal at sea does arise, it will be the Contractor's responsibility to liaise with the Regional Ocean Disposal Advisory Committee and acquire the necessary permit from Environment Canada in accordance with applicable regulatory requirements.

Construction Site Offices

The requirement for construction site offices and ancillary buildings will be confirmed as part of the completion of the final design of the Project. Areas within the right-of-way to be used for offices or ancillary buildings will be managed in accordance with the CEMP (**Section 12.0 Management Plans**). When Project construction is complete, land used for these purposes and not required for permanent infrastructure, will be rehabilitated in a manner consistent with its prior condition.

Contaminated Sites Management

Since the Project involves excavation, pile driving and other ground disturbing activities, contaminated soil or groundwater could be encountered during construction if the Project alignment overlaps any contaminated sites. Potentially contaminated material may also be encountered during demolition of existing structures. Project-related considerations pertaining to management of potential contaminated sites are outlined below.

A preliminary study involving a review of current and historical land use information to assess the potential risk of contamination was conducted to identify contaminated sites that may be present within or adjacent to the Project alignment.

The study indicated no substantial risk or concerns related to site contamination for properties within and adjacent to the Project alignment, but did identify six properties with a moderate potential for the presence of contamination. Further reviews and field investigations as appropriate will be completed during later Project planning stages to support the effective management of potentially contaminated soils and/or water during Project construction.

Any contaminated soil or groundwater encountered during construction will be managed in accordance with applicable legislation and regulations, including the B.C. *Environmental Management Act*, S.B.C. 2003, c. 53, and associated *Contaminated Sites Regulation*, *Hazardous Waste Regulation*, and the *Waste Discharge Regulation*. Contaminated sites management will be described in more detail in the Project's CEMP (**Section 12.0 Management Plans**).

Hazardous Materials Management

In 2014, the Ministry undertook a study to identify potentially hazardous building materials commonly used during Tunnel construction. The study identified materials within the Tunnel that must be managed appropriately during decommissioning, including materials that potentially contain lead and asbestos that may require control, containment, or removal prior to decommissioning of the Tunnel.

Building on the results of this study, the Contractor will develop a detailed plan for removing and appropriately disposing of potentially hazardous materials. Hazardous building materials will be managed in accordance with the *Hazardous Waste Regulation* and the Workers' Compensation Board of B.C. *Occupational Health and Safety Regulation*.

1.1.8.3 Project Operations and Maintenance

During the operations phase of the Project a number of operations and maintenance (O&M) services and activities will take place to provide for the operation of the Bridge and associated sections of highway alignment. These activities include, but are not limited to:

- Routine operations, maintenance, and rehabilitation of the Highway
- Bridge/structure maintenance and rehabilitation
- Roadside maintenance, including signage
- Drainage maintenance
- Winter maintenance
- Emergency maintenance

- Traffic maintenance
- Line marking
- Electrical asset maintenance
- Culvert replacement
- Slope stabilization
- Interface with stakeholders, communities, the public, emergency services, and the Province

All O&M activities will be carried out in accordance with established environmental best practices, as described in the Operation EMP (OEMP) for the Project (**Section 12.0 Management Plans**). Services associated with ongoing O&M activities will be provided in accordance with defined performance measures , in a manner consistent with the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).

Regular highway inspections will be scheduled to ensure that maintenance issues are identified and addressed on a continuing and consistent basis. The nature of O&M services varies seasonally with maintenance activities being scheduled at appropriate times of the year. Response times and performance timeframes will be in accordance with contract requirements.

Drainage maintenance and roadside maintenance are ongoing activities that will be undertaken either throughout the year or as needed, based on seasonal requirements and in-stream work windows. Structure maintenance and traffic maintenance (e.g., signage and electrical assets) will be scheduled according to the requirements as identified during highway inspections.

The Contractor responsible for O&M will, as part of the final design, confirm the need for any facilities to store and service highway maintenance vehicles and to store and stockpile roadway maintenance materials and supplies.

Potentially hazardous materials required to support O&M activities will be stored and managed in compliance with local, provincial and federal regulations and Workplace Hazardous Materials Information System (WHIMIS) standards.

The OEMP will include procedures for responding to emergencies including vehicle accidents and spills of hazardous materials.

The Contractor will develop and implement an ISO 9001:2000 certified Quality Management System (QMS) (ISO 2000) that documents the processes and procedures to be used to achieve the requirements. The Ministry will audit the Contractor's systems, procedures and records to verify compliance.

Tolling

The Ministry intends to finance the Project's capital, operating, maintenance, and rehabilitation costs through user tolls. This section outlines the provincial guidelines with respect to tolling highway infrastructure projects and the anticipated tolling system for the Project.

The provincial tolling guidelines (B.C. MOTI 2003) guide tolling of bridges operated by the provincial government. These guidelines are summarized below:

- Only major projects that result in significant capacity increases will be subject to tolling.
- Tolls will be implemented only if there are demonstrable net benefits for the users (user benefits may include time savings, vehicle operating costs, reliability and safety).
- Tolls will be implemented only if a reasonable untolled alternative is available.
- The toll amount and the frequency of increases will be established in advance.
- Public consultation will occur in all cases where tolls are considered.
- The public will have the same rights to access tolled highways as non-tolled highways.
- Tolls will be used to generate revenue for transportation projects and to provide a return on the investment of the private sector partners.
- The same maintenance, safety and other standards, and rules of the road will apply to tolled highways as apply to non-tolled highways.
- The privacy of information used to levy and collect tolls will be protected.
- A fair and expeditious process will be available for resolving tolling disputes.
- The consequences of failing to pay tolls will be fair and reasonable.

Tolling also will help to manage future traffic growth so that the travel time savings, reliability, and vehicle operating cost savings are long lasting.

Key elements of the proposed tolling framework for the Project include:

- A point toll at the bridge.
- A toll rate for four classes of vehicles.
- A fully electronic free-flow collection system.

The point toll model anticipated for the Project involves users paying a toll at the new bridge. Users who do not pass this location are not required to pay a toll. With point tolling, toll collection is commonly located at the most expensive part of a highway corridor, such as a bridge where the major user benefits of the project are realized.

Point toll collection involves the simplest infrastructure, and when combined with modern open road tolling technology, does not require that the traffic stream be stopped for toll collection. This open road point toll system is currently in use at both the Port Mann and Golden Ears Bridges and has proven to be an effective customer-friendly technology over a number of years of operation.

The proposed tolling system will be consistent with the system that is used at the Port Mann and Golden Ears Bridges and will be interoperable with these other existing facilities.

Future regional tolling initiatives

In light of TransLink's plans to construct a new tolled Pattullo Bridge and the Province's plan to toll the new Tunnel replacement bridge, there continues to be vibrant discussion regarding funding future transportation initiatives in greater Vancouver. A number of road pricing options have been suggested, including that all bridges in the region should be tolled.

The Project's Phase 3 consultation program specifically invited feedback on tolling in concert with other elements of the Project Definition Report as described in **Section 11.0 Public Consultation**. Most participants supported some form of tolling. It is anticipated that discussions regarding regional tolling will continue for some time and encompass a broad range of considerations. Any changes to the Provincial Tolling Guidelines may affect additional crossings and would be considered in advance of the anticipated opening of the new bridge in 2022.

Proceeding with self-supporting tolling as currently proposed does not preclude the ability to consider other options such as a longer term regional funding strategy in the future. The Province will also continue discussions with the federal government to explore a funding partnership.

1.1.8.4 Project Procurement and Delivery

The Project will be procured using a Design-Build-Finance-Operate (DBFO) delivery model with a private partner responsible to design, build, partially finance, operate, maintain and rehabilitate the asset for a term of 30 years. This approach is supported by a detailed assessment that has been conducted to determine the procurement model for the Project that is

expected to best meet objectives and provide value to taxpayers. The Procurement Options Report and Business Case provide further detail regarding the analysis of alternative models and are available at www.masseytunnel.ca.

The analysis shows that the DBFO model will best:

- Manage and mitigate key project risks
- Maximize competition, providing innovation and efficiencies
- Maximize corridor service quality and full life asset performance
- Maximize cost and schedule certainty over the full life of the asset
- Provide value for money

Under a DBFO, the contractor is responsible to design and construct the full scope of the Project and assumes all risks related to maintenance and rehabilitation during the operating period. Accordingly, the contractor must carefully consider the long-term rehabilitation requirements and the upfront capital investment to optimize the balance. This extends innovation potential and leverages the expertise of the private sector within a competitive environment so that the final design solutions create value well into the asset's useful life.

The contractor is paid, as set out in the agreement, on achieving key milestones during construction and regularly during operations based on operating performance criteria. Poor performance is subject to penalties until the contractor remedies the problems. By having the contractor commit to a long-term performance-based contract with strict handback conditions, the risk of poor asset performance and deferred rehabilitation is minimized. The DBFO model secures optimal asset quality and performance over the term of the contract and is more likely to result in better asset conditions beyond the term of the contract.

Project procurement will proceed in 2016 to select a private sector DBFO partner. The competitive selection process will include two stages: a request for qualifications (RFQ) stage and a request for proposals (RFP) stage. RFQ respondents will be evaluated based on the strength and relevance of their experience and capability as demonstrated through previous projects. It is anticipated that a short-list of three proponents will be invited to submit a proposal in response to the RFP. The preferred proponent will be selected based on the evaluation criteria set out in the procurement documents.

International and local firms forming joint venture teams are expected to participate in the procurement process. There will be opportunities for local firms to partner/subcontract with these teams. The Ministry is also developing a process to encourage commitment to local participation, including plans for business-to-business workshops that will introduce international firms to local contractors.

Following completion of the procurement process, the successful proponent will finalize the design and proceed with construction. Project delivery will include the engagement of subcontractors and the provision of services aligned with the proponent's purchasing strategy. The breakdown of goods, labour, and services amongst local, provincial, national, and international markets will be influenced by the proponent's design and delivery strategy. Local and provincially based firms are expected to provide a substantial portion of labour and materials during the construction phase of the Project such as design services; supply and placement of asphalt and concrete; electrical and mechanical equipment and services; traffic management; and construction labour.

The overall capital construction cost of the Project is estimated at \$3.5 billion in as-spent dollars. The value of services during the construction phase are anticipated to range between ten and thirty per cent of the overall services for each of the five years of construction; ramping up from year one, with the peak occurring in years two and three and the remainder diminishing through to the completion of construction and commencement of operations.

During the operations phase, annual operating and maintenance costs are estimated in the range of \$15 million to \$25 million, and rehabilitation costs will vary by year (e.g. repaving on a multi-year cycle). It is anticipated maintenance and rehabilitation services will be delivered through a combination of the proponent's in-house resources and local sub-contractors procured through the proponent's purchasing mechanisms.

Further details regarding the estimated value of contracts and services during the construction and operations phases of the Project are confidential as disclosure may harm the negotiating position of the Ministry during the competitive selection processes.

The Transportation Investment Corporation (TI Corp) will oversee the Project and will be responsible for recovering Project costs through tolls.

1.1.9 Costs

The Ministry developed cost estimates for the construction and operations phases of the Project as described in the Capital Cost Estimate Report (Government of B.C. 2015b) and Operations, Maintenance and Rehabilitation Base Cost Estimate Report (Government of B.C. 2015c) based on the reference concept described in this Application. The summary presented below provides an overview of the cost items that were considered in developing of the overall Project capital cost estimate of \$3.5 billion in as-spent dollars. Construction cost categories within the budget estimate include:

- Roadways – site preparation, excavation and fill, paving, barriers, drainage

- Structures – Foundations, substructure, superstructure, approaches, retaining walls
- Tunnel Decommissioning.
- Utilities
- Systems – ITS System, signage/lighting/traffic controls, tolling infrastructure
- Environment – Noise mitigation, habitat enhancement, biofiltration/stormwater management
- Project Management/Engineering – Project management, engineering, health and safety, community relations
- Property – property acquisition, licenses to construct

The substantial majority of capital construction costs is associated with structural elements including the new bridge, new interchanges and Tunnel decommissioning. These elements comprise approximately two-thirds of the overall cost. The Roadway and Systems categories which include highway widening, transit infrastructure and ITS and related work throughout the Project corridor, collectively approximate ten per cent of the construction estimate.

Annual operating costs are estimated in the range of \$15 million to \$25 million. Key operating cost categories include:

- Routine road and bridge maintenance - – surface, drainage, roadside, signage and lane markings, winter maintenance etc.
- Additional services – cable maintenance, maintenance of joists and bearings, painting of structural components, etc.
- Electrical maintenance - traffic signals, lighting.
- General administration/contract support

A breakdown of costs for each construction and operations category as well as anticipated timing of expenditures has been developed and incorporated in the Capital Cost Estimate Report and Operations, Maintenance and Rehabilitation Base Cost Estimate Report. Details regarding specific quantities, costs or cash flow are confidential pending conclusion of the procurement process as disclosure may harm the negotiating position of the Ministry during the DBFO competition to select the private sector partner.

1.1.10 Business Case

A Business Case has been developed that establishes the need for investing in improvements to the Highway 99 corridor and how the Project will contribute to the objectives and strategies to improve transportation infrastructure in greater Vancouver. The George Massey Tunnel Replacement Project Business Case (Government of B.C. 2015d) includes an assessment of the key economic and other benefits of the Project, relative to its costs. Following is a summary of the methodology undertaken and the key conclusions.

Project benefits considered in the business case include:

- **Quantified user benefits** – including travel time, reliability and vehicle operating cost savings, traffic safety, and seismic risk reduction.
- **Unquantified user benefits** – including benefits to cyclists/pedestrians; benefits to future transit; and other unquantified benefits.
- **Economic development benefits** – including increased economic activity and employment, both during construction and in the longer-term.
- **Social, community and environmental benefits and considerations** – such as improved community connectivity; improvements to Deas Island Regional Park; improved emergency response capability; and restoration of the Fraser River shoreline.

Benefits and costs are estimated based on the initial scope of the Project, including a 10-lane bridge (with dedicated transit/HOV lanes, multi-use cyclist/pedestrian pathways, replacement interchanges, highway widening, and tolling similar to the Port Mann and Golden Ears Bridges), compared to the baseline option of maintaining the four-lane Tunnel.

The methodology is based on economic benefit-cost analysis principles, estimating present value (PV) of Project benefits and costs in accordance with provincial guidelines. The analysis of economic benefits and costs is performed in “real” (net of inflation) 2014 dollars with an annual discount rate of six percent applied to future-year benefits and costs. Benefits have been estimated over a 35 year planning horizon.

When compared to the base case of maintaining the existing Tunnel, the Project provides benefits to users as well as to the economy in terms of economic development and employment. In addition, there are socio-economic and other community and environmental benefits anticipated.

The Project capital costs are estimated at \$3.5 billion in as-spent dollars. The present value of net Project costs is approximately \$2.0 billion in 2014 dollars, before allowing for interest during construction.

The summary provided in **Table 1.1-6** shows that the net present value of user benefits is estimated at approximately \$2.5 billion, and the net present value of economic development impacts is in the range of \$1.6 billion. When compared to the net present value of the Project costs, these benefits represent a benefit-cost ratio of 2.1:1; more than twice the Project costs.

Table 1.1-6 Present Value of Benefits and Costs

| | Present Value (2104\$M) |
|--|--------------------------------|
| Total Net Project Cost | \$2,016 |
| Travel Time, Reliability, Operating Cost Savings and Safety/Seismic Benefits | \$2,485 |
| User Benefit/Cost Ratio | 1.2:1 |
| Economic Development Benefits | \$1,652 |
| Total Benefits | \$4,137 |
| Total Benefit/Cost Ratio | 2.1:1 |

The Project also provides for additional unquantified social, community, and environmental benefits as compared to the base case, including:

- Benefits to pedestrians and cyclists
- Benefits to transit users
- Reduced local traffic congestion
- Improved emergency response capability
- Improved cross-highway agricultural and local community connections
- Deas Island Regional Park enhancements
- Environmental restoration/improvements to the river shoreline and land/marine habitat
- Greenhouse gas reductions
- More efficient support of Metro Vancouver’s projected growth in population and employment
- Support of TransLink’s Regional Transportation Strategy

The benefit-cost outlook for the Project is favourable based solely on user benefits such as congestion relief and increased safety, even before considering economic development and job creation as well as benefits for cyclists/pedestrians and local community and recreational users.

1.1.11 Project Benefits

As a key component of the regional, provincial and national transportation system, the Project has been developed to address safety, community, economic, and environmental challenges associated with current and forecast traffic demands at the Tunnel. As such, advancing the Project is anticipated to result in a number of benefits. The following section summarizes Project benefits to economic, social, environmental and health values in local and regional communities. The benefits identified in this section have been determined through studies undertaken to support Project planning.

1.1.11.1 Economic

Employment during construction

Project planning and construction expenditures are estimated to result in direct employment benefits of more than 9,000 jobs. This estimate includes project management, design and engineering, as well as direct employment in construction (Government of B.C. 2015b). In addition, indirect employment benefits of more than 8,000 jobs are estimated for the businesses that support and supply the direct construction activities.

Job numbers are estimated based on the number of individuals employed, while full-time-equivalent (FTE) positions are estimated using an average of 1,750 hours per year. Construction industry workers typically work overtime, i.e. more than the standard weekly hours on which FTE estimates are based. Using the FTE method, the construction employment estimate is approximately 11,000 direct FTEs, plus 8,500 indirect FTEs.

Wage and earning levels in the construction industry are high, and the average income for transportation engineering construction jobs is estimated to be more than \$90,000 annually.

Construction will take place on a year-round basis, with limited seasonal impacts for certain activities (e.g. paving).

Employment during operations

The Project also will directly generate additional permanent jobs, to support ongoing operations and maintenance activities. Based on the experience of the Port Mann/Highway 1 Improvement Project, employment during operations (road and bridge maintenance, tolling, administration) is expected to be in the range of 60 to 90 permanent direct jobs, primarily full-time. Indirect employment during operations is estimated as an additional 60 to 70 permanent jobs.

Wage rates for these permanent positions vary by function, and will be aligned with levels in comparable situations in the Lower Mainland. For example, road and bridge maintenance contracting staff working on the Port Mann/Highway 1 Project inventory have wage levels in the range of \$25 to \$38 hourly, consistent with annual earnings in the range of \$45,000 to \$65,000 in 2011 dollars (prior to cost of living adjustments).

The majority of construction and operations jobs are expected to be filled from within BC, as has been the case with other Lower Mainland transportation projects in recent years.

Tax revenues during construction

During the construction program, the estimated tax revenue impact is \$518 million. This includes \$301 million in tax revenues generated as a result of direct construction activities (mainly income taxes, and some taxes on products), \$164 million from industries further back in the supply chain, and \$53 million in industries benefitting from spending by workers.

By level of government, the \$518 million in tax revenues during construction includes \$162 million accruing to the federal government, \$135 million to the provincial government and \$4 million to local governments (BC Stats 2015).

Tax revenues during operations

During the operations phase, the tax revenue impacts are forecast to follow the annual pattern of contractor construction expenditures, as described in **Section 1.1.7.4**, Project Procurement and Delivery. Annual tax revenues from operating expenditures are estimated at \$4 million per year, including \$2.2 million to the federal government, \$1.6 million to the province, and \$0.3 million accruing to local governments. Most of the ongoing federal and provincial tax revenues are income taxes, while most of the local government revenues are property taxes.

Vehicle travel time savings and reliability during operations

The new bridge will relieve congestion, resulting in important direct user benefits (improved travel times and reliability, reduced vehicle costs, etc.) Travel time savings benefits of 25 to 35 minutes per day for round trip commutes are forecast in the initial year of operation, resulting in more than \$70 million in avoided congestion costs. These user benefits will increase over time, relative to the increasingly congested situation under continued Tunnel operation (Government of B.C. 2015).

Over a 35-year planning horizon, the total economic benefit of travel time savings, is estimated at \$ 1,977 million (Government of B.C. 2015d), reflecting the following types of travel time benefits:

- Time Savings for Weekday Traffic – Current and future Tunnel congestion delays will be eliminated with the operation of the new bridge, resulting in immediate travel time savings for traffic, especially during peak periods.
- Time Savings for Weekend and Holiday Traffic – The new bridge will better accommodate seasonal variations in demand. Traffic and congestion patterns at the Tunnel vary on a daily and seasonal basis, with the greatest delays experienced by the one lane of northbound afternoon traffic (e.g., 45-50 minutes delays on Friday afternoons in August, and often higher).
- Increased Travel Time Reliability – Congestion-related delay times are highly variable from day to day. For example, while the peak delay times for morning mid-week traffic at the Tunnel average 8 minutes, actual delay times from day to day typically range up to more than 20 minutes. The new bridge’s improved reliability will eliminate the need for travellers to build extra time allowances into their travel plans as a guard against arriving late at their destinations.
- Benefits for same-side traffic – Reconstruction of, and improvements to, the existing Highway 17A and Steveston Highway interchanges will provide further travel time savings and reliability benefits for traffic that is not travelling across the new bridge. In particular, significant improvements are being planned for Westminster, Steveston and Highway 17A that will improve cross-highway connectivity and the flow of local traffic.

Vehicle operating cost savings

In addition to travel time savings, the new bridge will also result in reduced vehicle operating costs. The present value of vehicle operating savings, over the 35-year horizon, has been estimated at \$182 million (Government of B.C. 2015d). These savings will result from:

- Reducing congestion-related travel delay times, and increasing average vehicle speeds, resulting in better fuel economy.
- Reducing the wear and tear on vehicles associated with stop-and-go traffic during congested conditions.

Safety benefits

The new bridge also will result in significantly increased safety levels, both in terms of traffic safety and seismic resilience levels.

The Tunnel is designed to 1950s safety standards. Based on a review of current collision rates at the Tunnel and adjacent intersections, and considering the reductions achieved at the new Port Mann Bridge, a 35 per cent overall reduction in collision rates is forecast for the new.

The new bridge also will be designed to modern seismic resistance standards, increasing the crossing's level of seismic resistance from the current 1-in-275-year-earthquake to a future 1-in-2,475-year-quake.

Commercial vehicle economic benefits

By addressing peak-period Tunnel congestion, the new bridge will enable efficient scheduling of commercial vehicle movements throughout the day.

Agricultural economic benefits

Through engagement with the Delta Farmers Institute, the Richmond Farmers Institute and farmers with operations in the vicinity of the Tunnel, the Ministry has worked to ensure that the Project will have important agricultural economic benefits in addition to those described above. These unquantified benefits include:

- Less spoilage/waste as a result of the improved reliability in getting perishable goods to market.
- Increased efficiency of farming operations as a result of the improved travel times and improved access between farms on both sides of Highway 99.
- Improved drainage and irrigation ditches along Highway 99, which will help improve the productivity of existing agricultural lands.
- Potential increase in land available for farming.

Long-term economic development benefits

A number of studies have noted the substantial impacts of traffic congestion on economic development. For example, a 2015 study for TransLink and the Metro Vancouver Mayors' Council estimates that, in 2011 dollars, "...the costs of delay and excess traffic effects (excess time, vehicle costs, accidents, and emissions) amount to about \$407 million and the lost GDP amounts to nearly \$321 million" (MVMC 2015).

Based on the results of a major study of the effects of Lower Mainland transportation infrastructure on economic growth, undertaken by the Greater Vancouver Gateway Council (Delcan 2003), the Project is forecast to increase the rate of regional GDP growth by about \$13 million per year starting in 2021 (Government of B.C. 2015*d*). By 2045 increased rate of

growth is forecast to result in incremental GDP growth of \$325 million per year, and incremental employment (direct, indirect and induced) of approximately 4,500 to 5,000 permanent jobs. The present value of this incremental GDP growth is estimated at \$1.652 billion (Government of B.C. 2015d).

Support for regional population, employment and economic growth targets

Metro Vancouver's regional growth strategy (Metro Vancouver 2015) forecasts that population and employment growth south of the Fraser (Richmond, Surrey, White Rock, Delta, and Tsawwassen) will grow by more than 60 per cent between 2006 and 2041 (an average growth rate of more than 1.4 per cent per year). The new bridge will remove the major bottleneck on the Highway 99 corridor, supporting economic growth in these communities and helping to achieve local and regional population and employment targets.

1.1.11.2 Social and community benefits

Support for local and regional land use and transportation plans

As discussed in **Section 5.1 Traffic** and **Section 5.3 Land Use**, the Project will provide social and community benefits associated with infrastructure that complements the goals and objectives of local and regional land use plans as well as TransLink's Regional Transportation Strategy. Specifically, the Project design, including enhancements for transit, HOV, cycling and pedestrians, will help to address future transportation needs that are anticipated with projected population and employment growth in a manner that supports regional objectives for more sustainable modes of travel.

Improved mobility and transportation choices

As noted in the **Section 1.1.7.1**, the Project design includes improvements that will result in increased travel options for people and changes in the current mode distribution. Improved mobility and transportation choices will result in benefits to people in local and regional communities. Specific benefits provided by the Project include the following:

- **Enhanced Transit and HOV** - The new bridge will provide for a dedicated transit/HOV lane in each direction, while relieving peak-period congestion for all traffic. These dedicated transit/HOV lanes between Bridgeport Road in Richmond and Highway 91 in Delta will support increased use of transit and ride-sharing. In addition, the Project design includes integrated transit stops at the Steveston Highway and Highway 17A interchanges and dedicated transit-only ramps at Bridgeport Road and Highway 17A that will improve the speed and reliability of transit trips. The new bridge will also be designed to accommodate future rapid transit.

- Enhanced pedestrian and cycling access - At present, cyclists and pedestrians are not permitted to use the Tunnel due to safety considerations. A shuttle service through the Tunnel is provided for these users, but operates only during limited hours. The new bridge will include multi-use pathways for pedestrians and cyclists, separated from the vehicle traffic lanes.
- The new multi-use pathways will enable pedestrians and cyclists to travel across the bridge, at all times, rather than having to rely on a periodic shuttle service. Pathways will connect to local walking/cycling routes on either side of the Fraser River including the Millennium Trail in Delta.
- In addition to cycling benefits associated with the new bridge, the Project will provide additional cycling improvements at a number of locations within the Highway 99 corridor to help address gaps in the current cycling network. These improvements will enhance connectivity within and between Richmond and Delta as well as important destinations like the BC Ferries Tsawwassen terminal and Vancouver International Airport to encourage commuter cycling as well as tourism and recreational cycling and walking.
- Improved cross-highway community connectivity and cohesion within communities - If the Tunnel is not replaced, peak period queues on local roads are forecast to grow in the future, with line-ups in Richmond extending along Steveston Highway and other South Richmond roads, as well as backing up along Highway 99. In Delta, Tunnel traffic delays would back up on River Road, Ladner Trunk Road, and other local roads as well as onto Highways 99, 17A and 17. The Project will significantly improve community connectivity across the highway in both Richmond and Delta.
 - In Richmond, the clearances underneath the new bridge, combined with the reconstruction and upgrading of the Steveston Highway overpass and the Westminster Highway overpass will result in improved connectivity between east and west Richmond and new access to/ from Rice Mill Road will improve access for commercial and industrial areas in South Richmond.
 - In Delta, the clearances under the new bridge will create opportunities for the Corporation of Delta to extend River Road helping to improve agricultural, road, and pathway connections across the highway. The new Highway 17A interchange will also improve access between North and South Delta.

1.1.11.3 Environmental

The Project is within an active transportation corridor that has been affected by past development and historic increases in traffic and congestion. The Project represents an opportunity to address current environmental challenges and enhance important environmental features.

Air quality and greenhouse gas emissions

In addition to the quantified user benefits realized through reduced fuel costs, the Project will also provide environmental benefits in terms of reduced greenhouse gas emissions (**Section 4.9 Air Quality**). A reduction in greenhouse gases will result from the combined effects of more fuel-efficient travel speeds and reduced idling associated with:

- Reducing congestion-related travel delay times
- Providing enhanced opportunities for alternate, less fuel intensive modes of transportation (i.e., transit, HOV, cycling, walking)

As discussed in (**Section 4.9 Air Quality**), relieving congestion at the Tunnel will provide benefits with respect to reducing idling-related emissions and result in an improvement in air quality over existing conditions as well as future conditions without the Project.

Habitat enhancement opportunities

The Project includes a number of opportunities for enhancing habitat values in the Project area including:

- Improvements to Deas Island Regional Park – the new bridge will result in enhancements to Deas Island Regional Park by improving the connection between the western and eastern portions of the park after the Tunnel portal is removed. The Project will restore the area under the new bridge with native vegetation and reconstruct marshlands, providing habitat improvements and connections for wildlife. Restoration of the shoreline of Deas Island also represents an opportunity to enhance fisheries values.
- Enhancing habitat values – Re-establishing drainage features parallel to Highway 99 provides an opportunity to enhance habitat values by ensuring the drainage features are designed to maximize habitat benefits.
- Green Slough – Relocating Green Slough back to its pre-Tunnel construction location, will result in benefits to fish and fish habitat by ensuring the design maximizes potential benefit to fisheries and wildlife.
- Improving water quality–Infrastructure to manage stormwater runoff from the road and bridge, including biofiltration ponds, will provide a benefit in terms of attenuating and treating flows before discharge to adjacent watercourses.

1.1.11.4 Health

Traffic safety

The Tunnel and adjacent interchanges have high collision rates. ICBC records indicate an average of 326 collisions annually at the Tunnel and adjacent interchanges between 2005 and 2013, of which approximately one-third involved an injury (B.C. MOTI 2015c).

The Project will result in significant traffic safety benefits, reducing collision rates by more than 35 per cent. This reduction is consistent with the actual traffic safety levels achieved at the new Port Mann Bridge. Overall, the traffic safety benefits resulting from the Project have a present value of \$135 million (Government of B.C. 2015d).

Seismic safety

The Tunnel, originally built to the standards of the 1950s, has been upgraded several times, including a structural strengthening program in 2006 to increase its resistance to failure in the event of an earthquake.

At present, a 1-in -275 year seismic event would lead to Tunnel failure - far below the current design standards of 1-in -2,475 years to be achieved with the new bridge. The seismic risk reduction benefit of the replacement bridge is estimated to have a present value of \$192 million in 2014 dollars (Government of B.C. 2015d).

Improved emergency response

Consultation with emergency responders during Project planning has clearly indicated that the current Tunnel presents challenges in providing emergency fire, police, and ambulance services both within the Tunnel itself and for across-the-river responses. By addressing existing congestion, the Project will result in improved emergency response capabilities and faster response times.

In addition, the Project will be designed to provide improved emergency vehicle access to incidents (e.g., providing better opportunities for police, fire, and ambulance vehicles to turn around and cross over lanes in emergency situations).

Human health benefits

As discussed in **Section 7.1 Human Health**, predicted decreases in vehicle emissions and general improvement in local and regional air quality are expected to result in human health benefits.

In addition to benefits to human health associated with improvements in air quality, the Project will result in broader human health benefits, including those associated with improved access to transit, cycling and walking infrastructure, as discussed in **Section 7.2 Health Impact Assessment**.

1.2 Applicable Authorizations

1.2.1 Provincial Permits and Approvals

This section of the Application identifies the provincial legislation and policies that apply to the Project and the provincial regulatory approvals that may be required following the issuance of an EAC and prior to commencement of Project construction, operation or decommissioning activities (see **Table 1.2-1**). The Ministry will not be requesting concurrent permitting for any of the authorizations under the Concurrent Approval Regulation.

Table 1.2-1 Potential Provincial and Federal Permits, Approvals, and Authorizations

| Name of Authorization | Statute and Authorizing Agency | Description of Need for Authorization |
|---|--------------------------------|---|
| Provincial | | |
| <i>Agricultural Land Commission Act</i> , S.B.C. 2002, c. 36 Agricultural Land Reserve Use, Subdivision and Procedure Regulation, B.C. Reg. 171/2002 Section 6, Permission for non-agricultural use | Agricultural Land Commission | New bridge and related highway corridor widening for new areas located within the Agricultural Land Reserve |
| <i>Environmental Management Act</i> , S.B.C 2003, c. 53 Contaminated Sites Regulation, B.C. Reg 375/96 | B.C. MOE | Soil or sediment requiring removal or offsite disposal during Project construction ² |
| <i>Heritage Conservation Act</i> , R.S.B.C. 1996, c. 187, s. 12 and s.14 Heritage Inspection Permit, Heritage Investigation Permit, or Site Alteration Permit | B.C. FLNR, Archaeology Branch | Heritage inspection, investigation, or site alteration of lands in the Project alignment |

² All material that contains potential contaminants in excess of the standards prescribed under section 7 of the CSR will be subject to a Contaminated Soil Relocation Agreement if they are to be moved offsite to locations other than approved landfills. Discharge of water generated during Project-related activities, such as dewatering or sediment removal, to the sanitary sewer may require a Metro Vancouver waste discharge permit.

| Name of Authorization | Statute and Authorizing Agency | Description of Need for Authorization |
|--|--|---|
| <i>Land Act</i> , R.S.B.C. 1996, c. 245 | B.C. FLNR | Tunnel decommissioning and construction of Project components on provincial Crown land |
| <i>Water Sustainability Act</i> , S.B.C. 2014, c. 15, Section 11 Water Sustainability Regulation, B.C. Reg. 36/2016, Parts 2 and 3 Change Approval (under Part 2 of the Regulation) or Notification (under Part 3 of the Regulation) for changes in and about a stream | B.C. FLNR | Activities in and about watercourses, including construction of the new bridge and approaches, and Tunnel decommissioning |
| <i>Wildlife Act</i> , R.S.B.C. 1996, c. 488 General Permit for wildlife relocation or salvage | B.C. FLNR | Relocation or salvage of wildlife within the Project alignment as required during Project construction |
| Federal | | |
| <i>Aeronautics Act</i> , R.S.C. 1985, c. A-2 Approval for construction of works in or near Canadian aerodromes | Transport Canada | Construction of the new bridge |
| <i>Canada Marine Act</i> , S.C. 1998, c. 10 VFPA Project Permit | VFPA Planning and Development Department | Decommissioning of the Tunnel and construction of Project components within VFPA navigational jurisdiction |
| <i>Fisheries Act</i> , R.S.C. 1985, c. F-14 S. 35(2)(b) Authorization | Fisheries and Canada | Tunnel decommissioning and other Project-related activities within the Fraser River |
| <i>Migratory Birds Convention Act, 1994</i> , S.C. 1994, c. 22 | Environment Canada | Construction of the new bridge, Tunnel decommissioning and other Project-related activities within the Fraser River |
| <i>Navigation Protection Act</i> , S.C. 2014 Permit or Approval | Transport Canada | Tunnel decommissioning, bridge clearance, and other Project-related activities within the Fraser River |
| <i>Species at Risk Act</i> , S.C. 2002, c. 29 Permit or Agreement | Environment Canada | Relocation or salvage of listed wildlife as needed during Project construction |

1.2.2 Federal Permits and Approvals

While the Project does not trigger a federal review under the *Canadian Environmental Assessment Act*, S.C. 2012, c.19, s. 52, federal involvement with the Project is anticipated to include requirement for issuance of a permit, approval or authorization from Department of Fisheries and Oceans (DFO), Environment Canada, TC, or VFPA. Federal legislation and regulatory approvals of relevance to the Project are identified in **Table 1.1-6**.

1.2.3 Other Requirements

The Project involves construction across railway tracks in three locations as identified in **Section 1.1.6.1**. Of these three locations, only the CN rail crossing at Rice Mill Road will result in a potential impact to existing rail infrastructure. The Ministry has and will continue to consult with CN regarding construction access at this crossing as Project planning proceeds. The agreement between the two parties related to construction access will become an order of the Canadian Transportation Agency and will allow the Ministry to undertake the Project according to agreed-upon terms.

In 2003, the Washington State Department of Ecology and the B.C. EAO signed a *Memorandum of Understanding* to facilitate information sharing and mutual understanding of EA/environmental review laws, and notification and information exchange on major project proposals. For the purposes of the agreement, a major project proposal in B.C. is considered to be in the vicinity of the State of Washington if it is located within 100 km of the international border. Given the location of the Project within 13 km of the Canada–U.S. border, the B.C. EAO will be responsible for notifying and providing Project-related information to the Washington State Department of Ecology.

1.3 Alternatives to the Proposed Project

This section presents an assessment of alternatives to the Project described in **Section 1.1**. The scope of the alternatives formally considered in this assessment was informed by the results of public consultation undertaken to confirm the Project need.

Public consultation identified transit-only alternatives for addressing the transportation challenges associated with the Tunnel. Based on this input, early engagement with TransLink, and preliminary analysis on alternatives, it was determined that a transit-only solution would be insufficient given the local, regional, provincial, and national importance of Highway 99 and the combined trip purpose/vehicle requirements/origins and destinations of existing traffic as well as planned future population and employment growth.

In response to interest in enhanced transit along the Highway 99 corridor, the Ministry worked with TransLink and area municipalities to identify transit improvements that could be incorporated into the Project to provide needed capacity improvements while also further encouraging alternatives to single occupancy vehicles. As such, the Project includes measures to promote mode shifts to transit, car-pooling, walking and cycling as alternatives to single occupant vehicles.

Improvements on opening day include dedicated transit/HOV lanes within the median for approximately 24 km in each direction, integrated transit stops within the Steveston and Highway 17A interchanges and a dedicated transit ramp at Bridgeport Road to highway 99, enabling direct transit access to and from the Canada Line at Bridgeport Station and a southbound transit ramp to Highway 17A that will improve the speed and reliability of transit trips. These measures will make transit more convenient and improve the reliability of transit travel times. Multi-use pathways on the bridge with connections to the existing trail and cycling network in Richmond and Delta will allow cyclists and pedestrians to freely cross the Fraser River at this location. The new bridge also will be built to accommodate potential future rapid transit.

1.4 Assessment of Project Alternatives

This section presents an analysis of feasible project options that were identified and considered during the planning phase of the Project, as alternative means to meeting the Project objectives. **Section 1.4.1** provides an overview of technical work undertaken to assess requirements for the number of lanes for the facility. **Section 1.4.2** provides an overview of the multiple accounts evaluation (MAE) conducted on alternative approaches.

1.4.1 Lane Requirements

A 10-lane bridge with one dedicated transit/HOV lane in each direction and four lanes for trucks and cars in each direction (a total of five lanes in each direction) would:

- Significantly reduce traffic collisions due to improvements in merging and reduced weaving.
- Eliminate congestion from opening day and accommodate future traffic growth, with no significant congestion to at least 2045.
- Eliminate the need for a counterflow operation.
- Provide a separate lane for trucks and other slower-moving traffic as they navigate the grade of the new bridge (similar to the Alex Fraser Bridge), without compromising travel times for faster-moving traffic.

- Potential to convert the transit/HOV lanes to rail rapid transit at some future point while retaining four lanes of capacity in each direction.
- Have a more favourable benefit-cost ratio, despite having a higher cost than an eight-lane crossing.

Operational modelling has shown that a 10-lane bridge provides proportionately greater benefits than an eight-lane bridge, which would have peak-period congestion on opening day. The 10-lane bridge provides a higher benefit-cost ratio despite the slightly higher cost, and would result in no significant change in total traffic volumes as compared with an eight-lane bridge.

Further details of the lane assessment are presented in George Massey Tunnel Replacement Project Traffic Data Overview Report (Government of B.C. 2015a).

1.4.2 Assessment of Alternatives

The information presented in this section summarizes the methodology and key conclusions of the evaluation of crossing scenarios presented in Evaluation of Crossing Options (MMK 2014) and includes:

- Description of crossing scenarios (alternatives) considered
- Evaluation methodology
- Identification of the preferred alternative

1.4.2.1 Identification of crossing alternatives considered

In 2012 the Ministry initiated consultation on the replacement of the George Massey Tunnel. The Phase 1 consultation process focused on understanding the project need, determining objectives, and developing the preliminary project scope and design requirements.

As a result of this consultative process, six Project goals were identified as outlined in **Section 1.1.1**.

The results of this phase of consultation were used to inform Phase 2 Consultation, undertaken in 2013, which focused on considering the following five alternatives, referred to as scenarios in the MAE, that were developed as a result of consultation input and technical analysis:

- 1) Maintain existing Tunnel: Rehabilitate the Tunnel's mechanical systems, improve its ability to withstand future earthquakes (although not to new-construction standards), and make improvements to the existing interchanges at Steveston (to the north) and Highway 17A (to the south).

- 2) Replace existing Tunnel with new bridge: Construct a new bridge along the existing right-of-way, after which the Tunnel would be decommissioned.
- 3) Replace existing Tunnel with new Tunnel: Construct a replacement Tunnel along the existing right-of-way, likely upstream from the existing Tunnel, after which the existing Tunnel would be decommissioned.
- 4) Maintain existing Tunnel and build new crossing along existing Highway 99 Corridor: The new crossing could be either a bridge or Tunnel.
- 5) Maintain existing Tunnel and build new crossing in a new corridor. The new crossing would be a bridge located between the existing Tunnel and the Alex Fraser Bridge, and accessed via the South Fraser Perimeter Road on the south side and via a newly constructed connection to Highway 91 on the north side.

1.4.2.2 Evaluation Methodology

The evaluation methodology that was used to consider the five project alternatives noted above, incorporated a multiple accounts evaluation (MAE) framework that included specific criteria, grouped under six categories as below:

- 1) Efficient transportation for all users – traffic congestion; transit capability; travel time reliability; and pedestrian and cycling accessibility.
- 2) Safety – incident response capability; earthquake protection; and traffic safety.
- 3) Agriculture – agricultural land effects; and access to/from agricultural areas.
- 4) Environment – local and regional air quality; wildlife and terrestrial habitat; and marine life and habitat.
- 5) Jobs and the economy – access to gateways and trade corridors; access to business and industrial land; and marine access for goods movement.
- 6) Social and community considerations – community access (including across the highway within communities); private property effects; noise effects; and visual effects.

In addition to the evaluation criteria identified during Phase 2, capital costs and risks were included in the analysis. This resulted in a total of 28 individual criteria within seven major categories (**Table 1.4-1**). Most of the evaluations were performed on a four-point scale, based on the degree to which each scenario is assessed as potentially achieving the relevant project goals, relative to the other scenarios. Capital and O&M costs were compared on a three-point scale, since the scenarios are high-level concepts for which detailed cost information was not available at the time of the evaluation. The individual assessments, and the overall comparison of scenarios, represent the combined results of preliminary planning and technical work undertaken by the Ministry and its engineering, environmental, and economic/financial advisors, as well as the public feedback and input received through the Phase 1 and Phase 2 consultation and review processes.

Table 1.4-1 MAE Assessment of Project Alternatives

| Evaluation Area | Specific Criterion | Alternative | | | | |
|-------------------------------------|--|--------------------|-----------------------|-----------------------|--|---|
| | | 1. Maintain Tunnel | 2. Replacement Bridge | 3. Replacement Tunnel | 4. Maintain Tunnel, Add In-Corridor Crossing | 5. Maintain Tunnel, Add New-Corridor Crossing |
| Transportation efficiency | Traffic congestion | xx | ✓✓ | ✓✓ | ✓✓ | ✓ |
| | Transit capability | * | ✓✓ | ✓✓ | ✓✓ | ✓ |
| | Travel time reliability | xx | ✓✓ | ✓✓ | ✓✓ | ✓✓ |
| | Pedestrian and cyclist accessibility | xx | ✓✓ | ✓ | ✓✓ | * |
| | Overall assessment | xx | ✓✓ | ✓✓ | ✓✓ | ✓ |
| Safety | Incident response capability | xx | ✓✓ | ✓ | ✓ | ✓ |
| | Earthquake protection | xx | ✓✓ | ✓✓ | * | * |
| | Traffic safety | xx | ✓✓ | ✓✓ | ✓ | ✓ |
| | Overall assessment | xx | ✓✓ | ✓✓ | ✓ | ✓ |
| Agriculture | Agricultural land effects | ✓✓ | ✓ | * | * | xx |
| | Access to and from agricultural areas | * | ✓ | * | * | xx |
| | Overall assessment | ✓ | ✓ | * | * | xx |
| Environment | Local air quality | * | ✓ | * | * | * |
| | Regional air quality | * | * | * | * | xx |
| | Wildlife and terrestrial habitat | ✓ | ✓ | * | * | xx |
| | Marine life and habitat | * | ✓ | xx | xx | xx |
| | Contaminated sites | ✓ | * | xx | xx | xx |
| | Overall assessment | * | ✓ | xx | xx | xx |
| Jobs and the economy | Economic and employment impacts | | | | | |
| | Marine traffic effects during construction | xx | ✓✓ | ✓✓ | ✓✓ | ✓✓ |
| | Road access to gateways and trade corridors | * | ✓ | xx | * | * |
| | Marine access to gateways and trade corridors | xx | ✓✓ | ✓✓ | ✓✓ | ✓ |
| | Access to business and industrial land | * | ✓ | ✓ | * | * |
| | Access to business and industrial land | * | ✓✓ | ✓✓ | ✓✓ | ✓ |
| | Overall assessment | xx | ✓✓ | ✓ | ✓ | ✓ |
| Social and community considerations | Access across the highway within communities | xx | ✓✓ | ✓ | ✓ | * |
| | Private-property effects | ✓✓ | ✓ | * | ✓ | xx |
| | Compatibility with community/regional planning | * | ✓ | ✓ | ✓ | * |
| | Noise effects | ✓✓ | * | * | * | xx |
| | Visual effects | ✓✓ | * | ✓ | * | * |
| | Overall assessment | ✓ | ✓ | * | * | xx |
| Financial costs and risks | Capital construction costs | \$ | \$\$ | \$\$ | \$\$ | \$\$\$ |
| | Capital cost risks (construction) | xx | ✓ | * | xx | xx |
| | Capital cost risks (operations) | * | ✓ | ✓ | * | * |
| | Operating and maintenance costs | \$ | \$ | \$\$ | \$\$\$ | \$\$\$ |
| | Overall assessment | * | ✓ | * | xx | xx |

Notes: ✓ relatively high achievement of goals; ✓✓ very high achievement of goals; * relatively limited achievement of goals; xx low/no achievement of goals; \$ relatively lower cost; \$\$ mid-range relative cost; \$\$\$ relatively higher cost. Retrieved from George Massey Tunnel Replacement Project - Evaluation of Crossing Scenarios (MMK 2014).

Selection of the preferred alternative

As summarized on **Table 1.4-2**, Alternative 2 (Replacement Bridge) was identified as the superior alternative. Its overall rating was similar to or preferred to the four other alternatives in each evaluation area. The comparative ratings for Alternative 2 for each evaluation area, are as follows:

- **Transportation efficiency** – Benefits in terms of congestion relief, transit capability, and travel time reliability, associated with Alternative 2, are similar to those of Alternatives 3 and 4, greater than those of Alternative 5, and much greater than those of Alternative 1. Alternative 2 is also preferable (along with the Alternative 4 bridge option) in terms of the potential to improve pedestrian and cyclist accessibility.
- **Safety** – Alternatives 2 and 3 are preferable in terms of both traffic safety and seismic (earthquake) safety. An all-new crossing would be designed to significantly higher standards than what is achievable through maintaining the existing Tunnel.
- **Agriculture** – Alternative 2 is preferable to all other alternatives in improving the connectivity between agricultural areas on either side of the corridor, because of the ability to provide access underneath the bridge for agricultural traffic. Alternative 2 would require more properties to be acquired than Alternative 1, where acquisition requirements would be minimal.
- **Environment** – Alternative 2 is preferable or similar to all other alternatives in terms of marine and aquatic biota, wildlife, shorelines, habitat, and regional air quality. Under Alternative 2, bridge piers can be situated outside of the river, while all other alternatives would involve significant in-river disturbance. Alternative 2 is also preferable to all other alternatives in terms of local air quality, because particulates can naturally disperse in the open air, minimizing local concentrations.
- **Jobs and the economy** – Alternative 2 is considered to provide longer-term employment and economic benefits relative to Alternative 1, and is similar to or higher than every other alternative. Alternative 2 would also have the least effect on marine traffic during construction.
- **Social and community considerations** – Alternative 2 has the greatest ability to improve access across the highway between communities, because of the potential for local road connections underneath the bridge abutments on either side of the crossing. Alternative 2 also provides the capacity to serve the existing and future transportation needs of the population targets for the adjacent communities (Richmond, Delta, Tsawwassen, Surrey, White Rock) established by Metro Vancouver's RGS (2015). Alternative 2 would introduce new above-ground visual and noise effects at the existing crossing that would require mitigation.

A detailed description of the analysis of each alternative, is presented in George Massey Tunnel Replacement Project Evaluation of Crossing Options (MMK 2014).

The results of the evaluation of the remaining alternatives was as follows:

Alternative 1 – Maintaining the Tunnel

The evaluation of maintaining the Tunnel indicated that, even with investments to address seismic resistance and rehabilitate aging internal infrastructure, this alternative would not contribute to achieving most of the Project objectives including primary objectives related to transportation efficiency (i.e., congestion, travel time reliability, pedestrian and cyclist access etc.). Maintaining the existing Tunnel would also not provide for improved access to agriculture nor provide benefits with respect to improved access within and across communities or support community and regional planning objectives.

While upgrades to the infrastructure associated with this alternative would reduce seismic risk, the rehabilitated infrastructure would not meet current seismic standards and the existing traffic safety issues associated with the lower design standards (i.e., lane widths and clearances) would remain. Tunnel rehabilitation would also result in substantially greater construction effects on marine users and river-associated environmental values. In addition, while maintaining the Tunnel would have the lowest capital construction costs it would not contribute to achieving the employment and economic objectives of the Project and would have the highest capital cost risk associated with works required to address the current seismic issues.

Alternative 3 – Replacement Tunnel

While replacing of the Tunnel with a new tunnel would meet many of the transportation and safety objectives of the Project, construction works associated with building a new tunnel would have substantially larger effects on marine users, fisheries and habitat values and agricultural land requirements. In addition, local air quality that is influenced by the concentration of vehicle emissions at the tunnel portals would not be addressed. While estimated capital costs for building a replacement tunnel would be similar to the proposed Project, there would be substantial risk associated with building in proximity to the existing Tunnel.

Alternative 4 – Maintain Tunnel/New crossing in 99 corridor

Maintaining and rehabilitating the Tunnel and adding a new crossing in the Highway 99 corridor would meet many of the transportation efficiency objectives of the Project as well as social and community considerations. However, safety objectives of the Project, including incident response, earthquake protection and traffic safety, would not be fully achieved. Rehabilitating the Tunnel would also result in greater effects to marine users and in-river environmental values during construction, as is the case in Alternative 1. Maintaining the Tunnel would also not result in improvements to local air quality as the concentration of air emissions at the Tunnel portals would remain.

In addition to the challenges associated with maintaining the Tunnel, construction of a new bridge crossing in the Highway 99 corridor would require an offset from the alignment of the Tunnel resulting in greater effects on agricultural land required for the bridge approaches. The combination of rehabilitating and maintaining the Tunnel and building a new bridge crossing also results in amongst the highest operation and maintenance costs and substantial risk during construction

Alternative 5 - Maintain existing Tunnel/new crossing in new corridor

Maintaining and rehabilitating the Tunnel and adding a new bridge crossing in a new corridor would meet some of the transportation efficiency objectives of the Project though would not address pedestrian and cycling access or seismic considerations. The requirement for a new corridor associated with Alternative 5 would result in the greatest effects on agriculture and the environment as well as substantial socio-community effects including noise issues. Establishing a new corridor would also result in the greatest capital construction costs as a result of the requirement to acquire land.

As with other alternatives involving retention of the Tunnel, safety objectives of the Project, including incident response, earthquake protection and traffic safety would not be achieved. Rehabilitating the Tunnel would also result in substantial effects to marine users and in-river environmental values during construction and would not address local air quality concerns associated with the concentration of air emissions at the Tunnel portals. The combination of maintaining the existing Tunnel and establishing a new corridor would result in the highest capital construction costs and risk as well as high operating and maintenance costs.

Table 1.4-2 Summary comparison of project alternatives

| Evaluation Area | Alternative | | | | |
|-------------------------------------|--------------------|-----------------------|-----------------------|--|---|
| | 1. Maintain Tunnel | 2. Replacement Bridge | 3. Replacement Tunnel | 4. Maintain Tunnel, Add In-Corridor Crossing | 5. Maintain Tunnel, Add New-Corridor Crossing |
| Transportation efficiency | xx | ✓✓ | ✓✓ | ✓✓ | ✓ |
| Safety | xx | ✓✓ | ✓✓ | ✓ | ✓ |
| Agriculture | ✓ | ✓ | x | x | xx |
| Environment | x | ✓ | xx | xx | xx |
| Jobs and the economy | xx | ✓✓ | ✓ | ✓ | ✓ |
| Social and community considerations | ✓ | ✓ | x | x | xx |
| Financial costs and risks | x | ✓ | x | xx | xx |
| Overall evaluation | | Preferred | | | |

Notes: ✓✓ very high achievement of goals; ✓ relatively high achievement of goals; x relatively limited achievement of goals; xx low/no achievement of goals. Retrieved from George Massey Tunnel Replacement Project - Evaluation of Crossing Scenarios (MMK 2014).

Financial costs and risks

The capital costs associated with Alternative 2 are expected to be similar to those of Alternatives 3 and 4, and to be significantly lower than those of Alternative 5. While capital costs are much higher for Alternative 2 than Alternative 1, Alternative 1 does not achieve the Project’s key safety and congestion relief goals, and is only a medium term option due to the existing Tunnel’s age and condition. With regard to risks, Alternative 2 is assessed as having lower risks during both construction and operation than any other alternative, due to (a) avoiding the need to undertake seismic improvements to the existing Tunnel that would be required under Alternatives 1, 4 and 5, and (b) avoiding the significant in-river work that would be required under Alternative 3.

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2.0 Environmental Assessment Process

2.1 Provincial EA Process

On December 16, 2015, the Environmental Assessment Office (EAO) issued a section 10 Order confirming that the Project is a reviewable project pursuant to the B.C. Environmental Assessment Act (*EAA*), and that it requires an EAC. On March 7, 2016, EAO issued a section 11 Order which outlines the scope, procedures and methods for the environmental assessment of the Project. The section 10 and 11 Orders are available on EAO's website (https://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_430.html).

This section describes the regulatory context for the proposed George Massey Tunnel Replacement Project (Project), the need for an environmental assessment (EA), and the key EA process milestones.

This section provides an overview of participation from Aboriginal Groups, the public, and government agencies in the Project's EA prior to and during the pre-Application stage. More detail, including information on consultation planned during the Application Review stage is provided in **Section 10 Aboriginal Consultation** and **Section 11 Public Consultation** of the Application.

2.1.1 Regulatory Context

2.1.1.1 Project Triggers under B.C. *EAA*

The Project was deemed reviewable by EAO under section 10(1)(c) of the B.C. *EAA* on December 16, 2015. The Project constitutes a reviewable project pursuant to Part 5 of the Reviewable Projects Regulation (B.C. Reg. 370/02), as it involves a dismantling or abandonment of an existing shoreline modification facility that, if it were a new facility, would entail dredging, filling, or other direct physical disturbance of equal to or greater than 2 ha of foreshore or submerged land, or a combination of foreshore and submerged land, below the natural boundary of an estuary. It also constitutes a reviewable project pursuant to Part 8, as it involves a modification of an existing public highway that results in the addition of equal to or greater than 2 lanes of paved public highway to an existing paved public highway over a continuous distance of equal to or greater than 20 km. As a reviewable project, the Project requires an EAC before provincial agencies can issue other necessary approvals required to start construction.

2.1.1.2 Application Development

The Application has been developed pursuant to the Application Information Requirements (AIR) that EAO approved on May 24, 2016 and complies with relevant instructions provided in the section 11 Order issued on March 7, 2016.

2.1.2 Key EA Process Milestones

Table 2.1-1 documents the Project’s key EA process milestones.

Table 2.1-1 Key EA Process Milestones for the Project

| Key Milestones | Date |
|--|---------------------------------|
| EAO Issued Documents | |
| Section 10 Order Available online on EAO Project Information Centre (e-PIC): https://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39645.html | December 16, 2015 |
| Section 11 Order Available online on e-PIC: https://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39946.html | March 7, 2016 |
| AIR Available online on e-PIC: https://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_40443.html | May 24, 2016 |
| Technical Working Group Meetings | |
| Technical Working Group Meeting #1 | January 21, 2016 |
| Technical Working Group Meeting #2 | March 10, 2016 |
| Public Comment Periods | |
| Public comment period on the Project Description and Key Areas of Study | January 15 to February 15, 2016 |
| Open houses | January 26/27, 2016 |

2.1.3 Aboriginal Groups Participation

This section provides an overview of the consultation activities undertaken before and during the Project's pre-Application stage with Aboriginal Groups potentially affected by the Project, as identified in the section 11 Order, and as outlined in the Aboriginal Consultation Plan. Additional information is provided in **Section 10 Aboriginal Consultation**.

The Ministry is committed to ongoing consultation and engagement with Aboriginal Groups. The Aboriginal Consultation Plan and the Aboriginal Consultation Report describe the consultation activities the Ministry has and will undertake during the pre-Application, Application, and post-Application phases of the EA to satisfy the requirements of the section 11 Order.

2.1.3.1 List of Aboriginal Groups that Participated in the EA

The following Aboriginal Groups, as set out in the section 11 Order, have participated in the EA and were invited to participate in EAO's Technical Working Group:

- Cowichan Tribes
- Halalt First Nation
- Katzie First Nation
- Kwantlen First Nation
- Lake Cowichan First Nation
- Lyackson First Nation
- Musqueam Indian Band
- Penelakut First Nation
 - Hwlitsum¹
- Semiahmoo First Nation
- Squamish Nation
- Stz'uminus First Nation
- Tsawwassen First Nation
- Tseil-Waututh Nation

In accordance with the section 11 Order, notification of the Project and the Technical Working Group process has been sent to People of the River Referrals Office.

¹ This reference to the Hwlitsum is not intended to signify any change in the position that the Province may have taken in other contexts in relation to the duty to consult with this group.

2.1.3.2 Summary of Aboriginal Group Participation

Initial Consultation

The Ministry recognizes the importance and value of early engagement with the Aboriginal Groups that have Aboriginal Interests within the Project area, and undertook an Initial Consultation Phase prior to the pre-Application phase. The Ministry consulted with all of the Aboriginal Groups later assigned to Schedule B of the section 11 Order. During the Initial Consultation Phase, the Ministry also offered to meet with the Stō:Lò Nation and Stō:Lò Tribal Council and received a deferral from the People of the River Office (representing member communities of the Stō:Lò Nation and Tribal Council) in May 2014. In January 2016, PRRO advised EAO of their interest in deeper consultation given the decommissioning of the Tunnel component of the Project including the removal of sections of the Tunnel. As a result, EAO added PRRO to Schedule C of the Section 11 Order in March 2016.

At meetings with Aboriginal Groups, the Ministry provided introductory information regarding the Project scope and schedule, sought input with respect to Aboriginal Groups' current use of the Project alignment for traditional purposes and obtained information on concerns related to potential impacts on Aboriginal interests. The Ministry also sought to determine community-specific preferences with respect to participation in Project consultation, EA review, and related activities. During this phase of consultation, communications protocols were established and key contacts were identified and/or confirmed.

Pre-Application Phase Consultation

The Ministry consulted with all Schedule B Aboriginal Groups during the Pre-Application Phase. In addition to meetings with Chief and Council and/or Aboriginal Groups' staff, the Ministry also facilitated site visits and community meetings; facilitated participation of Aboriginal Groups' representatives in fieldwork; and participated in two, EAO led, Technical Working Group meetings.

During this phase, the Ministry sought input into key Project and EA planning documents. Schedule B Aboriginal Groups were provided funding for Traditional Use or other Project related studies.

2.1.3.3 Key Issues Raised

The Ministry maintains an Aboriginal Group consultation record to track communication and consultation activities. A high-level overview of the key issues raised by Aboriginal Groups during the Initial and pre-Application consultation phases is provided below. A detailed breakdown of issues identified by individual Aboriginal Groups, and the status of those issues is presented in **Appendix B of Section 10 Aboriginal Consultation**.

The key issues raised during pre-Application consultation included:

- Environmental Assessment Process
- Potential effects to Aboriginal Interests (fishing, harvesting, cultural and social resources, trade, land use, marine navigation and knowledge transfer)
- Consultation and engagement
- Participation in Project
- Cumulative effects
- Accidents and Malfunctions
- Tolling
- Traffic
- Potential Project-related effects to:
 - Air Quality
 - Archaeology and heritage resources
 - Atmospheric noise
 - Contaminated sites
 - Fish and fish habitat
 - Human health
 - Marine use
 - River hydraulics
 - Terrestrial Wildlife
 - Water quality and sediment

Feedback received from Aboriginal Groups has helped in developing the avoidance, mitigation, and management strategies for the Project. A description of the Ministry's procedures for tracking and reporting on information received from Aboriginal Group consultation is provided in **Section 10 Aboriginal Consultation**. For a complete summary of key issues raised and status of resolution, please refer to **Appendix B in Section 10 Aboriginal Consultation**. The Ministry is committed to ongoing consultation and engagement with Aboriginal Groups. As described in the Aboriginal Consultation Plan, consultation and engagement will continue through the Application review and post-Application stages.

Table 2.1-2 Summary and Status of Key Issues Raised by Aboriginal Groups

| Issue Raised | EA Section Reference/Status |
|--|--|
| Environmental Assessment Process and consultation process | The environmental assessment process is discussed in this section, and more specifically focused to Aboriginal Groups in Section 10.0 Aboriginal Consultation . |
| Potential Project-related effects to Aboriginal Interests | Historical and current Aboriginal Interests and the potential interactions of the Project on Aboriginal Interests are discussed in Section 10.0 Aboriginal Consultation . |
| Aboriginal Participation and Project Related Opportunities | Aboriginal participation in the Project is discussed in this section and in more detail in Section 10.0 Aboriginal Consultation |
| Cumulative Effects | Applicable projects and the methodology undertaken to assess cumulative effects are discussed in Section 3.0 Methodology . |
| Potential accidents or spills during Project construction | Potential Project-related construction or operation phase accidents or malfunctions are discussed in Section 8.0, Accidents and Malfunctions |
| Changes in air quality as a result of the Project | Potential changes in air quality as a result of the project are discussed in Section 4.9 Air Quality |
| Potential effects to archaeology and heritage resources within the Project area | Archaeological and heritage resources have been assessed and are discussed in Section 6.1 Heritage and in Section 10.0 Aboriginal Consultation |
| Potential increased atmospheric noise during Project construction | Potential changes in atmospheric noise as a result of construction and operation of the project are discussed in Section 4.10 Noise |
| Potential Project-related effects to fish and fish habitat | Section 4.4 Fish and Fish Habitat |
| Potential Project-related effects to health | The potential for the Project to effect health is discussed in Section 7.0 Human Health |
| Potential disruptions to marine use affecting Aboriginal use of the Project area | Potential Project-related changes to commercial, recreational, and Aboriginal navigation and fishing activities during construction or operation are discussed in Section 5.2 Marine Use and in Section 10 Aboriginal Consultation |
| Potential changes in riverbed during and following Tunnel removal | Potential changes to river hydrology and morphology during and after Tunnel removal are discussed in Section 4.1 River Hydraulics and River Morphology |

| Issue Raised | EA Section Reference/Status |
|---|--|
| Potential Project-related effects to terrestrial wildlife or wildlife habitat | Existing habitat, wildlife species known to be present, and potential Project-related effects to wildlife or wildlife habitat are discussed in Section 4.8 Wildlife |
| Changes in traffic during and after Project construction | Existing traffic and the anticipated changes in traffic during construction and operation for the Project are discussed in Section 5.1 Traffic . |
| Culturally and ecologically sensitive ecosystems within the Project area | Sensitive ecosystems within the Project area have been identified. The potential for the Project to effect sensitive ecosystems and proposed mitigation are discussed in Section 4.7 Vegetation |
| Potential changes in water quality due to Project construction and operation | Potential Project-related effects to water quality during construction and operation are discussed in Section 4.2 Water Quality |

2.1.4 Public Participation

This section provides an overview of the consultation activities undertaken during the Project’s pre-Application stage with the public and stakeholders. References to “public and stakeholders” include any individuals with an interest in the Project who have not been identified as members of involved Aboriginal Groups or representatives of government agencies. Public and stakeholder participation for the Project has been guided by the Ministry’s Public Consultation Plan, which is available on EAO’s website for the Project. Additional information is provided in **Section 11.0 Public Consultation**. The Public Consultation Plan, and the Public Consultation Report describe the public consultation activities the Ministry has and will undertake during the pre-Application, Application, and post-Application phases of the EA to satisfy the requirements of the section 11 Order issued for the Project.

Public participation to date has included: a wide variety of stakeholders representing a breadth of interests including local residents; businesses and property owners; people who have visited, called, or e-mailed the Project’s Information Office; presentations and meetings with community and business groups and private individuals; cycling advocacy groups; commercial and recreational marine users; environmental groups; and others enquiring about the Project. Consultation has included formal meetings and open house events as well as informal community relations activities. More information on comments received during the pre-Application consultation phase is provided in **Section 11.0**.

2.1.4.1 Summary of Public Participation

Since announcement of the Project in September 2012, the Ministry has been providing information about the Project, engaging stakeholders and interested parties in dialogue, and responding to Project-related enquiries. Key outreach activities conducted before and during the pre-Application phase are described below.

Public Consultation

The Ministry undertook three phases of consultation for the Project leading to the EA process. Each phase included open houses with display boards, discussion guides, and feedback forms, and provided participants with an opportunity to speak with Project staff. All consultation materials were made available online at masseytunnel.ca during and after each consultation event, and all events were advertised through print newspapers, on the Project website, through the Project e-database (see “Project Office” section, below), and through media releases that often generated news stories. Following each consultation event or series of events, a Consultation Summary Report was prepared, documenting the input received.

- **Phase 1: Understanding the Need** (November to December 2012) – Conducted early in the Project’s planning process, this phase of consultation sought input to gain a better understanding of travel demand, operating conditions, and opinions and interests on the importance of various design considerations.
 - A total of 1,150 people participated in this phase of consultation. Congestion relief and economic growth were identified as the most important factors when considering solutions for the Tunnel. Doing nothing was not viewed as an option. Participants noted the importance of considering all users, including drivers, goods movers, transit riders, cyclists, and pedestrians. Participants were also interested in short-term solutions while planning for a long-term solution continued.
- **Phase 2: Exploring the Options** (March to April 2013) – Sought input on five potential tunnel replacement scenarios and the criteria to evaluate these scenarios.
 - More than 1,000 people participated. Participants expressed general support for Project goals and evaluation criteria. There was also an overall preference for a new bridge on the existing corridor (Scenario 2), with polarized views on the other scenarios, particularly, maintaining and upgrading the Tunnel (Scenario 1), and constructing a new crossing along a new corridor to the east (Scenario 5). Participants also expressed questions and concerns about the safety of tunnels and a desire for plans to allow for future rapid transit. Participants also requested more information about cost and funding options.

- **Phase 3: Project Definition Report** (December 2015/January 2016) sought input on the Project Definition Report (<http://engage.gov.bc.ca/masseytunnel/files/2015/12/GMT-Project-Definition-Report-Dec-2015.pdf>) including the proposed Project scope, Project success measures, funding options, and traffic management during construction. This input assisted in finalizing the EA Application and also will be used to finalize the Project scope and cost estimate. Results can be viewed in the Phase 3 Consultation Summary Report (<http://engage.gov.bc.ca/masseytunnel/files/2016/04/Phase-3-Consultation-Summary-Report-March-2016.pdf>).
 - More than 1,035 people participated, including 750 who attended the open houses, which were held concurrent with open houses for the pre-Application Public Comment Period (see below). Participants expressed continued support for the Project overall and interest in more detail about specific elements including interchange designs, traffic forecasts, and the upcoming environmental assessment. There was also strong support for capacity improvements to address congestion and proposed transit, cycling and pedestrian measures. Most participants who commented about tolls supported tolling as a funding mechanism; however, many participants suggested that tolling should be applied in the context of a regional tolling policy.

As part of the pre-Application consultation for the Project, the EAO held a public comment period. The public comment period included open houses with display boards, audio/visual displays, discussion guides, and feedback forms, and provided participants with an opportunity to speak with EAO staff and Project staff. All consultation materials were made available online at masseytunnel.ca during and after each consultation event, and all events were advertised through print newspapers, on the EAO and Project websites, through the Project e-database (see “Project Office” section, below), and through media releases that often resulted in news stories.

- **Pre-Application Public Comment Period** (January 15 – February 15, 2016) – sought input on the Project Description and Key Areas of Study document for the Project. Two open houses, led by EAO, were held in support of the 31-day public comment period (January 26 and January 27, 2016).
 - A total of 750 people attended the open houses (held concurrent with the open houses held for the PDR) and EAO received 450 public submissions. All EAO submissions were posted to EAO’s electronic Project Information Centre (ePIC) within seven days of the comment being received by EAO.

The key themes from Project representatives’ discussions with members of the public at the Open Houses, written comments received during the 31-day review period and ongoing consultation with stakeholders are provided in **Section 11.0 Public Consultation** of this Application.

Project Office

A Project website (www.masseytunnel.ca) was established in November 2012 to provide information about the Project, including historical information and reports; current Project status; Project-generated reports and information including consultation materials; answers to frequently asked questions; how to contact the Ministry; and an option to subscribe to the Project e-database for Project updates by e-mail. In addition, the Project works with the Ministry's social media team to incorporate Project updates into the Ministry's @TRANBC Twitter feed.

A Project-related electronic database (e-database) was established in November 2012 enabling people to sign up and receive e-mails about the Project. The database now has more than 1,800 subscribers.

Also established in November 2012, a Project information telephone line (1-855-MASSEY) and e-mail address (masseytunnel@gov.bc.ca) enables one-to-one correspondence and direct replies to enquiries. A goal of initial response within two business days was established.

A Project Office in Richmond was opened in January 2014. The Project Office has two full-time community relations staff who provide Project information to the public; and manage the website, the information telephone line, and the e-database. The office includes information display boards, access to the Project website, and fly-through animation of the Project corridor. To date (up to 15 May 2016) more than 4,000 people have visited the Project office.

Community Outreach

The Ministry has engaged in a variety of additional outreach activities as described below:

- **Presentations on request** to a variety of business and community groups. More than 100 presentations have been made to date including:
 - Community and recreational clubs and organizations
 - Boards of Trade and Chambers of Commerce
 - Business clubs and associations
 - Professional organizations
 - Metro Vancouver planning, transportation, and engineering symposia

- **Meetings with key stakeholder groups** to gather input in support of developing conceptual designs for the new crossing. Since 2012, the Ministry has:
 - Consulted extensively with stakeholder groups including agricultural organizations, business organizations, commercial and recreational and commercial marine users, community and resident groups, recreational groups, and first responders
 - Attended a variety of community events with the Delta and Richmond Chambers of Commerce

Advertising and Media Relations

The Ministry maintains an ongoing and open dialogue with the media. Since November 2012, numerous stories have been published on the Project, including interviews with the Minister of Transportation and Infrastructure, the Executive Project Director, and other Project spokespersons. Highlights include:

- More than 750 directly related articles have been published in local and regional newspapers, primarily the Vancouver Sun, the Province, the Delta Optimist, South Delta Leader, Richmond News, and the Globe and Mail.
- Notification for each phase of consultation has been advertised in local and regional newspapers.

2.1.4.2 List of Key Issues Raised and Status of Resolution

Table 2.1-3 summarizes key issues raised as a result of public and stakeholder consultation and engagement to date, and the status of the issue. Detailed results, including more information on issues raised and status or resolution are presented in **Table 11.2-3; Section 11.0 Public Consultation.**

Table 2.1-3 Summary and status of Key Issues Raised by Public during pre-Application Consultation

| Key Issue Raised | Section Reference/ Status |
|--|---|
| Transit/Project Alternatives | Alternatives to the Project that were assessed are discussed in Section 1.3 Project Design and/or Alternative Means of Carrying out the Project. |
| Potential loss of agricultural land | Section 5.4 Agricultural Use describes potential changes to the boundaries of a small number of farms and the mitigation to be applied to minimize land requirements, as well as offsetting opportunities. |
| Potential changes in air quality and greenhouse gas emissions | Potential Project-related changes to air quality and greenhouse gas are discussed in Section 4.9 Air Quality. |
| Changes in traffic as a result of the Project | Section 5.1 Traffic discusses the anticipated changes in traffic, including expected improvements of the Project on traffic within the highway 99 corridor. |
| Tolling | Tolling is discussed in Section 1.1 Description of Proposed Project. |
| Effects of Tunnel removal on salinity and irrigation intake | Salinity in the context of irrigation intake is discussed in Section 4.1 River Hydraulics and River Morphology and Section 5.5 Agricultural Use. |
| Effects of changes in noise for residential areas near the new bridge | Potential Project-related changes in atmospheric noise and effects to residential areas is discussed in Section 4.10 Atmospheric Noise. |
| Effects of visual changes for residential areas near the new bridge | Section 5.5 Visual Quality describes the changes in viewsapes that would be expected as a result of the new bridge. Photos showing existing conditions and renderings with the anticipated new viewsapes are included. |
| Effects of wildlife and fish and fish habitat associated with the Fraser River | Potential Project-related effects to fish and fish habitat are discussed in Section 4.4, Fish and Fish Habitat ; potential Project-related effects to wildlife are discussed in Section 4.5 At-Risk Amphibians, Section 4.6 Marine Mammals, and Section 4.8 Terrestrial Wildlife. |
| Consultation process | The public consultation process is discussed in this section and in more detail in Section 11.0 Public Consultation. |
| Project Cost | Project cost and benefits is discussed in Section 1.1 Description of Proposed Project |

2.1.5 Government Agency Participation

2.1.5.1 List of Government Agencies that Participated in the EA

Consultation was initiated by the Ministry in 2012 and has been ongoing throughout the Project's pre-Application stage.

The Project team has consulted with the regulatory and non-regulatory agencies identified below.

Regulatory Agencies:

- Provincial:
 - Agricultural Land Commission
 - B.C. Environmental Assessment Office
 - B.C. Ministry of Environment
 - B.C. Ministry of Forests, Lands, and Natural Resource Operations
 - B.C. Ministry of Transportation and Infrastructure
- Federal
 - Canadian Environmental Assessment Agency
 - Environment and Climate Change Canada
 - Fisheries and Oceans Canada
 - Transport Canada
 - Port of Vancouver

Municipal and Regional Agencies:

- Local Governments and Organizations
 - City of Richmond
 - City of Surrey
 - City of Vancouver
 - City of White Rock
 - Corporation of Delta
 - Fraser Health Authority
 - Metro Vancouver
 - TransLink
 - Tsawwassen First Nation
 - Vancouver Coastal Health Authority

2.1.5.2 Technical Working Group

A key component of agency participation has been the establishment of the Technical Working Group. The purpose of the Technical Working Group is to provide advice and input on aspects of the environmental assessment. Consultation with the Technical Working Group, and other agencies, will continue through the Application review stage and future Project phases.

The Technical Working Group is comprised of Aboriginal Groups identified in Schedule B of the section 11 Order and the following government agencies:

- Provincial Agencies:
 - Agricultural Land Commission
 - B.C. Environmental Assessment Office
 - B.C. Ministry of Environment
 - B.C. Ministry of Forests, Lands, and Natural Resource Operations
 - B.C. Ministry of Transportation and Infrastructure
- Federal Agencies:
 - Environment and Climate Change Canada
 - Port of Vancouver
 - Transport Canada
- Municipal and Regional Agencies:
 - City of Richmond
 - Corporation of Delta
 - Fraser Health Authority
 - Metro Vancouver
 - TransLink
 - Vancouver Coastal Health Authority

2.1.5.3 Summary of Government Agency Participation

Since the Project was announced in September 2012, the Project team has been working to raise awareness, engage interested parties in dialogue about the Project, and respond to enquiries.

Introductory meetings were held with local governments including the Corporation of Delta, City of Richmond, City of Surrey, City of Vancouver, TransLink, Metro Vancouver staff and the Agricultural Land Commission in fall 2012, prior to the start of public consultation.

Regular meetings with Delta (approximately every two weeks), Richmond (approximately every two weeks) and Metro Vancouver (approximately every six weeks) staff have been ongoing since 2013. The Ministry has participated in more than 85 meetings with City of Richmond staff, more than 85 meetings with Corporation of Delta staff and more than 30 meetings with Metro Vancouver staff. Meetings with Surrey, White Rock, and TransLink have also been ongoing. The purpose of these meetings has been to identify local government interests, concerns about potential Project-related effects, and opportunities to address issues through improvements and/or mitigation strategies. Engagement with these groups is ongoing.

The Ministry has also engaged with municipal, provincial, and federal elected officials through informal meetings and formal presentations.

As part of the overall engagement strategy, the Ministry undertook the following consultation activities with government agencies during the pre-Application phase:

- Engaged with the EAO Technical Working Group to exchange information and respond to questions and comments on the Project Description and Key Areas of Study and the AIR
- Continued to meet with Delta, Richmond, Metro Vancouver, and TransLink staff to refine traffic modelling
- Identified and documented questions, issues, and interests raised
- Identified measures to avoid or mitigate potential adverse effects
- Attended supplemental and/or sub-committee Technical Working Group meetings as appropriate for matters requiring more detailed or agency-specific discussion
- Maintained an issues tracking database, including provision of frequent status updates, to show how the Project team is appropriately responding to the issues raised by Technical Working Group members

Consultation planned during the Application and post-Application phases are described in **Section 11.0** and in the Public Consultation Plan.

2.1.5.4 List and Status of Key Issues Raised

Key issues that have arisen in consultation and engagement with government agencies conducted to date and the status of the issues are summarized in **Table 2.1-4**.

Table 2.1-4 Summary and status of Key Issues Raised by Government Agencies

| Issue Raised | EA Section Reference/Status |
|---|---|
| Potential Project-related effects on environmentally sensitive areas including wetlands | Section 4.7 Vegetation identifies sensitive ecosystems within the vicinity of the Project and describes mitigation measures to minimize of off-set potential effects. |
| Occurrence of species at risk within the Project area | Potential and known occurrences of species at risk within the Project area are discussed in Section 4.5 At-risk Amphibians , Section 4.7 Vegetation and Section 4.8 Terrestrial Wildlife . |
| Potential effects to wildlife within Deas Island Regional Park | Wildlife and wildlife habitat within Deas Island Regional Park is identified and discussed in Section 4.8 Wildlife . |
| Changes in traffic as a result of the Project | Section 5.1 Traffic discusses the anticipated changes in traffic, including expected improvements of the Project on traffic within the highway 99 corridor. |
| Potential effects on commercial, recreational and aboriginal navigation | Section 5.2 Marine Use discusses commercial, recreational, and Aboriginal navigation and the potential effects of the Project on navigation during construction and operation. |
| Potential effects on recreational use within Deas Island Regional Park | Section 5.3 Land Use discusses recreational activities within Deas Island Regional Park and Section 5.2 Marine Use discusses recreational activities within Deas Slough. |
| Potential loss of agricultural land | Section 5.4 Agricultural Use describes potential changes to the boundaries of a small number of farms and the mitigation to be applied to minimize land requirements, as well as offsetting opportunities. |
| Change in viewsapes resulting from the bridge | Section 5.5 Visual Quality describes the changes in viewsapes that would be expected as a result of the new bridge. Photos showing existing conditions and renderings with the anticipated new viewsapes are included. |
| Potential effects of the project on human health | Section 7.0 Health assesses the potential changes in human health as a result of Project-related changes. |

Part B – Assessment of Environmental, Economic, Social, Heritage and Health Effects

3.0 Assessment Methodology

The methods for assessing the environmental, economic, social, heritage, and health effects (referred to as pillars by the Environmental Assessment Office) of the Project were developed in order to meet the requirements of the *B.C. Environmental Assessment Act*, S.B.C. 2002, c. 43. (BCEAA), and followed the methodological steps outlined in EAO's [Guideline for the Selection of Valued Components and Assessment of Potential Effects](#) (September 2013) as shown on **Figure 3-1**. This section describes each of these steps, and focuses on the process of selecting valued components (VC) and the steps followed in assessing potential Project-related residual and cumulative effects on these VCs.

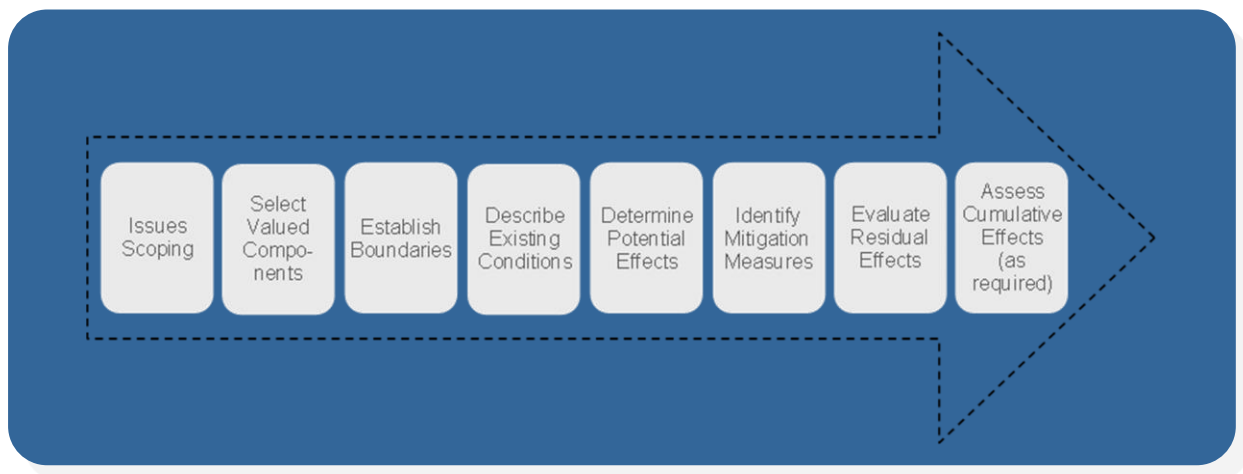


Figure 3-1 Summary of Methodological Steps

3.1 Issues Scoping and Selection of Valued Components

3.1.1 Issues Scoping

Issues scoping is the process of compiling and analyzing available information to identify environmental, economic, social, heritage, and health issues that may be related to the Project. These Project-specific issues are indicative of the local and regional values held by the public, Aboriginal Groups, and other stakeholders in the area within which the Project is proposed. They may also reflect issues of interest to the scientific community or to government agencies. The issues identified through issues scoping are used to inform the selection of VCs for the assessment (EAO 2013).

Project-related issues identified through engagement with Aboriginal Groups, public consultations, and government agency consultations are summarized in **Section 2.0 Environmental Assessment Process**.

3.1.2 Selection of Valued Components

For the purposes of an environmental assessment under the BCEAA, VCs are components of the natural and human environment that are considered by the proponent, public, Aboriginal Groups, scientists and other technical specialists, and government agencies involved in the assessment process to have scientific, ecological, economic, social, cultural, archaeological, historical, or other importance. Valued components are selected to reflect the key values of society, inform proponents on the issues to be considered as part of project design, and inform decision-makers about the costs and benefits of a project. Using VCs as the focus for the assessment concentrates efforts on matters that are central to decision-making, thereby introducing practicality and cost-effectiveness into the EA process (EAO 2013). Further detail on the VC selection process and the steps taken in selecting the VCs for Project effects assessment are presented in **Appendix A**.

The process for selecting VCs began with identifying candidate VCs based on issues identified through public, Aboriginal Group, and government agency consultation and engagement, as well as prior experience and expertise of the Project team. Candidate VCs were refined on the basis of knowledge and values gathered from Aboriginal Groups, stakeholders and public interests, scientific or regulatory interest, conservation status, and sensitivity to proposed Project effects. Candidate VCs were then evaluated against defined criteria to determine if they should be included as VCs to support the assessment of the proposed Project.

Appendix A, Table 2 lists the VCs and the rationale for selecting the final VCs, which was based on the following criteria:

- Is the component present in the relevant area?
- Does the Project have the potential to interact with and adversely affect the component?
- Is the component the ultimate receptor in a Project-related effect pathway?

Components that did not meet these criteria were not included as VCs in this assessment. For example, economic effects were not selected as a VC since the influence of the Project on economic conditions is anticipated to be positive (see **Section 1.1.7 Economic Benefits**). Similarly because the Project has limited potential for interaction with benthic and aquatic invertebrates, those components were not studied. Water and sediment quality is an example of a component that was not assessed as a VC, because it is not the ultimate receptor of potential

Project-related effects. Potential effects of the Project on water and sediment quality were assessed in terms of the effect of Project-related change in sediment and water quality on ultimate receptor VCs such as fish and fish habitat, marine mammals, vegetation, and at-risk amphibians.

The rationale for including or excluding candidate VCs for assessment is provided in **Appendix A, Table 2** and **Table 3**, respectively, with additional selection rationale in the relevant VC section. **Table 3.1-1** lists the VCs selected for assessment.

Table 3.1-1 List of Valued Components Selected for Assessment

| Pillar | Valued Component |
|----------------|---|
| Environmental | Fish and fish habitat At-risk amphibians Marine mammals Vegetation Terrestrial wildlife |
| Socio-economic | Land use Marine use Agricultural use Visual quality |
| Heritage | Heritage resources |
| Health | Human health |

3.1.2.1 Intermediate Components

In some cases, the potential effects of a project on a component are part of a longer effects pathway. In such cases, components have been classified in the assessment as intermediate components (ICs) rather than VCs.

Consideration of potential Project-related changes in ICs helps to inform understanding of potential changes that may occur along a pathway as a result of the Project and result in changes to a VC.

For example, the assessment of the human health VC depends on the results of assessing Project-related changes in air quality and atmospheric noise since each of these influences the conditions of human health. This relationship is illustrated in **Figure 3.1-1**.

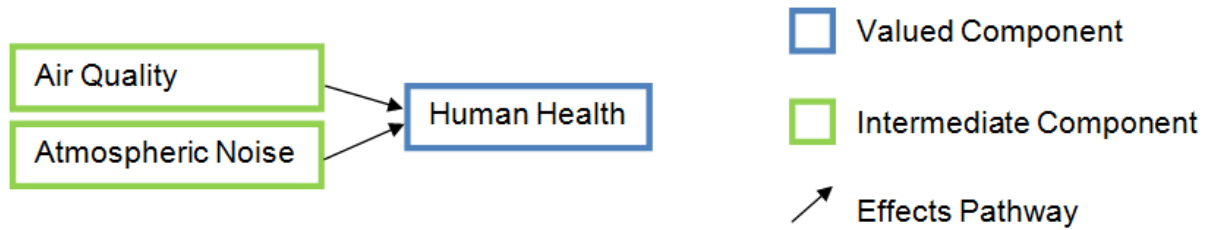


Figure 3.1-1 Example of Pathway of Effects Showing the Relationship between Valued Components and Intermediate Components

The ICs in this assessment, all of which are studied in **Section 4.0 Environment Effects Assessment**, include the following:

- River hydraulics and morphology
- Surface water and sediment quality
- Underwater noise
- Air quality
- Atmospheric noise
- Traffic

Linkages between these and VCs are shown in **Table 3.1-2**, where 'x' indicates that the IC in the row informs the VC in the column.

Table 3.1-2 Linkages between Valued Components and Intermediate Components

| | | Valued Components | | | | | | | | | | |
|---|---------------------------------|-----------------------|--------------------|----------------|------------|----------------------|----------|------------|------------------|----------------|--------------------|--------------|
| | | Fish and Fish Habitat | At-risk Amphibians | Marine Mammals | Vegetation | Terrestrial Wildlife | Land Use | Marine Use | Agricultural Use | Visual Quality | Heritage Resources | Human Health |
| An 'x' indicates that the intermediate component in the row supports the assessment of the valued component in the column . | | | | | | | | | | | | |
| Intermediate Components | River Hydraulics and Morphology | x | | x | | | | x | | | | |
| | Sediment and Water Quality | x | x | x | x | | | | | | | |
| | Underwater Noise | x | | x | | | | | | | | |
| | Air Quality | | | | | | | | | | | x |
| | Atmospheric Noise | | | | | x | | | | | | x |
| | Traffic | | | | | x | x | | | | | x |

3.1.2.2 Subcomponents and Indicators

To focus the definition of VCs and provide more structure for the assessment, subcomponents are sometimes identified for VCs. For example, the marine mammal VC is focused on harbour seals and two species of sea lions which are the two marine mammals most likely to occur in the Project alignment.

Indicators are parameters that are used to measure and evaluate the interaction of the Project with a specific VC and enable a meaningful and informative assessment of Project-related effects on each VC.

Table 3.1-3 describes the subcomponents and indicators chosen for the VCs identified in **Table 3.1-2**. The rationale for their selection is included in each VC section.

Table 3.1-3 Valued Components, Subcomponents, and Indicators

| Valued Component | Subcomponents | Indicators |
|-----------------------|---|--|
| Environmental | | |
| Fish and fish habitat | <ul style="list-style-type: none"> • Salmon • Sturgeon • Eulachon • Trout • Char | <ul style="list-style-type: none"> • Likelihood of injury or mortality of fish • Total suspended solid levels and turbidity • Underwater sound levels • Loss of habitat area |
| At-risk amphibians | <ul style="list-style-type: none"> • Northern red-legged frog | <ul style="list-style-type: none"> • Presence of at-risk amphibians • Change in area of available at-risk amphibian habitat • Change in water quality in at-risk amphibian habitat |
| Marine mammals | <ul style="list-style-type: none"> • Harbour seal • California and Steller sea lions | <ul style="list-style-type: none"> • Underwater sound levels |
| Vegetation | <ul style="list-style-type: none"> • At-risk plant species | <ul style="list-style-type: none"> • Presence and extent of population(s) |
| | <ul style="list-style-type: none"> • At-risk ecosystems | <ul style="list-style-type: none"> • Presence and extent |
| Terrestrial wildlife | <ul style="list-style-type: none"> • Upland birds • Riverine birds • Small mammals | <ul style="list-style-type: none"> • Habitat loss: amount and quality of foraging and/or breeding habitat that overlaps with Project components. • Sensory disturbance: changes to usability of foraging and/or breeding habitat within the Project alignment. • Collision: risk of mortality |

| Valued Component | Subcomponents | Indicators |
|-----------------------|---|--|
| Socio-economic | | |
| Land use | <ul style="list-style-type: none"> • Land Use | <ul style="list-style-type: none"> • Consistency with land use plans and designations • Compatibility with adjacent or proximal land uses • Spatial area (ha) of change in existing land uses • Disturbance to other land uses from construction or operation activities |
| | <ul style="list-style-type: none"> • Regional Growth | <ul style="list-style-type: none"> • Change in regional population growth and distribution • Change in non-residential (industrial and commercial) development and distribution |
| Marine use | <ul style="list-style-type: none"> • Commercial navigation • Commercial, recreational, and Aboriginal (CRA) fish harvesting • Recreational boating | <ul style="list-style-type: none"> • Access to waterways |
| Agriculture | <ul style="list-style-type: none"> • Land in Agricultural Land Reserve (ALR) | <ul style="list-style-type: none"> • Change in ALR land by capability class |
| | <ul style="list-style-type: none"> • Irrigation and drainage | <ul style="list-style-type: none"> • Change in irrigation and drainage systems |
| | <ul style="list-style-type: none"> • Farm infrastructure and operations | <ul style="list-style-type: none"> • Change in farm operations |
| Visual quality | <ul style="list-style-type: none"> • None | <ul style="list-style-type: none"> • Change in visual quality from sensitive locations |

| Valued Component | Subcomponents | Indicators |
|--------------------|---|---|
| Heritage | | |
| Heritage resources | <ul style="list-style-type: none"> n/a | <ul style="list-style-type: none"> Disturbance of archaeological sites, objects, and features Disturbance of historical sites, objects, and features that are subject to protection under the B.C. <i>Heritage Conservation Act</i>, R.S.B.C. 1996, c. 187 (HCA) Changes in level of accessibility to archaeological sites, objects, and features Changes in level of accessibility to historical sites, objects, and features that are subject to protection under the HCA |
| Health | | |
| Human health | <ul style="list-style-type: none"> Air emissions | <ul style="list-style-type: none"> Acute inhalation risk quotient Chronic inhalation risk quotient Chronic risk quotient for multi-media exposures |
| | <ul style="list-style-type: none"> Noise and vibration | <ul style="list-style-type: none"> Annoyance associated with highway noise during operations Sleep disturbance Ability to maintain adequate speech comprehension Annoyance associated with ground-borne vibration |

3.2 Assessment Boundaries

Assessment boundaries define the scope or limits of the assessment, and encompass the areas within and times during which the Project is expected to interact with the VCs (spatial and temporal boundaries, respectively). Boundaries may also reflect constraints that may be placed on the assessment of those interactions due to jurisdictional, social, or economic realities (administrative boundaries) and limitations in predicting or measuring changes (technical boundaries) (EAO 2013).

Presence of conservation lands (including provincial Wildlife Management Areas, the National Wildlife Area, the Migratory Bird Sanctuary) and other conservation areas in the vicinity of the Project were taken into consideration when defining the assessment boundaries for specific VCs.

Spatial, temporal, administrative, and technical boundaries are identified for the VCs and the ICs.

3.2.1 Spatial Boundaries

Spatial boundaries are defined to encompass the geographic extent within which the Project is expected to have potential effects on the selected VCs.

Three assessment areas have been defined for each VC, based on the geographic scale of influence of the Project. The smallest scale includes the footprint of temporary and permanent physical works associated with the Project, and the area within which activities associated with the Project will occur. This area, referred to as the Project alignment, is common for all VCs, and is defined as follows:

- The Project footprint and all lands, including lands under water that are subject to disturbance from construction activities associated with the Project, where the Project footprint is defined as areas that are permanently altered by the Project.

The next scale of spatial boundary, referred to as the **Local Assessment Area (LAA)** comprises the area within which there is a reasonable potential for the Project or Project activities to affect the biophysical and human environment. The LAA is defined by the scope and nature of Project-related effects on specific VCs, and is defined for each VC under the corresponding effects assessment section.

A larger **Regional Assessment Area (RAA)** is used to provide context for the assessment of potential Project-related effects. The RAA is typically based on a natural transition (e.g., watershed boundary, ecological zone) or an artificial delineation (e.g., jurisdictional or economic district or zone) that is relevant to specific VCs. The RAA for each VC is defined under the corresponding effects assessment section.

The spatial boundary for the assessment of cumulative effects—i.e., effects of the interaction of residual effects of the Project on a VC with the residual effects of other projects and activities, encompasses the area within which the residual effects of the Project on a given VC are likely to interact cumulatively with the residual effects of other past, present, and reasonably foreseeable future projects and activities on that VC. In most cases, the RAA can be used as the spatial boundary for the assessment of potential cumulative effects. Spatial boundaries of the cumulative effects assessment area are defined under the discussion on potential cumulative effects on specific VCs.

An approach similar to the one outlined above, based on the nature, scope and extent of potential Project-related effects, was used to define spatial boundaries of the study areas for ICs.

3.2.2 Temporal Boundaries

The temporal boundaries defined for the assessment encompass the periods during which the Project is expected to interact with the VCs and ICs. Temporal characteristics (timing) of the Project construction phase (including decommissioning of temporary construction-related facilities and the Tunnel), and operation phases are defined in **Section 1.1.3 Project Phases and Schedule**. The temporal boundaries established for the assessment of adverse Project effects on the VCs and ICs include these Project phases.

3.2.3 Administrative and Technical Boundaries

The administrative boundaries for the Project refer to limitations imposed on the assessment by jurisdictional or economic constraints. Examples are municipal boundaries and wildlife management zones. Technical boundaries might include limitations in information, data analyses, and data interpretation relevant to particular VCs and ICs (e.g., unavoidable data gaps or model limitations). Administrative or technical boundaries may not be applicable to all VCs and ICs.

3.3 Existing Conditions

A description of existing conditions of each VC and components that support it, based on requirements set out in the AIR, is provided in the corresponding effects assessment section, along with trends where relevant. The data for existing conditions were collected through a combination of desk studies and field programs, with the latter being used to fill gaps in knowledge about existing conditions.

Information contained in this section for each VC and IC, includes:

- A description of the existing (or baseline) conditions within the assessment area with sufficient detail to allow for the identification, understanding, and assessment of potential Project-VC/IC interactions.
- A description of the quality and reliability of the existing (or baseline) data and its applicability for the purpose used, including any gaps, insufficiencies and uncertainties, particularly for the purpose of monitoring activities.

- Reference to natural and/or human-caused trends that may alter the environmental, economic, social, heritage and health setting, irrespective of the changes that may occur as a result of the Project or other project and/or activities in the area.
- Explanation of if and how other past and present projects and activities in the assessment area have affected or are affecting the VC.
- Documentation of the methods and data sources used to compile information on existing (or baseline) conditions, including any standards or guidelines followed. Where additional Project and VC-specific field studies were conducted, the scope and methods to be used have followed published documents pertaining to data collection and analysis methods. Where methods used for the assessment deviate from applicable published guidance, the rationale for the variance is provided.
- A description of the Traditional Ecological Knowledge (TEK), including Aboriginal Traditional Knowledge (TK), that is used in the VC assessment.

The methods used to collect and assemble data on existing conditions are based on the following procedures and standards:

- Collection, analysis, and presentation of data follow the appropriate provincial or federal standards (e.g., B.C. Resource Information Standards Committee)
- Information from Aboriginal Groups traditional knowledge/traditional use (TK/TU) studies is incorporated alongside information from scientific studies, where relevant and appropriate
- Maps are used to show data collection points
- Existing reports and documents are appended or referenced, as appropriate

The sections that describe the assessment methods for each VC and IC also provide the following:

- The rationale for selecting sampling sites and analytical parameters, where applicable.
- Descriptions of field and laboratory methods, as well as quality assurance and quality control measures applied.
- Comments regarding the quality and reliability of these data and their applicability for the purpose used, with the identification of gaps, insufficiencies and uncertainties.

Where appropriate, technical volumes describing baseline studies and existing conditions are included as appendices, with key findings contained in these technical volumes summarized in the Application.

3.4 Potential Effects

The assessment of potential effects of the Project on each VC begins with a description of Project activities and physical works that could result in an environmental effect. A description of Project-related activities is provided in **Section 1.1.4 Project Components and Activities**.

A matrix, presented in **Appendix B, Table 1**, which shows potential interactions between Project activities and each VC and IC during specific Project phases, was used to identify potential effects on VCs/ICs. Determination of the potential for an activity to interact with each VC and IC is based on review of relevant literature, other environmental assessments, and professional judgment. Feedback from Aboriginal Groups, the public, stakeholders and government agencies on VC/IC selection and assessment was incorporated, as relevant.

Where it was determined that an interaction between a Project activity and VC or IC could occur, a preliminary effects-rating using the categories defined in **Table 3.4-1** was assigned.

Table 3.4-1 Preliminary Effects-Rating for Project Interactions

| Rating | Description |
|------------------|---|
| No effect | An interaction with the Project activity is likely to occur but would not be expected to result in a detectable or measurable effect on the VC. |
| Potential effect | An interaction with the Project activity is likely to occur and would be expected to result in a potential effect on the VC. |

For each activity that is anticipated to interact with a VC, a rationale that supports the preliminary effects rating is provided, along with a description of the nature of the interaction and anticipated effect(s). Interactions with potential effects are carried forward in the assessment. The methods and criteria used to justify any excluded project activity-VC interaction will be provided.

In cases where a VC could potentially be affected indirectly by a Project-related change in another component (i.e., an IC as described in **Section 3.1.2.1 Intermediate Components**), interactions between Project activities and the ICs, and associated changes in the ICs were identified using a process similar to the one described above for VCs. Project-related changes in ICs are assessed in terms of the effects of those changes on the VCs that are the ultimate receptors of the effects of the Project.

3.5 Mitigation Measures

Where potential effects are determined to occur, mitigation measures are identified to avoid or reduce potential adverse effects of the Project on VCs and subcomponents. Mitigation measures that will reduce or eliminate an adverse effect are described for each VC and IC, with an emphasis on how these measures will help alter the effect. Mitigation measures for VCs and ICs include the following information, where relevant:

- A description of the approach to identify and analyze mitigation measures, including any management and compensation plans proposed, which will be implemented to address potential effects.
- A description of the mitigation measures incorporated into the Project, including site and route selection, project scheduling, project design, and construction and operation procedures and practices.
- A description of any standard mitigation assumed or proposed to be implemented, including consideration of best management practices, environmental management plans, environmental protection plans, contingency plans, emergency response plans, and other general practices.
- An indication of how the mitigation measures will mitigate the potential adverse effects on the VC or IC.
- The rationale for the proposed mitigation measures, including why further avoidance or reduction measures for adverse effects may not be considered feasible, and the need for and scope of any proposed compensation or offset.
- An evaluation of the anticipated success of each mitigation measure and a description of the rationale and analysis for these evaluations, including, where relevant, a description of the potential risks and uncertainties associated with use of the mitigation.
- A description of the time required for mitigation to become effective.

A summary of the mitigation measures by Project phase is included, as well identification of mitigation measures that are in management or compensation plans. In some cases, mitigation may include monitoring programs to verify results of the assessment, or monitor effectiveness of mitigation measures. If appropriate, or applicable, mitigation strategies discussed on the Applications will include mitigation measures or opportunities for enhancement of the environment in addition to avoiding or minimizing Project-related effects.

3.6 Characterization of Residual Effects

Where residual effects are expected to persist after implementation of mitigation measures, such effects are characterized for each VC/IC using the criteria listed below. Some criteria definitions have been developed for specific VCs or ICs, and these are described in each effects assessment section. The assessment of effects also considers the likelihood of each predicted residual effect occurring.

The following generalized definitions are used as a guide for establishing specific effects characteristics for each VC/IC.

- **Direction** refers to the overall nature of the residual effect. The direction of Project effects may be positive (i.e., beneficial), neutral, or negative (i.e., adverse).
- **Magnitude** refers to the amount of change to the existing condition of a VC/IC. Magnitude is generally measured in terms of the proportion of the VC/IC that is affected within the assessment area (LAA or RAA) relative to the range of natural variation (or historic variation, in the case of human environment VCs). The definition of magnitude is VC/IC-specific.
- **Geographic extent** refers to the area over which Project-related changes would occur. The geographic extent of effects may be site-specific (limited to the Project alignment), local (limited to the LAA), regional (limited to the RAA), or beyond. The definition may vary by VC/IC.
- **Duration** refers to the period of time for a VC/IC to return to its existing condition. The duration of an effect may be short-term, long-term, or permanent (i.e., the VC/IC won't return to its existing condition). Definitions of short- and long-term vary by VC/IC, to take into account VC/IC-specific temporal characteristics, such as breeding times in the case of wildlife.
- **Frequency** refers to the number of times that an effect might occur. The frequency of an effect may be continuous, frequent, uncommon, or rare.
- **Reversibility** refers to the degree to which existing conditions can be regained after the factors causing the effect are removed. Effects can be reversible, irreversible (permanent), or partially reversible.

Residual effects are discussed in the context of the current and future sensitivity of the VC/IC and its resilience to change caused by the Project. Consideration of context is based on the description of existing conditions of the VC/IC, which reflect cumulative effects of other projects and activities that have been carried out, and especially information about the impact of natural and human-caused trends in the condition of the VC/IC. Sensitivity or resilience is ranked using qualitative terms such as low, medium, or high, where appropriate.

The characterization of each residual effect and the rationale used to support each rating are summarized in the relevant effects assessment section of each VC/IC.

For each VC/IC, a table is provided describing the residual effects using the residual effects criteria context, magnitude, extent, duration, reversibility, and frequency, as defined in EAO's Guideline for the Selection of Valued Components and Assessment of Potential Effects. Where feasible, these criteria will be described quantitatively. When residual effects cannot be characterized quantitatively, the effects have been characterized qualitatively. The use of any qualitative terms (e.g. high, moderate, low, etc.) is accompanied by distinct definitions for each of these rankings. An explanation is included for the conclusion reached for each criterion used to characterize a residual effect.

3.7 Likelihood

The likelihood for all residual adverse effects occurring is assessed using appropriate quantitative or qualitative terms, in sufficient detail to help understand how the conclusions are reached. Definitions of any qualitative terms, such as 'low', 'moderate', or 'high' probability for each VC/IC are provided.

3.8 Proponent's Determination of Significance

For each VC, a conclusion of significance of residual adverse effects is provided. To determine the significance of a residual effect, the effects assessment methods consider the nature and likelihood of each residual effect, and the context within which it is expected to occur. Significance thresholds are defined for each VC based on federal and provincial regulatory requirements, standards, objectives, or guidelines, as well as resource management objectives, community standards, scientific literature, or ecological functions, as applicable. Residual effects on ICs along the pathway of effects are reflected in the significance determination of each receptor VC.

3.9 Confidence and Risk

The level of confidence (low, moderate, or high) for each residual effect prediction, associated with both the significance and likelihood, is provided. The level of confidence is based largely on professional judgment, and takes into consideration factors such as uncertainties, quality of available data, as well as nature and extent of potential effect. A description of any measures to reduce uncertainty through monitoring, adaptive management, or other follow-up programs, is provided.

A risk assessment for the residual effects prediction will be conducted when the following conditions apply:

- There is a high degree of uncertainty in an effects prediction (i.e., low confidence)
- There is a possibility of a significant adverse effect
- Follow-up programs may not be sufficient to manage the potential risk

If additional risk assessment is required, the process and methodology used for this analysis and the conclusions are provided, including the range of likely, plausible and possible outcomes with respect to likelihood and significance.

For each VC/IC, a summary is provided of the Project interactions, proposed mitigation measures, and the characterization of residual effects.

3.10 Cumulative Effects Assessment

A cumulative effects assessment is conducted when adverse residual effects of the Project on a VC/IC have the potential to interact with the residual effects of other certain and reasonably foreseeable projects and activities.

The methods for cumulative effects assessment are based on federal guidance provided in the *Cumulative Effects Assessment Practitioners Guide* (Hegmann et al. 1999). As identified in [EAO's Guideline for the Selection of Valued Components and Assessment of Potential Effects](#), the steps outlined in **Figure 3.10-1** below are used to determine residual Project effects and the subsequent cumulative effects assessment.

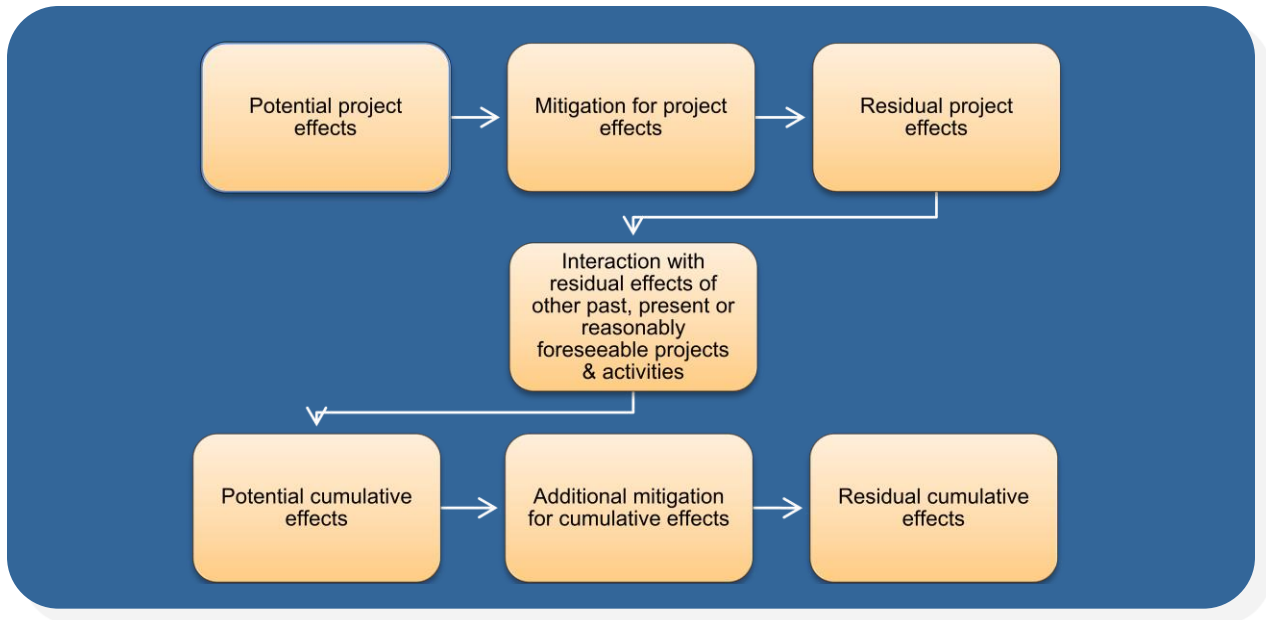


Figure 3.10-1 Steps to Determine Residual Project and Cumulative Effects

Unless stated otherwise, the effects of past developments are considered to be included in the existing conditions of a VC or IC. The cumulative effects assessment also considers approved land use plan provisions and overlapping effects associated with others present (i.e., construction is underway during development of the Application), and future certain or reasonably foreseeable developments. A list and details of other present and future certain or reasonably foreseeable developments that are included in this assessment is provided in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**.

Potential residual effects of the Project that are negligible (not detectable or measurable) are not carried forward in the cumulative effects assessment. Whenever a residual effect of the Project has been excluded from detailed consideration in the cumulative effects assessment, the rationale for this exclusion is provided in the corresponding VC/IC assessment section.

3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities

The developments listed below have been identified as candidates for inclusion in the assessment of cumulative environmental effects of the Project, based on a review of the following: the EAO Project Information Centre (e-PIC), the Canadian Environmental Assessment Registry, and project websites. Locations of these developments are shown on **Figure 3.10-2**.

The following selection criteria were used in identifying projects and activities to be considered in the assessment of cumulative effects:

1. The project or activity could result in a residual effect or change on a VC or IC.
2. The Project-specific residual effect or change on a VC or IC is likely to act in a cumulative fashion with the residual effects of other present, and certain and reasonably foreseeable future projects and activities in the area.

Influence of projects and activities that have already been built/conducted, including but not limited to Deltaport, BC Ferries Terminal at Tsawwassen, Vancouver International Airport, Boundary Bay Airport, Fraser Wharves, Coast 200 Terminals, Lehigh Hanson Cement Plant, Varsteel, Seaspan Ferries Corporation Tilbury Terminal, and FortisBC Tilbury LNG Plant (existing), will be included in the assessment of baseline conditions of each VC; these projects have therefore not been included in the list of current projects and activities to be included in the cumulative effects assessment.

3.10.1.1 Certain Developments and Activities

Tilbury Liquefied Natural Gas (LNG) Facility Expansion Project: FortisBC is currently expanding the Tilbury Island LNG storage facility in Delta to provide increased LNG supply in the transportation sector, remote communities, industry, and the marketplace. The project will add approximately 46,000 cubic metres of LNG storage. Upgrades to existing and construction of new infrastructure are land-based. Construction commenced in the third quarter of 2014; the project is expected to be operational by November 2016. The project is situated approximately four kilometres upstream of the Project alignment.

Vancouver Airport Fuel Delivery Project: Having received an Environmental Assessment Certificate in December 2013, construction for this project is anticipated to be completed by Spring 2018. The project includes upgrades to an existing marine terminal in the lower Fraser River, and construction of a new aviation fuel receiving facility approximately 2.5 kilometres upstream of the Project alignment, as well as construction of a new pipeline to transfer aviation fuel to Vancouver International Airport through Richmond. During project operation, periodic (i.e., once every two years) maintenance dredging, which will not spatially overlap with the Project, will occur between the marine terminal and the Fraser River South Arm navigational channel to maintain adequate under-keel clearance for vessels calling at the terminal. Marine terminal upgrades are scheduled to occur in 2016. The project is anticipated to be operational by spring 2018.

Maintenance Dredging of the Lower Fraser River: Port of Vancouver carries out annual maintenance dredging of the lower Fraser River to maintain adequate depth in the navigational channel for commercial vessels to safely access port facilities.

Port of Vancouver Habitat Enhancement Program: The Habitat Enhancement Program is a Port of Vancouver initiative focused on creating, restoring and enhancing fish and wildlife habitat. The program consists of projects around the Lower Mainland and is intended to provide a balance between a healthy environment and future development projects that may be required for port operations. The Sturgeon Banks project is being considered as a potential habitat restoration site for the Habitat Enhancement Program. This project is located approximately ten kilometres from the Project.

3.10.1.2 Reasonably Foreseeable Developments

Fraser Surrey Docks Direct Transfer Coal Facility (Texada Coal): Recently approved by Port of Vancouver, this project involves development of a direct transfer coal facility, including supporting rail and yard infrastructure, to handle up to four million metric tonnes of coal per year. The project includes transfer of coal from rail onto barges, and barge transport of coal from the terminal to Texada Island. Marine vessel traffic is expected to include 500 cargo barges and 80 bulkers per year. The project is expected to be in operation at the time Project construction is proposed to commence. The proposed coal transfer facility location is approximately upstream 15 kilometres from the Project alignment.

WesPac Tilbury Marine Jetty Project: This proposed project includes construction of a marine jetty adjacent to the existing FortisBC Tilbury LNG Facility (discussed under Certain Developments above). Located in the lower Fraser River at Tilbury Island, in Delta, this jetty is intended for the berthing and transferring of approximately four billion cubic metres of LNG per year to marine barges and carriers for delivery to local fuel and offshore export markets. Proposed project construction activities include the removal of existing abandoned marine infrastructure, and construction of a new marine jetty (i.e., access trestle, loading platform, and mooring dolphins), and land-based infrastructure to receive processed LNG for transfer to marine vessels. Supply of LNG for the project is proposed to come via a pipeline from the existing adjacent FortisBC Tilbury LNG storage facility. The project is currently under review by the National Energy Board, and is subject to environmental assessments by the Canadian Environmental Assessment Agency (CEA Agency) and the EAO. In July, 2015 the CEA Agency approved the substitution of the federal environmental assessment process by that of the BCEAA for this Project. Construction is anticipated to begin in late 2016 and be operational in early 2018. The project is situated approximately four kilometres upstream of the Project alignment.

Fortis BC Tilbury LNG Facility Expansion Project – future phase: The proposed facility expansion will include an additional (second) storage tank. The second storage tank will approximately double the storage capacity up to one billion standard cubic feet. Current project plans outline an in-service date of 2016 for the proposed facility. The Tilbury LNG project is located approximately four kilometres from the Project.

Roberts Bank Terminal 2: This proposed project comprises a new three-berth marine container terminal at Roberts Bank in Delta to facilitate an additional 2.4 million twenty-foot equivalent units of container capacity per year. This project is currently under review, and will undergo an environmental assessment by a review panel. Project construction is proposed to begin in 2018 and proceed for a five-and-a-half year period. The proposed location of the marine terminal is approximately 13 kilometres from the Project alignment.

Ladner Harbour Revitalization: The Corporation of Delta is proposing to redevelop and revitalize the waterfront at Ladner Harbour. The proposed redevelopment will include new waterfront buildings and infrastructure. Conceptual pre-design drawings do not specify in-river construction activities. The project is at its conceptual pre-design phase and a schedule for project construction has not been identified yet. Delta has issued development variance permits for several lots. The project is approximately four kilometres downstream of the Project alignment.

South Richmond Terminal Project: Lehigh Hanson is proposing to develop an aggregate (sand and gravel) processing and distribution facility on leased property in southeast Richmond, at the south end of No. 7 Road. Proposed project construction includes establishment of an aggregate wash plant, material stockpiles, reclaimer, truck loading and rail loading facilities, and two marine barge berths in the lower Fraser River. The project is approximately 3.5 kilometres downstream of the Project alignment. The project is currently under review. Construction is proposed to begin between 2017 and 2018, and the site is proposed to be operational in 2020.

Pattullo Bridge Replacement: TransLink is proposing a new, four lane Pattullo Bridge, to be designed to accommodate a potential future expansion to six lanes. The proposed replacement bridge would have modern lane widths, better connections, a centre barrier and high-quality cycling and pedestrian facilities. The project is located approximately 16 kilometres from the Project with completion tentatively planned for 2022.

Kinder Morgan Trans Mountain Pipeline Expansion Project: Trans Mountain is proposing an expansion of this existing 1,150-kilometre pipeline between Strathcona County (near Edmonton), Alberta and Burnaby, BC. The proposed expansion would create a twinned pipeline that would increase the nominal capacity of the system from 300,000 barrels per day to 890,000 barrels per day. The Facilities Application was filed in December 2013. It is currently before the National Energy Board and the hearing process is underway. The Project entered the BC environmental assessment process on April 8th, 2016. The Burnaby Terminal is the terminus of the project's mainline, storing and distributing both crude oil and refined products through separate pipelines to local terminals, a refinery, and the Westridge Marine Terminal. The Burnaby Terminal is located on the south side of Burnaby Mountain, approximately 20 kilometres northeast of the Project. The Westridge Marine Terminal is located on the south shore of Burrard Inlet, approximately 21 kilometres northeast of the Project.

Relocation of BC Hydro's transmission line that runs through the George Massey Tunnel: A BC Hydro transmission line runs through the George Massey Tunnel and will require relocation. Conceptual designs for three alternatives for relocation are being studied. According to BC Hydro, the leading alternative at this time is an overhead transmission line crossing the Fraser River. Public consultation was carried out in November 2015 on all three alternatives.

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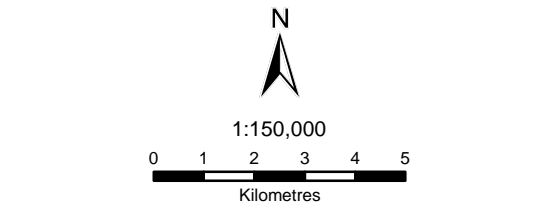


Legend

- Certain Developments and
- Reasonably Foreseeable Developments
- - - Kinder Morgan Trans Mountain Pipeline Expansion Project
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy
- Waterbody
- - - Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

IDENTIFIED PROJECTS AND ACTIVITIES

| | |
|---------------|------------|
| Figure 3.10-2 | 24/06/2016 |
|---------------|------------|

3.10.2 Conducting a Cumulative Effects Assessment

A rationale that supports the selection of spatial boundaries for the assessment of cumulative effects on each VC/IC is provided in the corresponding effects assessment section, including maps. The cumulative effects assessment is conducted for both construction and operation-related residual effects.

After the assessment area boundaries are determined, the list of present, and certain and reasonably foreseeable future developments is reviewed to determine if their incremental residual effects have potential to overlap spatially and temporally, and interact in a cumulative manner with the adverse residual effects of the Project. A table of all past, present and reasonably foreseeable developments that interact is provided for each VC/IC, where required. Where an interaction is considered likely, the potential cumulative effects are rated using the same categories described in **Section 3.4 Potential Effects** (i.e., no effect, potential effect). Potential interactions that have a rating of no cumulative effect are not carried forward for further analysis. The assessment considers technically and economically feasible measures to avoid, reduce, or otherwise mitigate potentially adverse cumulative effects or changes, including a description of how these measures might modify the characteristics of an effect or change. Residual cumulative effects that may persist following the application of mitigation are characterized using the same definitions detailed in **3.6 Characterization of Residual Effects**.

Where relevant, the significance of cumulative effects is determined by comparing the predicted future condition of a VC, taking into consideration the predicted cumulative effects with the threshold of significance defined for the VC. A level of confidence associated with the likelihood and significance determinations of each residual cumulative effect prediction is provided.

An approach similar to the one outlined above was used to identify potential and assess cumulative changes in ICs where there was a potential for Project-related changes in the component to act incrementally with changes associated with other projects and activities. Any cumulative effect that is identified for an IC is considered in the cumulative effects assessment of the corresponding receptor VC(s).

3.11 Follow-up Strategy

Where a residual adverse effect or cumulative effect is identified for a specific VC or IC, the Application will include a description of a follow-up strategy, where appropriate, that:

- Identifies the measures to evaluate the accuracy of the original effects prediction.
- Identifies the measures to evaluate the effectiveness of proposed mitigation measures.
- Proposes an appropriate strategy to apply in the event that original predictions of effects and mitigation effectiveness are not as expected. This may include reference to further mitigation, involvement of key stakeholders, Aboriginal Groups, government agencies and any other measures deemed necessary to manage the issue.

3.12 References

Environmental Assessment Office (EAO). 2013. Guideline for the selection of valued components and assessment of potential effects. 39 pp. Version 2, Prepared by B.C. EAO, Victoria, B.C. Available at http://www.eao.gov.bc.ca/pdf/EAO_Valued_Components_Guideline_2013_09_09.pdf. Accessed October 2014.

Hegmann, G., C. Cocklin, R. Creasey, S. Dupuis, A. Kennedy, L. Kingsley, W. Ross, H. Spaling, and D. Stalker. 1999. Cumulative Effects Assessment, Practitioners Guide. Prepared by AXYS Environmental Consulting Ltd. and the CEA Working Group for the Canadian Environmental Assessment Agency, Hull, QC. Available at <http://www.ceaa-acee.gc.ca/default.asp?lang=En&n=43952694-1>. Accessed October 2014.

APPENDIX A

Summary of Issues Identification and Valued Component Selection

1.0 Valued Component Selection Method and Results

This section describes the process for selecting the valued components (VCs) that will be studied, reported on, and assessed as part of the environmental assessment process. VCs describe components of the natural and human environment that are of particular importance of value to the proponent, public, Aboriginal Groups, scientists, other technical specialists, and government agencies. Proper selection of VCs is an important step in developing an environmental assessment that is thorough and adequate. VCs provide focus to the assessment and facilitate identification and evaluation of potential Project-related interactions in Part B of the Application. The method described here is consistent with advice provided in *Guideline for the Selection of Valued Components and Assessment of Potential Effects* (BC EAO 2013).

1.1 Key Terms

This section presents the key terms associated with the VC selection methods.

Pillars: The BCEAA requires an EA process to consider the environmental, economic, social, heritage, and health effects of a reviewable project. EAO refers to these five effects categories as pillars. The *Guideline for the Selection of Valued Components and Assessment of Potential Effects* (EAO 2013) specifies linkage to at least one of the five pillars as an attribute of a VC.

Issues: Issues are the broad range of environmental, economic, social, heritage, and health interests of government, Aboriginal Groups, the public, and the scientific community with respect to the Project. Issue identification is the first step in the VC selection process, and involves developing a list of issues related to each pillar that could be associated with construction and operation of the Project. Issue identification is undertaken through research, literature review, and engagement and consultation with interested parties.

Valued Components: According to guidance provide by the EAO, VCs are defined as “components of the natural and human environment that are considered by the proponent, public, Aboriginal Groups, technical specialists, and government agencies involved in the assessment process to have scientific, ecological, social, cultural, archaeological, historical, or other importance” (EAO 2013). VCs are selected to reflect the key values of society and inform proponents on the issues that need consideration as part of project design, and to inform decision-makers about the costs and benefits of a project. Selection of VC focuses the EA process on matters that need to be taken into account in making decisions; introducing practicality and cost-effectiveness into the EA process. The EAO’s VC selection guidance identifies the following essential VC attributes:

- Relevant to at least one of the five pillars and clearly linked to issues raised in relation to the Project.

- Comprehensive, enabling a full understanding of important project-related potential effects.
- Representative of societal values and important features of the environment.
- Responsive to the potential effects of the project.
- Concise, to facilitate clear understanding and minimize redundancy.

Indicators: Indicators are the parameters used to measure and evaluate the interaction of the Project with a specific VC. Indicators should be relevant, practical, measurable, responsive, accurate, and predictable (EAO 2013). VCs selected for assessment in the EA process are associated with measurable indicators to enable a meaningful and informative assessment of project-related effects on each VC.

Candidate Valued Components: Candidate VCs represent a subset of the issues identified during information gathering that have been evaluated against pre-set criteria. Candidate VCs are identified from the list of issues and must have the potential to interact with the proposed Project and experience potential adverse Project-related effects. They also reflect the values and priorities of government, Aboriginal Groups, the public, and the scientific community.

Intermediate Components: Intermediate components are environmental components along the pathway of an effect that are used to support the assessment of a VC. For example, water quality is an intermediate component when information from its study is used to support the assessment of the fish and fish habitat VC.

1.2 VC Selection Method

Building on guidance provided by the EAO (BC EAO 2013), the method for selecting VCs for the Project has followed a process that involves the following three steps:

1. Information gathering and identification of potential issues.
2. Issues scoping and identification of candidate VCs.
3. Evaluation of candidate VCs and selection of final VCs.

This section describes the key steps followed to determine the selection of Project-related VCs (**Figure 1**).

1.2.1 Step One – Information Gathering and Issues Scoping

Information was collected from a number of sources to support issues identification and scoping. Publicly-available information was reviewed by technical experts with knowledge of the components included in the five pillars (i.e., environmental, health, heritage, social and economic). This review supported the development of a list of Project-related issues that reflects the interests of government, Aboriginal Groups, the public, and the scientific communities. The Ministry conducted public consultation and Aboriginal Groups engagement on various options for the development of the Project, and results of this and information from environmental assessments of similar and related development projects in the Lower Mainland informed issues identification.

1.2.2 Step Two – Identification of Candidate Valued Components

Building on the list of issues identified during Step One, technical experts linked the issues to an environmental, economic, health, social or heritage component. Then these experts, with a thorough knowledge of the Project alignment, screened each component using a two-part test to determine whether it should be a candidate VC. The first test for inclusion as a candidate VC required a positive answer to two questions:

- Is the component present in the study area?
- Does the Project have the potential to interact with and adversely affect the component?

If the answer was “yes” to the first test questions, the component was further evaluated using a second test with a discipline-specific focus. Any positive answer to one of the questions in the second test was considered confirmation that the component was a candidate VC. The second test questions evaluated by discipline-specific technical experts were:

- Is the component important to government agencies?
- Is the component important to Aboriginal Groups?
- Is the component important to conservation or science?
- Is the component important to other stakeholders?

Discipline-specific criteria may have been developed to determine importance for each of these questions, or such criteria may have used published thresholds; e.g., federal or provincial designation as threatened species was the criteria for determining importance to conservation or science for the ecological components.

1.2.3 Step Three – Evaluation of Candidate Valued Components

In Step Three, candidate VCs were evaluated to minimize redundancy and duplication, and to focus the assessment on Project-environment interactions that are measurable and informative. In addition, indicators that will be used as the metrics for measuring and reporting on the condition and trend of the candidate VCs were selected.

In this step each candidate VC was screened against a range of practical considerations to determine if the candidate VCs were suitable for inclusion in the VC list. These considerations were:

1. Can effects on the candidate VC be effectively measured and monitored; i.e., are there suitable indicators? Each candidate VC must have at least one indicator which can be used to measure and report on potential effects.
2. Is the issue better represented by another VC, i.e., is there duplication in effects assessment? Where appropriate, candidate VCs were grouped and combined under the umbrella of a more general VC. For example, salmon, sturgeon, eulachon, trout, and char have been grouped under a fish and fish habitat VC. Each species is considered a sub-component of the umbrella VC, fish and fish habitat.
3. Where does the candidate VC fit in the effects pathway? In some cases, the potential effects of a project on the candidate VC are part of a longer-effects pathway. These candidate VCs are classified as intermediate components rather than a VC. For example, air quality and atmospheric noise are intermediate components along the pathway of effects leading to the ultimate receptor, human health.
4. Is the candidate VC protected through a legal instrument? This screening step eliminates components for which a non-EA process regulatory framework exists that includes legally binding requirements to ensure protection of the component (e.g., worker safety is managed under the BC *Occupational Health and Safety Regulation* and therefore does not need to be considered as a VC).

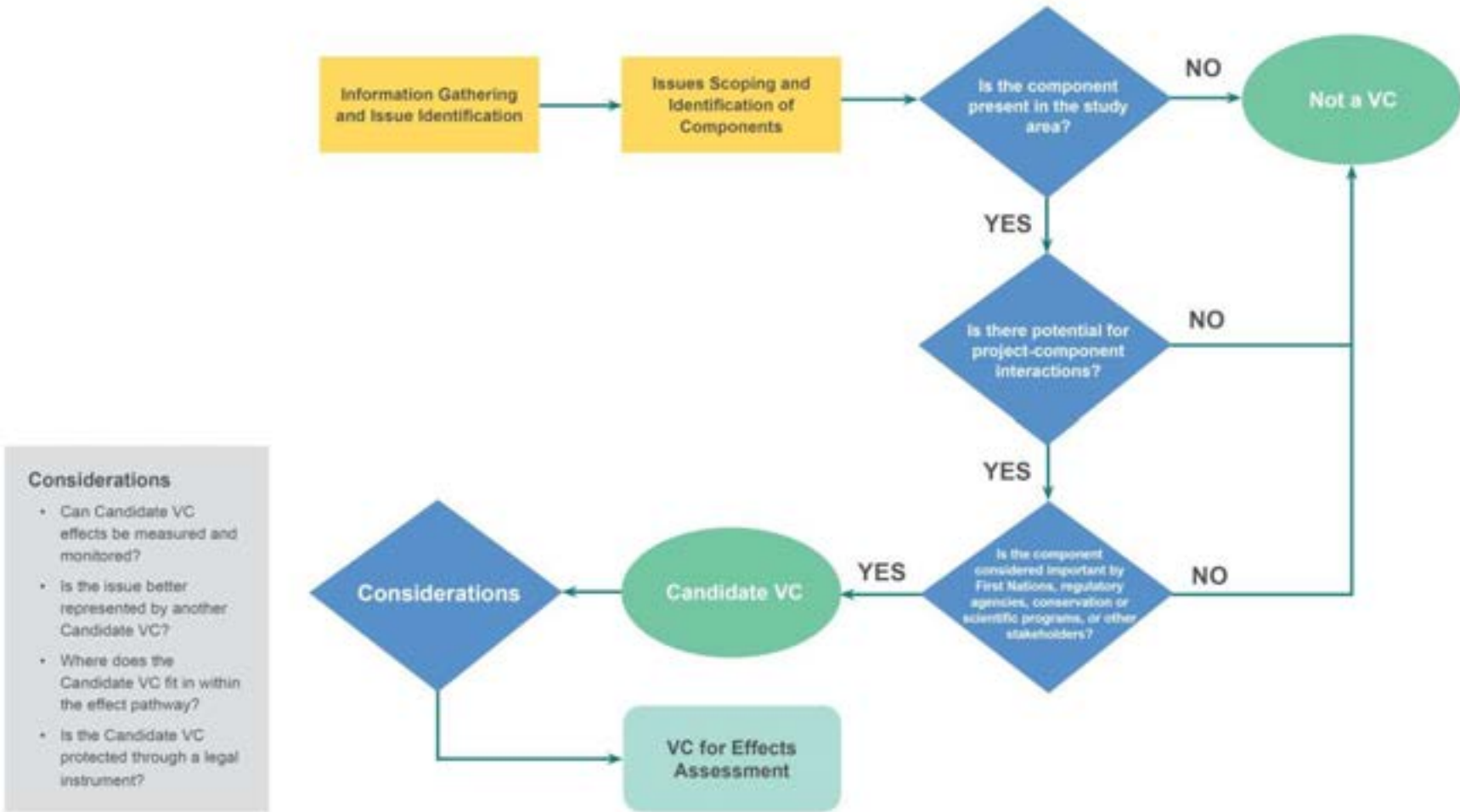


Figure 1 VC Selection Process

1.3 VC Selection Results

Potential Project-related issues were identified based on feedback received from initial public, Aboriginal Group, and agency consultation, knowledge of technical experts on the Project team, and review of relevant documents, including environmental assessment documentation on other recent projects in the area. These issues were linked to candidate VCs, grouped under the five assessment pillars, and the potential for Project components and activities to interact with the candidate VCs was assessed. An overview of the results of this assessment is provided in **Table 1**.

A decision on the need for including each candidate VC in the assessment, and whether it will be assessed as a VC (i.e. the ultimate receptor of Project-related effects) or an intermediate component (i.e. a component along the pathway of effects of the Project) was made based on the potential for interaction with Project components and activities, and anticipated nature of such interaction.

An overview of the VCs and intermediate components selected for assessment, issues related to them, and the rationale for their selection is provided in **Table 2**. Candidate VCs or sub-components of candidate VCs that were excluded from assessment, and the rationale for their exclusion are presented in **Table 3**.

Table 1 Overview of Potential Project Interactions with Candidate VCs

| Project Phase | Project Works and Activities | Pillars and Candidate VCs | | | | | | | | | | | | | | | | | | | | | | |
|---|---|------------------------------|---------------------------------|------------------------------------|------------------|-----------------------|----------------|------------|--------------------|----------|-------------|-------------------|---------------------|------------|----------|------------------|----------------|-------------------------------------|--------------------|--|----------|---------|--------------|--------------------|
| | | Environment | | | | | | | | | | Economic | Social | | | | | | | Health | Heritage | | | |
| | | Soil and Groundwater Quality | River Hydraulics and Morphology | Surface Water and Sediment Quality | Underwater Noise | Fish and Fish Habitat | Marine Mammals | Vegetation | At-risk Amphibians | Wildlife | Air Quality | Atmospheric Noise | Economic Conditions | Marine Use | Land Use | Agricultural Use | Visual Quality | Connectivity and Community Cohesion | Emergency Services | Utility, Infrastructure and Other Services | Aviation | Traffic | Human Health | Heritage Resources |
| Pre-construction / site preparation | Clearing and grubbing of vegetation | ✓ | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | - | - | - | - | - | - | - |
| | In-river ground improvements | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - | - | - | - | - | - |
| | Installing temporary drainage structures and diversions | - | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | - | - | - | ✓ | - | - |
| | Installing temporary bridges and barging facilities | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | - | - | ✓ | - | - |
| | Conducting additional site investigations such as a geotechnical drilling program | ✓ | ✓ | - | - | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | - | - | - | - | - | - |
| | Installing temporary roads, laydown areas, and site offices | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | - |
| | Relocating utilities that conflict with the proposed construction | - | - | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | ✓ | ✓ | - | ✓ | - | - |
| | Preloading for embankment and highway construction | - | - | - | - | ✓ | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | - | ✓ | - | ✓ | ✓ | - |
| | Acquiring land for the Project | - | - | - | - | - | - | - | - | - | - | - | ✓ | - | ✓ | ✓ | - | ✓ | - | - | - | - | - | - |
| Constructing new bridge including approaches and ramp connections | Installing upland piers and drainage structures | - | ✓ | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | - | |
| | In-river ground stabilization and piling | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | - | - | - | - | ✓ | |
| | Bridge construction from water-based equipment | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | - | |
| | Bridge and ramp construction from land-based equipment | - | - | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | - | |

"-" indicates no interaction
"✓" indicates potential interaction

| Project Phase | Project Works and Activities | Pillars and Candidate VCs | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|------------------------------|---------------------------------|------------------------------------|------------------|-----------------------|----------------|------------|--------------------|----------|-------------|-------------------|---------------------|------------|----------|------------------|----------------|-------------------------------------|--------------------|--|----------|---------|--------------|--------------------|---|
| | | Environment | | | | | | | | | | | Economic | Social | | | | | | Health | Heritage | | | | |
| | | Soil and Groundwater Quality | River Hydraulics and Morphology | Surface Water and Sediment Quality | Underwater Noise | Fish and Fish Habitat | Marine Mammals | Vegetation | At-risk Amphibians | Wildlife | Air Quality | Atmospheric Noise | Economic Conditions | Marine Use | Land Use | Agricultural Use | Visual Quality | Connectivity and Community Cohesion | Emergency Services | Utility, Infrastructure and Other Services | Aviation | Traffic | Human Health | Heritage Resources | |
| Highway 99 improvements, including interchange upgrades | Decommissioning the existing overpasses (i.e., Steveston Highway, Highway 17A, and Westminster Highway) | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ | ✓ | - | |
| | Highway 99 improvements and interchange upgrades | - | - | - | - | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ | ✓ | - |
| Tunnel decommissioning | Removing Tunnel segments and their protective cover | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | - | - | ✓ | ✓ | - |
| | Transporting Tunnel segments for offsite disposal, and operating support vessels for that activity | - | - | ✓ | ✓ | - | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | - | - | ✓ | ✓ | - |
| Decommissioning of Deas Slough Bridge | Decommissioning Deas Slough Bridge | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | ✓ | - | - | ✓ | ✓ | - |
| Operation of Highway 99 and interchanges | Operating reconfigured Highway 99 and interchanges | - | - | - | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | - | - | ✓ | ✓ | - |
| | Highway 99 and interchange maintenance | - | - | - | - | ✓ | - | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | - | - | - | ✓ | - | - | ✓ | - | - |
| Operation of new bridge | Operating the new bridge | - | - | ✓ | - | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | - |
| | Bridge maintenance | - | - | ✓ | - | ✓ | - | - | - | - | - | ✓ | ✓ | ✓ | - | ✓ | - | - | - | ✓ | - | ✓ | ✓ | - | - |

“-” indicates no interaction
“✓” indicates potential interaction

Table 2 Summary of Issues Identification and Valued/Intermediate Component Selection

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|--|---|---|--|--|
| Environmental | | | | | |
| <p>River Hydraulics and Morphology</p> <ul style="list-style-type: none"> • Suspended sediment and related effects on fish and fish habitat • Navigability of the Fraser River South Arm • In-stream infrastructure • River use during construction • Scour, erosion, deposition • Riverbed profile • Potential change in movement of the salt wedge within the Fraser River and its influence on irrigation | <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Changes to river hydraulics and morphology could affect current use and access to fish for traditional purposes or Aboriginal Interests.</p> <p>Aboriginal Groups have expressed concerns with potential scour and erosion from Tunnel removal activities.</p> | <p>Section 9 of the <i>Water Act</i> requires an approval prior to making “changes in and about a stream”.</p> <p>The <i>Navigation Protection Act</i> requires an approval for any works built in, on, over, under, through, or across the Fraser River.</p> <p>Maintenance of the navigation channel in the Fraser River South Arm is part of Vancouver Fraser Port Authority’s jurisdiction.</p> | <p>Changes to river hydraulics and morphology could affect species at risk or sensitive aquatic habitat for fish or amphibians.</p> | <p>Changes to river hydraulics and morphology could affect specific utilities along the bed and near the Tunnel.</p> | <p>River hydraulics and morphology was selected as an intermediate component because changes in river hydraulics and morphology have the potential to affect components such as fish and fish habitat, marine mammals, and marine use.</p> <p>River hydraulics and morphology is important to Aboriginal Groups, the public and other stakeholders and is of regulatory importance.</p> <p>Physical activities associated with Tunnel removal have the potential to affect the morphology of the Fraser River South Arm, including channel forms (i.e., cross-sectional form, bed configuration, bed slope, and channel pattern), and processes (i.e., bed and bank erosion, deposition, and sediment transport).</p> |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|---|--|--|---|---|
| <p>Sediment and Water Quality</p> <ul style="list-style-type: none"> • Surface water quality • Stormwater runoff • Sediment quality | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Potential changes in sediment and water quality have the potential to affect access to fish and other aquatic resources that are of interest to Aboriginal groups.</p> <p>Aboriginal Groups have identified potential effects of the Project on Fraser River water quality as an area of specific interest.</p> | <p>Section 36 of the federal <i>Fisheries Act</i> protects fish habitat.</p> | <p>Changes to sediment and water quality could affect fish and amphibian species at risk or sensitive aquatic habitat.</p> | <p>Changes to sediment and water quality have the potential to influence fish and fish habitat, marine mammals, and at-risk amphibians.</p> | <p>Sediment and water quality was selected as an intermediate component because changes in sediment and water quality have the potential to affect components such as fish and fish habitat, marine mammals, and at-risk amphibians.</p> <p>Sediment and water quality is important to Aboriginal Groups, the public and other stakeholders.</p> <p>During construction, in-water works associated with Tunnel removal and the decommissioning of Deas Slough Bridge have the potential to affect sediment and water quality. During operation, stormwater management has the potential to affect water quality.</p> |
| <p>Underwater Noise</p> <ul style="list-style-type: none"> • Underwater noise in river during construction and its effects on fish and other aquatic species | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Project-related construction activities have the potential to generate underwater noise that could affect fish and marine mammals valued by Aboriginal Groups.</p> | <p>N/A</p> | <p>Changes to underwater noise could affect fish and marine mammals.</p> | <p>Changes to underwater noise has the potential to affect fish and fish habitat and marine mammals.</p> | <p>Underwater noise was selected as an intermediate component because changes in underwater noise have the potential to affect components of other VCs such as fish and fish habitat and marine mammals.</p> <p>The Project has the potential to cause increased levels of underwater noise during construction, which may affect fish and fish habitat and marine mammals.</p> |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|---|---|---|--|---|---|
| <p>Fish and Fish Habitat</p> <ul style="list-style-type: none"> Physical injury or mortality of fish Change in quantity or quality of fish habitat | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>The Project involves activities that have the potential to affect fish and fish habitat that is of importance to Aboriginal Groups.</p> <p>The Tsawwassen Fishing Area overlaps the Project (Tsawwassen First Nation Final Agreement 2007).</p> | <p>Sections 35 and 36 of the federal <i>Fisheries Act</i> protect fish and fish habitat. In addition, under the <i>Fisheries Act</i>, Pacific salmon and their habitat are managed by Fisheries and Oceans Canada (DFO).</p> <p>The federal <i>Species at Risk Act</i> (SARA) protects at-risk fish species including white sturgeon and green sturgeon. In addition, bull trout populations of the south coast of B.C. and the eulachon populations of the Fraser River and central Pacific Coast are currently being considered by DFO for listing in SARA.</p> | <p>The Fraser River South Arm supports fish species that are provincially and federally of conservation concern (e.g., white sturgeon, green sturgeon, Pacific salmon, eulachon, coast cutthroat trout subspecies <i>clarkii</i>, and bull trout).</p> <p>Changes to fish habitat could affect fish species at-risk.</p> | <p>The Fraser River South Arm supports valuable commercial, recreational, and Aboriginal fisheries.</p> | <p>Fish and fish habitat was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and its regulatory importance.</p> <p>The Project intersects several watercourses and water features that are known to, or have the potential to, be inhabited by fish species with fisheries or conservation values of importance to recreational fisheries and Aboriginal Groups for traditional purposes.</p> <p>Project activities have the potential to affect fish and fish habitat through direct or indirect effects.</p> <p>The fish and fish habitat assessment will focus on:</p> <ul style="list-style-type: none"> Salmon Sturgeon Eulachon Trout Char |
| <p>Marine Mammals</p> <ul style="list-style-type: none"> Physical injury or mortality Behavioral changes | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>The Project involves construction activities in areas where marine mammals valued by Aboriginal Groups could be present.</p> <p>The Tsawwassen Fishing Area overlaps the Project (Tsawwassen First Nation Final Agreement 2007). The Final Agreement includes marine mammals in its definition of “Fish” (excluding cetaceans).</p> | <p>The federal <i>Fisheries Act</i> protects some marine mammals, including harbor seals, Steller sea lions, and California sea lions that are likely to be present in the vicinity of the Project.</p> <p>The federal SARA protects at-risk marine mammals, including Steller sea lions.</p> | <p>The Fraser River South Arm may support marine mammals that are provincially of conservation concern (e.g., Steller sea lions).</p> <p>Marine mammals are an integral part of the marine environment in their role as top predator.</p> | <p>Marine mammals are valued by the public.</p> | <p>Marine mammals were selected as a valued component due to their importance to Aboriginal Groups, the public, other stakeholders, and due to their regulatory importance.</p> <p>The Fraser River South Arm near the Project has the potential to support marine mammals that have associated recreational or Aboriginal uses.</p> <p>Underwater noise generated by pile driving, vibrodensification, dredging, and Tunnel decommissioning activities may affect marine mammals.</p> <p>The marine mammals assessment will focus on:</p> <ul style="list-style-type: none"> Harbour Seal Steller and California Sea Lions |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|---|--|---|--|---|
| <p>Vegetation</p> <ul style="list-style-type: none"> Vegetation within Project alignment At-risk plant species or ecosystems within Project alignment | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Plants and ecosystems within the Project area are of cultural importance to Aboriginal Groups.</p> <p>Aboriginal Groups have indicated that plant harvesting occurs along the shorelines, tidal wetlands, mudflats, drainage channels, and upland areas along the Lower Fraser River.</p> | <p>The federal SARA protects at-risk plant species and communities.</p> <p>Invasive species listed as noxious, invasive, or alien invasive are managed under the provincial <i>Weed Control Act</i> and Regulations.</p> | <p>The Project alignment may support plant species or communities that are provincially or federally of conservation concern.</p> | <p>At-risk plant species and communities are rare on the landscape, and therefore potential effects on them are of particular interest to the public.</p> <p>The type, amount, and distribution of vegetative cover in the Project alignment are important determinants of habitat value for wildlife.</p> | <p>Vegetation was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and due to its regulatory importance.</p> <p>The Project will require vegetation clearing, which may affect at-risk plant species and communities. A study of the vegetation in the Project alignment is required to quantify the types and amounts of habitats, including at-risk plant species and ecosystems anticipated to be affected, and identify opportunities for offsetting or compensating for such effects.</p> <p>The vegetation assessment will focus on:</p> <ul style="list-style-type: none"> At-risk ecosystems At-risk plant species |
| <p>At-risk Amphibians</p> <ul style="list-style-type: none"> At-risk amphibian mortality Habitat availability | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor; however, no specific feedback on the importance of amphibians to Aboriginal Groups has been received.</p> | <p>The federal SARA protects at-risk amphibians, including northern red-legged frog and western toad.</p> | <p>The Project alignment may support at-risk amphibian species that are provincially of conservation concern (e.g., northern red-legged frog and western toad).</p> | <p>None identified</p> | <p>At-risk amphibians were selected as a valued component due to their importance to Aboriginal Groups, the public, other stakeholders, and due to their regulatory importance.</p> <p>If present, at-risk amphibians could be affected through the loss or disturbance of their breeding or living habitat, or through mortality associated with construction.</p> <p>The at-risk amphibian assessment will focus on:</p> <ul style="list-style-type: none"> Northern red-legged frog Western toad |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|--|--|--|---|---|
| <p>Terrestrial Wildlife</p> <ul style="list-style-type: none"> Habitat availability Construction-related disturbance of wildlife Swallow nesting habitat Collision risk for large mammals | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Wildlife likely to be present in the general Project area includes species that are of cultural importance to Aboriginal Groups (e.g., Bald eagles).</p> <p>The Tsawwassen Wildlife Harvest Area and Tsawwassen Migratory Bird Harvest Area overlap the Project alignment.</p> | <p>The federal <i>Migratory Bird Convention Act</i> protects individual birds, eggs, and active nests.</p> <p>Section 34 of the B.C. <i>Wildlife Act</i>, prohibits possessing, taking, or destroying (i) a bird or its egg, (ii) the nest of an eagle, peregrine falcon, osprey, or heron, or (iii) the nest of a bird not mentioned in (ii), when the nest is occupied by a bird or its egg.</p> | <p>The Project alignment may support wildlife species that are provincially or federally of conservation concern (e.g., American bittern, rough-legged hawk, barn owl, common nighthawk, barn swallow, tundra swan, Caspian tern, western grebe, and Trowbridge’s shrew)</p> | <p>Public interest</p> | <p>Terrestrial wildlife was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and due to its regulatory importance.</p> <p>Construction activities such as vegetation removal, and post-construction traffic and presence of the new bridge have the potential to interact with wildlife.</p> <p>The terrestrial wildlife assessment will have the following subcomponents:</p> <ul style="list-style-type: none"> Upland birds Riverine birds Small mammals |
| <p>Air Quality</p> <ul style="list-style-type: none"> Air emissions Ambient air quality | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Changes in air quality could have human health effects.</p> | <p>The federal <i>Canadian Environmental Protection Act</i> provides regulations, standards and guidelines for motor vehicles and fuels, marine vessels, railways, and off-road engines.</p> <p>Applicable municipal (Metro Vancouver), B.C., or federal ambient air quality objectives for NO₂, CO, SO₂, and PM concentrations.</p> | <p>Changes in air quality can affect human health.</p> | <p>Air quality and its influence on human health are important to government agencies and the general public.</p> | <p>Air quality was selected as an intermediate component, because changes in air quality have the potential to affect components of other VCs such as human health.</p> <p>Changes in air quality, and the associated effects on human health, are important to Aboriginal Groups, the public, and stakeholders.</p> <p>Construction vehicle emissions and changes in traffic during Project operation have the potential to affect air quality.</p> |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|--|--|--|--|---|
| <p>Atmospheric Noise</p> <ul style="list-style-type: none"> Noise and vibration from construction activities Existing high-traffic noise exposures Noise related to traffic volume growth, potential speed increases Noise related to changes in vertical alignment along the new bridge and approaches | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Aboriginal Groups have expressed interest in the potential influence of change in noise conditions on wildlife and quality of experience in the context of traditional uses.</p> | <p>BCEAA requires consideration of adverse environmental effects.</p> <p>The City of Richmond Public Health Protection Bylaw imposes time constraints and a maximum noise level on construction activities.</p> <p>The Corporation of Delta Noise Control Bylaw imposes time constraints on construction activities.</p> | <p>Changes in atmospheric noise can affect wildlife species at risk and human health.</p> <p>Community noise impacts associated with provincial highway projects are addressed in the Ministry's <i>Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways</i> (Wakefield Acoustics Ltd. 2014).</p> | <p>Project-related changes in noise during construction and operations and their influence on human health and wildlife are of importance to government agencies and the general public.</p> | <p>Atmospheric noise was selected as an intermediate component because changes in atmospheric noise have the potential to affect components of other VCs such as human health and terrestrial wildlife.</p> <p>Construction activities associated with the Project have the potential to generate noise and vibration, which could in turn affect nearby residents, communities, and wildlife.</p> <p>Project-related changes in traffic volume and vertical alignment, and widening of the corridor could result in a change in noise levels in the vicinity of the Project.</p> |
| Socio-economic | | | | | |
| <p>Traffic</p> <ul style="list-style-type: none"> Changes to traffic during construction due to temporary construction zones, limited closures, and construction vehicles. Temporary changes to local cycling and pedestrian networks Post construction Project-related effects on traffic along the Highway 99 corridor are expected to be positive. | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> | <p>The Ministry's policies/guidelines around highway construction traffic management align with the overall objectives of federal, provincial, and regional plans, including Translink's Regional Transportation Strategy (2013) and the Mayors' Council Vision (2014).</p> | <p>Predicted Project-related change in traffic conditions will be used to inform the assessment of air quality and noise, which forms the bases of human health assessment.</p> <p>Potential effects of Project-related change in traffic conditions will be assessed in terms of its implications for the land use VC.</p> | <p>Project-related changes in traffic during construction and operation and its influence on human health, land use, and wildlife are of importance to government agencies and the general public.</p> | <p>Traffic was selected as an intermediate component because changes in traffic have the potential to affect components of other VCs such as human health, terrestrial wildlife, and land use.</p> <p>Construction activities associated with the Project, including temporary construction zones, limited detours, increases in construction vehicles, and temporary changes to local cycling and pedestrian networks, have the potential to lead to changes in traffic, which could in turn affect nearby residents, communities, and wildlife.</p> <p>One of the primary goals of the Project is to improve traffic conditions along the Highway 99 corridor, and post construction Project-related effects on traffic are expected to be positive.</p> |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|--|---|-------------------------------------|--|---|
| <p>Marine Use</p> <ul style="list-style-type: none"> • Disruption, interference, or obstruction to marine use in the Fraser River South Arm and Deas Slough • Navigability of the Fraser River South Arm due to vertical and horizontal clearances of the new bridge during operation | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Maintaining waterway navigability and access, specifically in the context of fisheries, has been identified as an area of interest by Aboriginal Groups.</p> | <p>BCEAA requires consideration of adverse environmental effects.</p> <p>The federal <i>Navigation Protection Act</i> protects the public's right to navigate the Fraser River South Arm.</p> <p>The <i>Canada Marine Act</i> establishes federal navigation jurisdiction by Port Metro Vancouver in the Fraser River.</p> <p>The federal <i>Fisheries Act</i> regulates and manages commercial, recreational or Aboriginal fisheries by protecting the ongoing productivity and sustainability of CRA fisheries.</p> | N/A | <p>Maintaining waterway navigability and access is important to many businesses and the general public.</p> | <p>Marine use was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and due to its regulatory importance.</p> <p>The Project will involve construction activities in the Fraser River South Arm and Deas Slough that may temporarily infringe on or obstruct navigation, commercial, recreational or Aboriginal (CRA) fisheries, and other recreational boating.</p> <p>The marine use assessment will focus on:</p> <ul style="list-style-type: none"> • Navigation • Commercial, recreational, and Aboriginal fisheries • Recreational boating |
| <p>Land Use</p> <ul style="list-style-type: none"> • Consistency with existing land use plans, and designations • Compatibility with adjacent land uses • Disturbance to other land uses | <p>Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor.</p> <p>Potential influence of the Project on adjacent land uses has been identified as an area of interest by Aboriginal Groups.</p> | <p>BCEAA requires consideration of adverse environmental effects.</p> <p>The B.C. <i>Agricultural Land Commission Act</i> permits uses within the provincial Agricultural Land Reserve (ALR).</p> <p>The B.C. <i>Local Government Act</i> establishes the legal framework for regional districts, the authority for regional growth strategies, and local government planning and zoning bylaws.</p> <p>The B.C. <i>Community Charter</i> establishes the legal framework for core municipal powers.</p> | N/A | <p>Requirements for municipal zoning and property acquisition of interest to the municipality and the public.</p> <p>Access to recreational areas and trails is of importance to the public.</p> | <p>Land use was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and due to its regulatory importance.</p> <p>The majority of the Project works will occur within the existing Highway 99 right-of-way, and is consistent with that existing land use; however, a limited amount of private land parcels beyond the Highway 99 ROW may be required. Project construction may also lead to temporary changes in land and resource use within and adjacent to the Project alignment.</p> |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|--|--|---|--|---|
| Agricultural Use <ul style="list-style-type: none"> Land base available for agricultural production Drainage and irrigation systems Transportation between farm parcels, markets, and suppliers Farm utilities and infrastructure | <p>Tsawwassen First Nation undertakes farming on their lands and has developed an agricultural plan to manage farming activity.</p> | <p>BCEAA requires consideration of adverse environmental effects.</p> <p>The B.C. <i>Agricultural Land Commission Act</i> permits uses within the provincial Agricultural Land Reserve (ALR).</p> | N/A | <p>Agricultural use is important to Metro Vancouver and the public in the Lower Mainland for economic, historical, ecological, and cultural reasons.</p> | <p>Agricultural use was selected as a valued component due to its importance to the public, other stakeholders, and due to its regulatory importance.</p> <p>Agriculture is the predominant use of land abutting the Highway 99 ROW in Richmond and Delta. The Project may affect access to and use of agricultural lands.</p> <p>The agricultural use assessment will focus on:</p> <ul style="list-style-type: none"> Land in ALR Irrigation and drainage Farm infrastructure and operations |
| Visual Resources <ul style="list-style-type: none"> Visual quality | <p>Changes in ambient lighting could influence wildlife that is of importance to Aboriginal Groups.</p> | <p>BCEAA requires consideration of adverse environmental effects.</p> <p>The <i>Government Action Regulation</i>, under the <i>Forest and Range Practices Act</i> establishes Visual Quality Objectives, however, there are no Visual Quality Objectives in the vicinity of the new bridge.</p> | <p>The Project could change ambient light conditions near the new bridge. Potential light effects from the Project will be considered under the Terrestrial Wildlife and Fish and Fish Habitat VCs.</p> | <p>The new bridge could change the visual quality of the area valued by the public for residential or recreational activities.</p> <p>The new bridge may cast a shadow that changes the current shading conditions. Potential shading effects from the Project will be considered under the Land Use VC.</p> | <p>Visual quality was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and due to its regulatory importance.</p> <p>Visual conditions around the Project will change due to the introduction of the new bridge in the place of the submerged crossing.</p> <p>The visual quality assessment will focus on change in visual conditions at select locations.</p> |
| Health | | | | | |
| Human Health <ul style="list-style-type: none"> Human health implications as a result of Project-related changes to ambient air quality, noise, and vibration | <p>Potential influence of the Project on human health/health determinants has been identified as an area of interest by Aboriginal Groups.</p> | <p>BCEAA requires consideration of adverse environmental effects.</p> <p>Environment Canada, Health Canada, B.C. Ministry of Environment, Metro Vancouver, and the B.C. Ministry of Health (as represented by the Vancouver Coastal Health and Fraser Valley Health Authorities) all have an interest in potential human health issues related to the Project.</p> | N/A | <p>Human health effects are a concern for local communities.</p> | <p>Human health was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and due to its regulatory importance.</p> <p>Project-related changes in ambient air quality and noise have the potential to affect human health. Ground-borne vibration as a result of highway operation could also be a potential concern and source of annoyance to communities.</p> <p>Human health will be assessment will focus on:</p> <ul style="list-style-type: none"> Air emissions Noise and vibration |

| Component and Potential Project-related Issues | Aboriginal Importance | Regulatory Importance | Conservation/ Scientific Importance | Other Stakeholder Importance | Rationale for Inclusion |
|--|--|---|--|---|---|
| Heritage | | | | | |
| <p>Heritage Resources</p> <ul style="list-style-type: none"> • Physical disturbance to heritage sites, objects, and features • Accessibility to heritage sites, objects, and features <ul style="list-style-type: none"> ▫ opportunities for scientific research, preservation, or public appreciation ▫ exposure to vandalism and unauthorized collection | <p>Protection of archaeological and heritage resources, including intangible heritage sites, has been identified as of specific importance by Aboriginal Groups.</p> | <p>BCEAA requires consideration of adverse environmental effects.</p> <p>The B.C. <i>Heritage Conservation Act</i> protects heritage resources.</p> | <p>The Project alignment may contain unknown heritage resources that could be affected by construction activities.</p> | <p>The Project alignment could contain heritage resources that are important to the public.</p> | <p>Heritage resources was selected as a valued component due to its importance to Aboriginal Groups, the public, other stakeholders, and due to its regulatory importance.</p> |

Table 3 Rationale for Exclusion of Candidate Valued Components, Intermediate Components, or Subcomponents

| Candidate Valued Component, Intermediate Component, or Subcomponent | Rationale for Exclusion |
|--|---|
| Soil and groundwater quality (Candidate VC) | <ul style="list-style-type: none"> • The Project has the potential to interact with potentially contaminated soil and groundwater; however, potential issues related with any such interaction will be managed according to the requirements of the <i>Environmental Protection Act</i>, and associated regulations. |
| Species listed under the Species At Risk Act (SARA) (Candidate VC) | <ul style="list-style-type: none"> • Individual species at risk are better represented as subcomponents under the following VCs: <ul style="list-style-type: none"> ▫ Fish and Fish Habitat ▫ Marine Mammals ▫ At-risk Amphibians ▫ Vegetation ▫ Terrestrial Wildlife |
| Wetlands (Candidate VC) | <ul style="list-style-type: none"> • Potential effects on wetlands (including estuaries) can be effectively considered within the assessment of the following VCs: <ul style="list-style-type: none"> ▫ Vegetation ▫ Terrestrial Wildlife • Assessment of potential Project-related effects on wetlands in terms of influence on vegetation and wildlife will be supported by the following studies: <ul style="list-style-type: none"> ▫ River Hydraulics and River Morphology ▫ Sediment Quality and Water Quality |
| Southern resident killer whale (SRKW) (Candidate Marine Mammal VC subcomponent) | <ul style="list-style-type: none"> • SRKW are not present in the Fraser River and therefore no direct interaction with Project activities is expected. • Preliminary results of underwater noise modelling indicate underwater noise generated during construction will not travel beyond the Fraser River. • Preliminary results of fish and fish habitat studies suggest potential effects on availability of Chinook salmon as food source for South Resident Killer Whale are negligible. |
| Benthic and aquatic invertebrates (Candidate intermediate component) | <ul style="list-style-type: none"> • Benthic and aquatic invertebrates are present within the Project alignment. • The Project alignment within the Fraser River South Arm is known to be a dynamic environment lacking the characteristics which are expected to promote highly productive benthic and aquatic invertebrate populations. • The Project has limited potential for interaction with benthic and aquatic invertebrates and their habitat. • Any notable interactions (e.g., Tunnel decommissioning) will occur over a very limited timeframe, and no long-term adverse effects are anticipated. |
| Nocturnal owls (except barn owls) (Candidate Terrestrial Wildlife VC subcomponent) | <ul style="list-style-type: none"> • There is limited potential for interaction with the nocturnal owls (except barn owls) and the Project. There are few affected forest areas with potential for owl species, and where they do occur, protection afforded to such species under the <i>Wildlife Act</i> and standard best management practices assures the identification and protection of active nests prior to felling. |
| At-risk terrestrial invertebrates (Candidate Terrestrial Wildlife VC subcomponent) | <ul style="list-style-type: none"> • Habitat in the Project alignment is unsuitable for the at-risk terrestrial mollusk species, butterfly species, and dragonfly species that occur in the Lower Mainland as there are no host plants present. • There is no potential for interaction between at-risk terrestrial invertebrates and the Project. |
| Sandhill cranes (Candidate Terrestrial Wildlife VC subcomponent) | <ul style="list-style-type: none"> • There is confirmed sandhill crane foraging during fall in the vicinity of the Project alignment, but there will be no footprint effects on this foraging habitat due to the Project. • There is limited potential for interaction between sandhill cranes with the Project. • Visual and aural effects on sandhill crane will be largely unchanged from the current situation. • The effects of the nearby South Fraser Perimeter Road on sandhill crane are being monitored and the preliminary conclusions of their patterns of use in southwest Delta can be used as a basis for not including sandhill cranes as a subcomponent for the Terrestrial Wildlife VC. • Addressed to some extent in the riverine birds VC. |

| Candidate Valued Component, Intermediate Component, or Subcomponent | Rationale for Exclusion |
|---|---|
| Large mammals (Candidate Terrestrial Wildlife VC subcomponent) | <ul style="list-style-type: none"> • Large mammals, specifically black-tailed deer live in areas adjacent to the Project alignment (Burns Bog); however, monitoring of the existing collision impacts of Highway 99 by the Ministry of Transportation, and reporting in the Wildlife Accident Reporting System (WARS), indicates few to no deer impacts in the portion of Highway 99 to be upgraded as part of the Project. • In the five-year period between January 1, 2009 and December 31, 2013, there were three incidents involving deer within the Project. All three collisions occurred within a five-kilometre section of Highway 99 near the Highway 10 entrance. • Highway improvements associated with this Project are not anticipated to result in an increase in collision risk for large mammals. |
| Economic conditions (Candidate VC) | <ul style="list-style-type: none"> • Project-related effects are anticipated to be positive. • Influence of the Project will be considered in the context of project benefits in the Application, under Section 1.1.7 Economic Benefits |
| Growth and Growth Patterns (Candidate VC) | <ul style="list-style-type: none"> • Potential effects on growth can be effectively considered within the assessment of the Land Use VC |
| Recreation (Candidate VC) | <ul style="list-style-type: none"> • Potential effects on recreation can be effectively considered within the assessment of the following VCs: <ul style="list-style-type: none"> ▫ Land Use ▫ Marine Use |
| Connectivity and Community Cohesion (Candidate VC) | <ul style="list-style-type: none"> • The Project is anticipated to have an influence on connectivity and community cohesion. These effects are anticipated to be positive. <ul style="list-style-type: none"> ▫ The Project will introduce new cycling and pedestrian facilities, making walking and cycling between Delta and Richmond a viable transportation option for many people. ▫ The Project will expand the transit and HOV network, increasing the reliability of these transportation options for communities and area residents. ▫ The Project has the potential to affect positive changes in local street connectivity and access, travel times to employment and commercial areas, and access to community gathering or recreational areas and other services. • Effects of the Project on connectivity and community cohesion will be discussed under Section 1.1.8 Other Project Benefits. |
| Emergency Services (Candidate VC) | <ul style="list-style-type: none"> • The Project is anticipated to have a positive influence on emergency services. • Emergency response times and corridor reliability were identified as issues during consultation for the Project. Addressing congestion at the Tunnel will alleviate safety concerns, reduce emergency response times, and improve access for emergency responders. • Effects of the Project on emergency response times and service reliability will be discussed under Section 1.1.8 Other Project Benefits. |
| Utility, Infrastructure, and Other Services (Candidate VC) | <ul style="list-style-type: none"> • The Project is anticipated to have an influence on local utility, infrastructure and services. These effects are anticipated to be negligible and not result in a measureable change to local utility, infrastructure and services. • The workforce needed for the Project will largely be drawn from the Lower Mainland, which is not expected to result in any measureable increased pressure on residential utility demand in nearby communities. |
| Aviation (Candidate VC) | <ul style="list-style-type: none"> • Potential aviation-related effects of the new bridge will be subject to review by Transport Canada under sub-section 5.9(2) of the federal <i>Aeronautics Act</i>, R.S.C. 1985, c. A-2. The Ministry will complete an aeronautical obstruction clearance application and will conform to the required marking and lighting standards. • Aviation will not be studied as aviation-related effects are subject to review by another legislative body. |
| Climate Change (Candidate VC) | <ul style="list-style-type: none"> • Potential effects on greenhouse gas GHG emissions can be effectively considered under the assessment of Air Quality. |

APPENDIX B

Potential Project Interactions with Valued Components and Intermediate Components

Table 1 Overview of Potential Project Interactions with the Selected Valued and Supporting Components

| Project Phase | Project Works and Activities | Valued and Supporting Components | | | | | | | | | | | | | | | | |
|--|--|---------------------------------------|----------------------------|------------------|-----------------------|--------------------|----------------|------------|----------------------|-------------|-------------------|---------|------------|----------|------------------|----------------|--------------------|--------------|
| | | River Hydraulics and River Morphology | Sediment and Water Quality | Underwater Noise | Fish and Fish Habitat | At-risk Amphibians | Marine Mammals | Vegetation | Terrestrial Wildlife | Air Quality | Atmospheric Noise | Traffic | Marine Use | Land Use | Agricultural Use | Visual Quality | Heritage Resources | Human Health |
| Pre-Construction / Site Preparation | | | | | | | | | | | | | | | | | | |
| Pre-construction / site preparation | Surveying | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| | Clearing and grubbing of vegetation within the existing Highway 99 ROW | - | - | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Restoration of Green Slough to its historic alignment | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | - | ✓ |
| | Installing temporary drainage structures and diversions | ✓ | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Installing temporary bridges and barging facilities | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ |
| | Conducting additional site investigations (e.g., a geotechnical drilling program) | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Installing temporary roads, laydown areas, and site offices | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Relocating utilities | - | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Preloading for embankment and highway construction | - | - | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Acquiring property for the Project | - | - | - | - | - | - | - | - | - | - | - | - | ✓ | ✓ | - | - | - |
| Construction | | | | | | | | | | | | | | | | | | |
| New bridge including approaches and ramp connections | Installing upland piers, including pile installation | - | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | - | ✓ |
| | Installing drainage structures/settling ponds | - | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Ground improvements associated with new bridge piers | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | - | ✓ |
| | Installing piers adjacent to Deas Slough and Green Slough, including pile installation | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ |
| | Hoisting pre-assembled deck segments from barges in the river or land-based transport system | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ |
| | Constructing approach spans (concrete deck slab on steel or concrete girder) | - | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | ✓ |
| | Constructing bridge towers and installing support cables using land-based equipment | - | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | - | ✓ |
| | Installing retaining walls | - | - | - | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | - | ✓ |

| Project Phase | Project Works and Activities | Valued and Supporting Components | | | | | | | | | | | | | | | | |
|---|---|---------------------------------------|----------------------------|------------------|-----------------------|--------------------|----------------|------------|----------------------|-------------|-------------------|---------|------------|----------|------------------|----------------|--------------------|--------------|
| | | River Hydraulics and River Morphology | Sediment and Water Quality | Underwater Noise | Fish and Fish Habitat | At-risk Amphibians | Marine Mammals | Vegetation | Terrestrial Wildlife | Air Quality | Atmospheric Noise | Traffic | Marine Use | Land Use | Agricultural Use | Visual Quality | Heritage Resources | Human Health |
| Highway 99 improvements, including interchange upgrades | Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A | - | - | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112 th Street | - | - | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| | Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | - | - | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | - | ✓ |
| Tunnel decommissioning | Removing electrical/mechanical/utilities equipment from the Tunnel | ✓ | - | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | - | ✓ |
| | Removing of four Tunnel segments and associated scour protection | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | - | ✓ |
| | Backfilling of onshore portions of Tunnel approaches | ✓ | - | - | ✓ | - | ✓ | - | - | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | - | ✓ |
| | Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | - | - | ✓ | - | ✓ |
| Decommissioning of Deas Slough Bridge | Removal of Deas Slough Bridge including substructures | - | ✓ | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ | |
| Operation and Maintenance | | | | | | | | | | | | | | | | | | |
| Highway 99 and interchanges | Operating reconfigured Highway 99 and interchanges | - | - | - | ✓ | ✓ | - | - | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ |
| | Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | - | - | - | ✓ | ✓ | - | - | ✓ | - | ✓ | ✓ | - | ✓ | ✓ | - | - | ✓ |
| New bridge | Operating the new bridge | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - | ✓ |
| | Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | ✓ | ✓ | ✓ | ✓ | - | - | - | - | - | ✓ | ✓ | - | ✓ | - | - | - | ✓ |

“-” indicates no interaction

“✓” indicates potential interaction

4.1 River Hydraulics and River Morphology Assessment Highlights:

- The proposed bridge will have a clear-span over the Fraser River South Arm, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure.
- The Fraser River South Arm is dynamic with scour in the order of several meters during freshet and migrating sand dunes with heights of up to four metres.
- Removal of the Tunnel is not expected to result in changes in water level or affect flow splits between the main channel and nearby channels.
- Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.
- Tunnel removal is expected to result in temporary bed lowering between the Tunnel and the Lulu Island–Delta watermain; however, with monitoring and mitigation, no permanent effect on the watermain is expected.
- No Project-related long-term residual effects or cumulative effects on river hydraulics or river morphology are expected.

4.1 River Hydraulics and River Morphology

This section describes the existing conditions related to water levels, velocities, and flow patterns (river hydraulics), and their influence on sedimentation and erosion (morphology) within the Fraser River, as well as anticipated Project-related changes in such conditions. River hydraulics and river morphology is studied as an intermediate component (IC), and information on predicted Project-related change in river hydraulics and river morphology is used to support the assessment of effects of the Project on fish and fish habitat (**Section 4.4 Fish and Fish Habitat**), marine mammals (**Section 4.6 Marine Mammals**), and marine use (**Section 5.2 Marine Use**).

A technical volume, **River Hydraulics and River Morphology Study**, containing further detail on existing conditions and methodology used in predicting Project-related effects is included in **Section 16.2**.

4.1.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on river hydraulics and river morphology in terms of Project setting, and defines the assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

4.1.1.1 Assessment Context

Although no permanent instream works are required in the Fraser River, temporary impacts to river hydraulics and river morphology as a result of Tunnel removal have been examined because of their potential to affect fish and fish habitat, marine mammals, and marine use. Input received through consultation with government agencies, Aboriginal Groups, and the general public also informed the decision to undertake a river hydraulics and river morphology assessment. During pre-Application consultation on the Project, Metro Vancouver expressed an interest in the potential effect of Tunnel decommissioning on Metro Vancouver Water Services infrastructure (i.e. River Road West Main and Lulu Island-Delta Main). No other feedback or information, including Traditional Knowledge, that would be of specific relevance to the assessment of river hydraulics or morphology was received during pre-Application consultation.

Additional information on the selection of VCs, and the link between river hydraulics and river morphology, and receptor VCs is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.1.1.2 Methodology

The assessment of river hydraulics and river morphology follows the general methodology described in **Section 3.0 Assessment Methodology**. In early 2014, the Ministry initiated studies to meet the following key objectives:

- Understand the morphological evolution of the lower Fraser River and estuary and describe existing conditions.
- Assess potential changes in water levels, velocities, and flow patterns related to the Project.
- Assess potential Project-related changes in sediment deposition and erosion patterns.
- Assess potential adjustment of the riverbed profile following Tunnel removal.

4.1.1.3 Assessment Boundaries

Assessment boundaries for river hydraulics and river morphology are defined below.

Spatial Boundaries

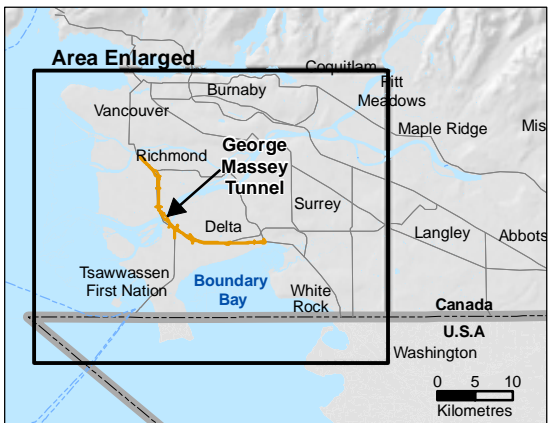
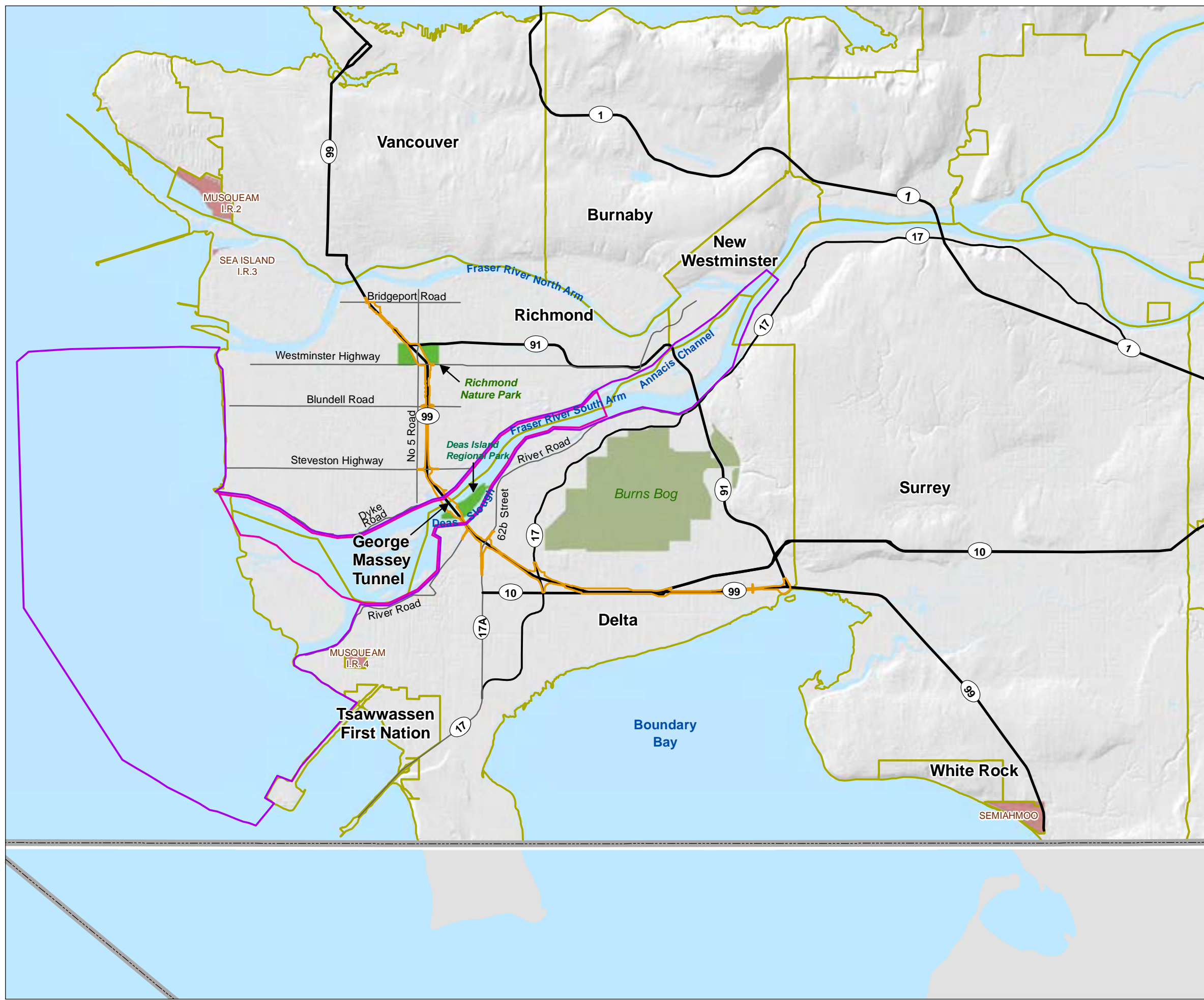
The local assessment area (LAA) includes the area where Project-related changes are likely to occur, and is defined as the Fraser River South Arm from just upstream of Tilbury Island to the mouth of the River, as shown on **Figure 4.1-1**.

The regional assessment area (RAA) is defined as the Fraser River South Arm, extending from just upstream of Annacis Island to the Fraser River estuary, including Sturgeon and Roberts Banks (**Figure 4.1-1**). While Project-related changes are not expected beyond the mouth of the Fraser River, the RAA incorporates the adjacent coastal waters to support tidal simulations and establish the boundary conditions for the numerical modelling used to predict Project-related effects.

Table 4.1-1 Spatial Boundaries for River hydraulics and river morphology Assessment

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local Assessment Area (LAA) | Fraser River South Arm from just upstream of Tilbury Island to the mouth of the River |
| Regional Assessment Area (RAA) | Fraser River South Arm, extending from just upstream of Annacis Island to the Fraser River estuary, including Sturgeon and Roberts Banks |

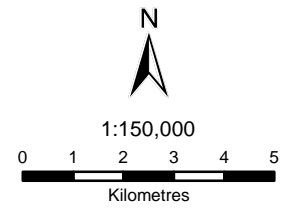
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- Legend**
- River Hydraulics and Morphology Local Assessment Area
 - River Hydraulics and Morphology Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

RIVER HYDRAULICS AND MORPHOLOGY
LOCAL AND REGIONAL ASSESSMENT AREAS

| | |
|--------------|------------|
| Figure 4.1-1 | 13/05/2016 |
|--------------|------------|

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on river hydraulics and river morphology were established based on the potential for each phase of the Project to interact with and have an effect on river processes. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect river processes within the Fraser River South Arm; therefore, the following temporal boundaries were defined for assessment of river hydraulics and river morphology:

- Existing conditions.
- Construction phase (including decommissioning of the Tunnel).
- Operations phase (new bridge and highway in operation).

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of Proposed Project**. Specific temporal considerations for the assessment of river hydraulics and river morphology and its sub-components are discussed in the context of Project interactions and potential effects in **Section 4.1.3 Potential Effects**.

Administrative Boundaries

No administrative boundaries have been identified that could impose limitations on the assessment of potential Project-related effects on river hydraulics and river morphology.

Technical Boundaries

Technical boundaries for predicting changes to river hydraulics and river morphology exist due to the interpretive nature of geomorphic studies and the limitations of the numerical methods used to model river hydraulics and river morphology. This uncertainty has been mitigated to some extent by using accurate data collection methods and by relying on data that were collected reliably by others.

The numerical modelling approach is consistent with standard practices and state of the science. Details of model validation are given in the technical volume, ***River Hydraulics and River Morphology Study*** included in **Section 16.2**.

4.1.2 Existing Conditions

This section provides an overview of the methodology used for collecting baseline data, and describes the existing conditions pertaining to current distributions, water levels and sedimentation patterns in the assessment areas. An overview of the regulatory context for management of surface water as relevant to the Project is also provided.

4.1.2.1 Baseline Data Collection

An interpretive geomorphology approach that involved the following tasks was used to collect baseline data and to understand the morphological evolution of the lower Fraser River and estuary:

- Literature review – Previous field, model, and theoretical studies were reviewed to understand the environment and driving forces at work near the Tunnel and interpret the results of the numerical modelling in this light.
- Aerial photograph interpretation – Aerial photographs of the LAA spanning the years 1938 to 2009 were analyzed. These provide insight into the planform changes that have taken place on the lower Fraser River since 1938 and the role of natural or man-made factors in driving these changes.
- Bathymetric surveys – Watermain crossings on the Fraser River have been surveyed regularly by the Greater Vancouver Water District since 1962. Data were also obtained from bathymetric surveys of the lower Fraser River conducted in 1988/89, 2000/01, 2008/09 and 2014 by Public Works and Government Services of Canada (PWGSC).

4.1.2.2 Regulatory Context

Two pieces of legislation are relevant to the Project in the context of river hydraulics and river morphology: the B.C. *Water Sustainability Act* S.B.C. 2014, c. 15, and the federal *Fisheries Act*, R.S.C. 1985, c. F-14.

In B.C., the ownership of water is vested in the Crown as stated in Section 5 of the *Water Sustainability Act*, the primary provincial statute regulating water resources. Since the Project involves works in or about the Fraser River, Sections 11 and 12 of the *Water Sustainability Act* and associated *Water Sustainability Regulation* B.C. Reg. 36/2016 would apply to such activities. Section 46 of the *Water Sustainability Act* regulates the introduction of foreign matter into streams. The *Water Sustainability Regulation* addresses the requirements to allocate surface water (e.g., application requirements) and identifies the requirements for using water or making changes to a stream in accordance with the regulation.

Fisheries Act

Section 35 (1) of the *Fisheries Act* regulates “any work, undertaking or activity that results in serious harm to fish that are part of a commercial, recreational or Aboriginal fishery, or to fish that support such a fishery.” Section 36 (3) regulates depositing or permitting the deposition of “a deleterious substance of any type in water frequented by fish”. A deleterious substance may include excess concentrations of suspended sediment.

4.1.2.3 Existing Conditions

George Massey Tunnel

The Tunnel is located on the Fraser River South Arm between km 18 and km 19 from Sand Heads (**Figure 4.1-2**). It is 629 m long and consists of six concrete segments (105 m long each). Tunnel width and height are 23.8 m and 7.3 m, respectively. The Tunnel configuration is shown in **Figure 4.1-3**.

The Tunnel is protected from scour by a rock apron and a flexible concrete mattress (**Figure 4.1-4**). The top of this scour protection layer was constructed to be flush with the riverbed in the centre channel. The elevation of the top of the Tunnel’s scour protection relative to the river bottom is shown in the as-built surveyed Tunnel cross sections provided in **Figure 4.1-5** and river bathymetry is shown in **Figure 4.1-6**.

George Massey Tunnel Replacement Project – **PART B**
RIVER HYDRAULICS AND RIVER MORPHOLOGY ASSESSMENT

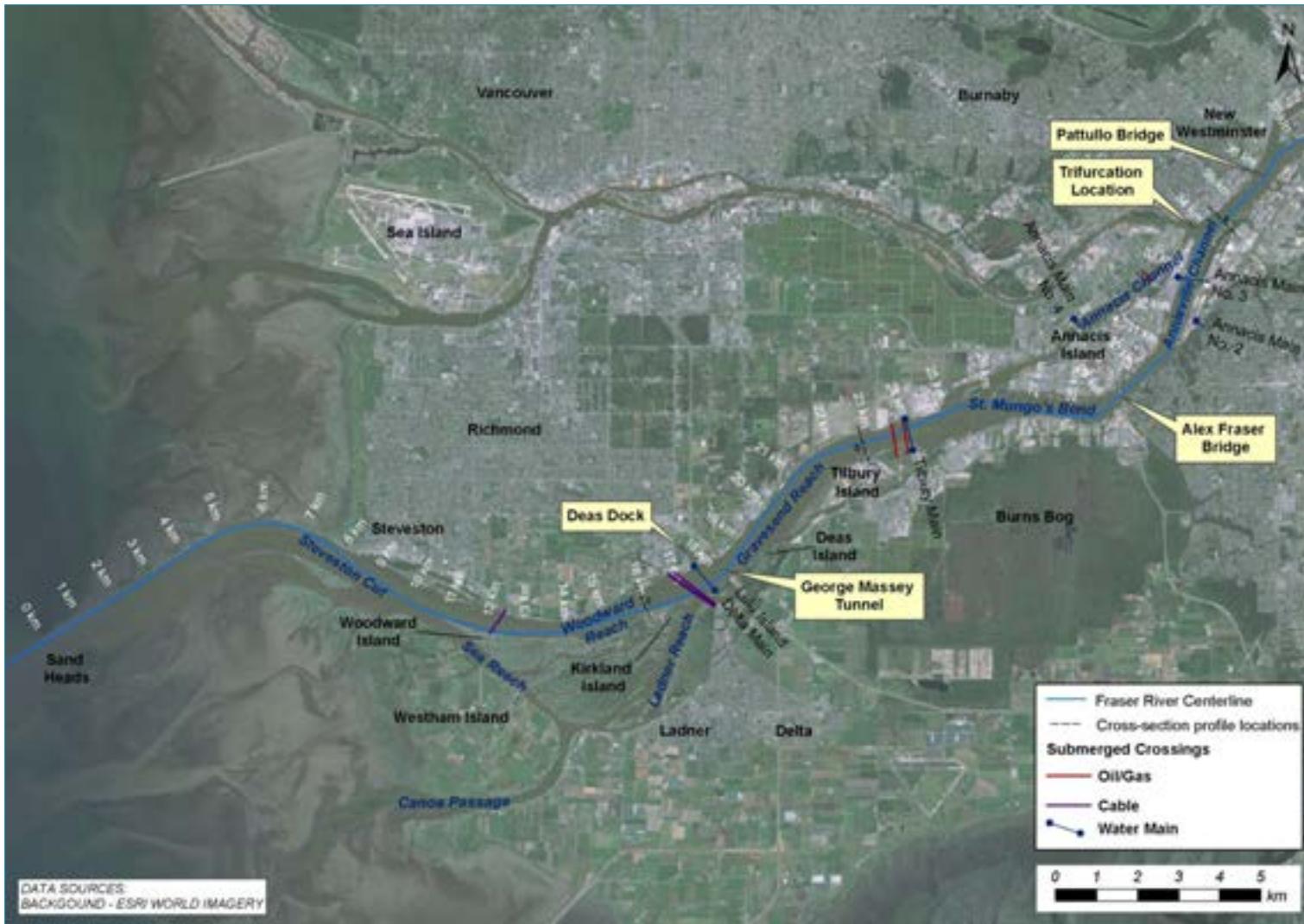


Figure 4.1-2 Overview Map Showing Locations of Interest near the Local Assessment Area

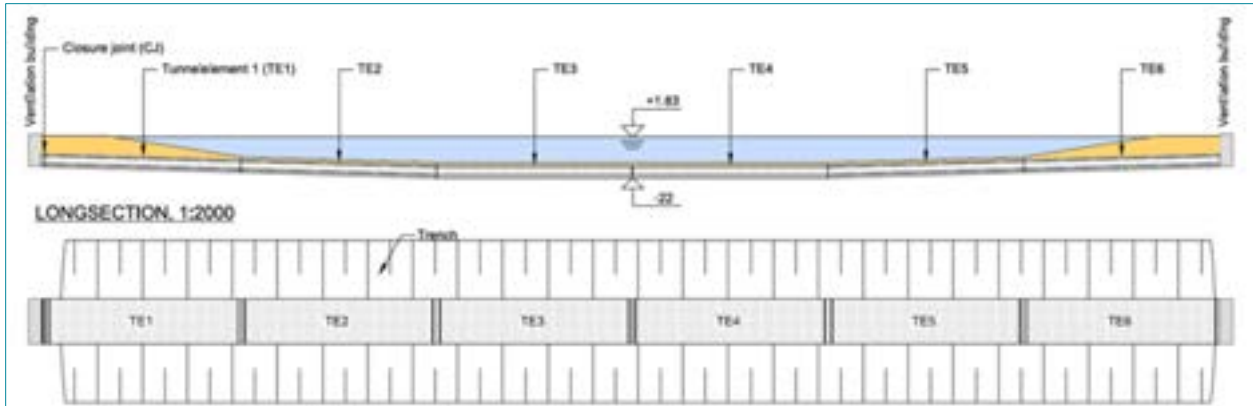


Figure 4.1-3 Longitudinal Section of the Tunnel (not to Scale)

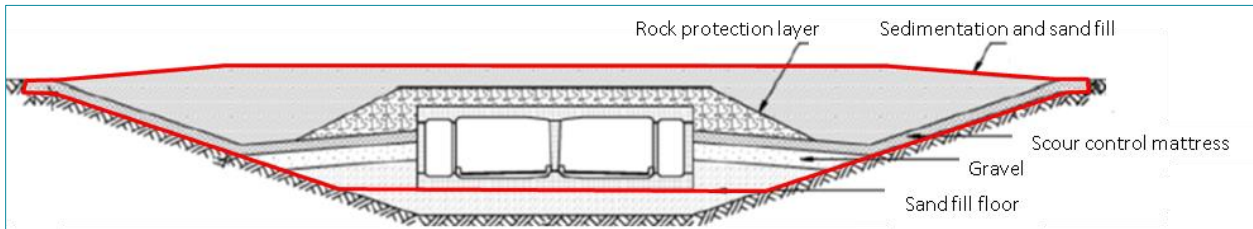


Figure 4.1-4 Cross-section of the Tunnel (not to Scale). Red Polygon Indicates Assumed Extent of Excavation.

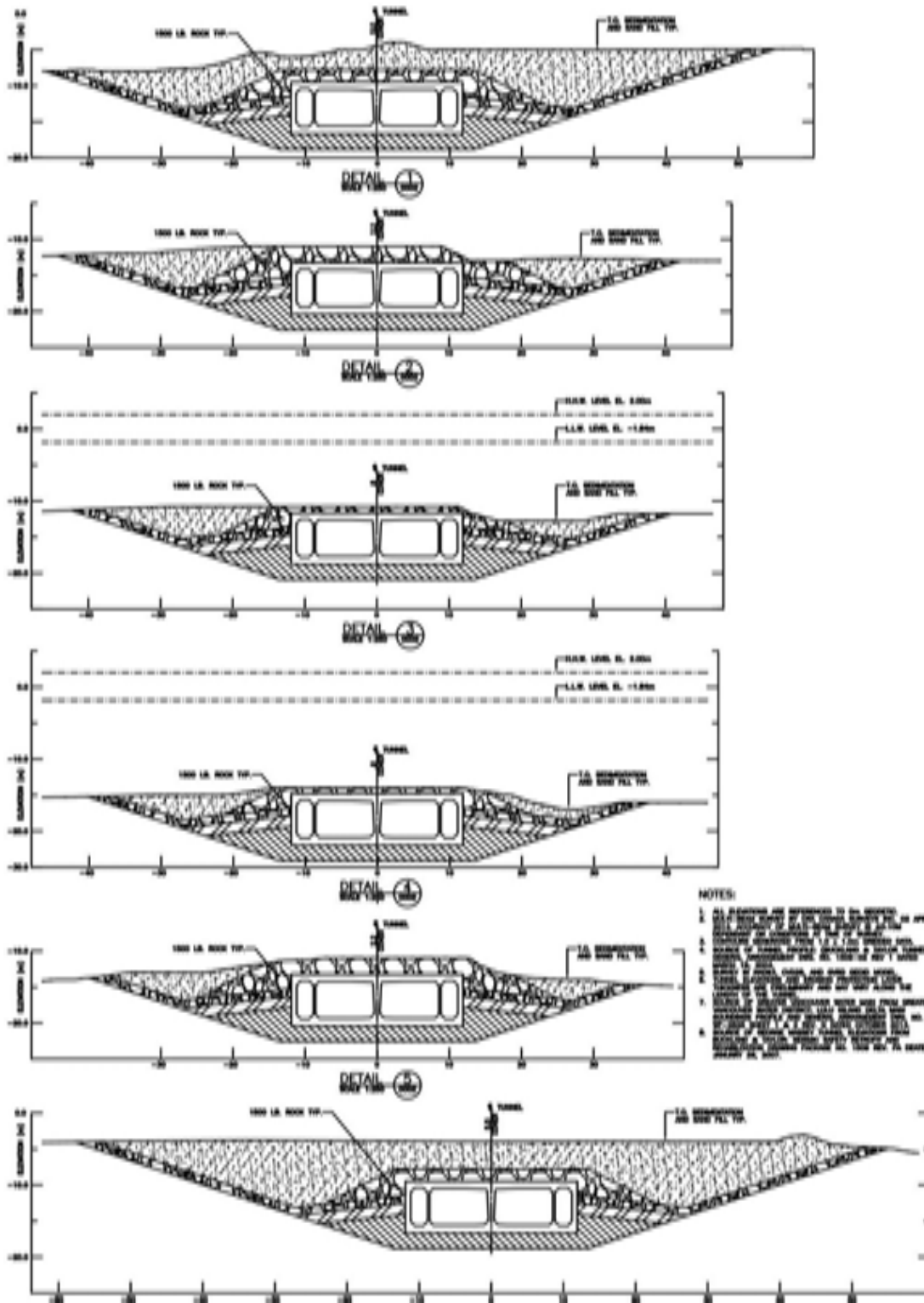


Figure 4.1-5 Surveyed Cross Sections of Tunnel

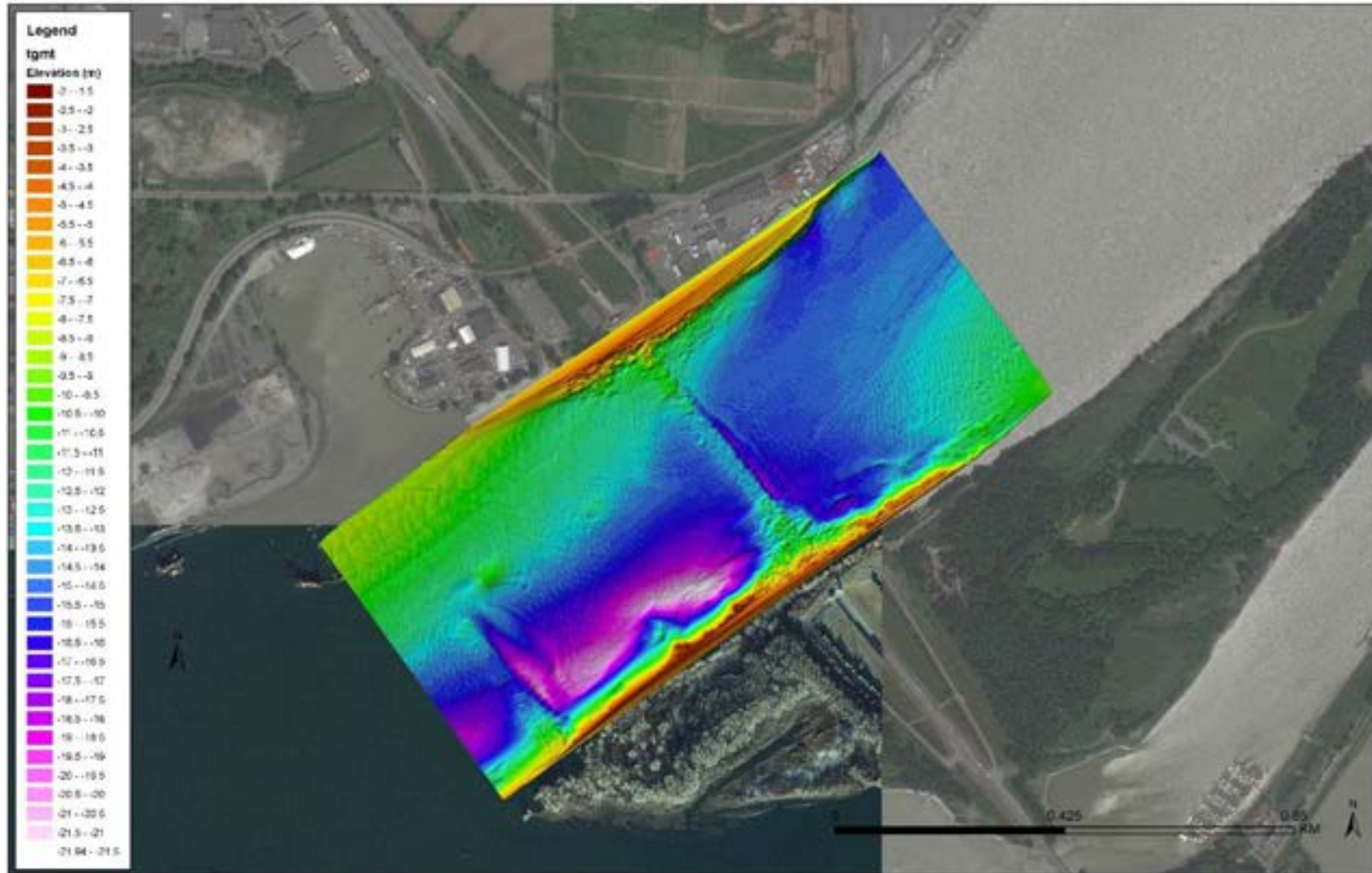


Figure 4.1-6 Riverbed Elevations from Bathymetric Survey Data Collected on April 2, 2014.

Fraser River Flows and Sediment Loads

The Fraser River South Arm is a single, meandering, sand-bed channel. Fraser River flows are dominated by snowmelt, with discharge typically rising in April, peaking between May and July during freshet, and receding during autumn and winter. Average peak flow of the Fraser River at Hope is about 7,000 m³/s in June and average low flow is approximately 850 m³/s in March (NHC 2002).

Sediment loads on the lower Fraser River range from 12.3 to 31.0 million tonnes/year (average 16.5 million tonnes/year) (1965-1986 data; McLean et al. 1999, NHC 2002). Fine sediments (i.e., washload) generally remain in suspension and have little effect on sedimentation patterns. In contrast, bed-material load (i.e., bedload or sediment load that gets deposited in the river) influences river morphology. In the lower Fraser River, bedload ranges from 1.2 million to 8.9 million tonnes/year (average 2.9 million tonnes/year; NHC 2002).

Dunes, characteristic features of a sand-bed channel, occur on the riverbed within a 1.2 km stretch centered over the Tunnel. Large dunes have also been observed from the Port Mann Bridge to the mouth of the river (NHC 2009). Dune height varies from 0.5 m to 2.0 m in approximately 12 m depth, although individual dunes can be considerably larger (Church and McLean 1994). As bedload sediments are transported downstream, dunes generate periodic scour and fill, and can increase total scour depths, damaging scour protection aprons and rock protection.

Flow in the lower Fraser River is influenced by a salt water wedge. The location of the salt wedge moves throughout the day in response to tide height variations, and seasonally in response to river discharge variations. The maximum upstream extent of salt water intrusion is about 30 km from the mouth during winter low flows and less than 15 km during freshet (Ward 1976). The salt wedge influences patterns of sediment entrainment and deposition, with rapid deposition occurring as the salt wedge migrates upstream, and re-entrainment as the salt wedge recedes (Kostaschuk and Luternauer 1989).

Water Levels

The river is tidally influenced. Tides in the Strait of Georgia are generally characterized by two highs and two lows of unequal height every lunar day (i.e., every 24 hours and 50 minutes). Greatest tidal amplitudes exceed 3.5 m from April to July and from October to January. At Deas Island, tides are moderated by Fraser River flows, and normal water levels range between minus 1.8 m (Canadian Hydrographic Service chart datum) and 2 m (Canadian Hydrographic Service high water datum). Extreme water levels in the Fraser River estuary are governed by

high tides and storm surge in the winter, rather than high discharges during freshet. Annual minimum water levels in the lower Fraser River have exhibited a downward trend between 1969 and the late 1980s, likely due to lowering of the riverbed.

In-River Utilities and Infrastructure

Utilities, including pipelines, that currently cross the Fraser River downstream of New Westminster include: six watermains, four natural gas pipelines, and one oil pipeline (**Figure 4.1-2**). Scour protection aprons at a number of these crossings create grade controls that affect riverbed elevations. The Lulu Island–Delta watermain, the pipeline nearest to the Tunnel, is located approximately 600 m downstream. It has a scour protection apron over its southern half, which imparts a variable cross-channel elevation. Bathymetric surveys show considerable scour and bed degradation up and downstream of the Lulu Island-Delta main crossing.

Bridge crossings in the reach include the Pattullo Bridge, opened in 1937; the Port Mann Bridge, originally opened in 1964 and replaced in 2012; and the Alex Fraser Bridge, opened in 1986 (**Figure 4.1-2**). The Skybridge just downstream of the Pattullo Bridge was constructed between 1987 and 1989.

Extensive river training and bank protection works, undertaken since 1910, along the Fraser River South Arm have led to narrowing and deepening (McLean et al. 2007), as well as lengthening of the river channel by approximately nine kilometres in a seaward direction.

Banks of the lower Fraser River have been hardened over the years by extensive riprap protection. The banks of Woodward Island were riprap-armoured on the main channel side between 1927 and 1941. By 1953, most of the right¹ bank of the Fraser River from Steveston to upstream of the Tunnel was protected with riprap (Pretious and Thorne 1953). The bank of Deas Island on the main channel side has also been protected with riprap, although the time of construction is not known.

¹ In hydrology, left bank and right bank are relative to an observer looking downstream.

Dredging

Annual dredging, conducted by Vancouver Fraser Port Authority, in the Fraser River South Arm has been extensive since 1960 and concentrated mostly downstream of New Westminster. Dredging volumes were greatest between 1976 and 1990, then declined through the following decade. During the height of dredging activity, about 15% of the total annual sediment removal on the Fraser River was from Gravesend Reach, upstream, and Woodward Reach, downstream, of the Tunnel (**Figure 4.1-2**). At Gravesend Reach, large-scale navigation and borrow dredging had a noticeable effect on bed levels. Bed lowering along Gravesend Reach occurred at a rate of about 25 cm/year, when dredging volume reached 700,000 m³/year during the 1980s, and remained relatively constant when dredging volume was in the order of 200,000 m³/year (NHC 2002). Although total removals have rebounded since 2001, less than one per cent of total dredging has been extracted from Gravesend Reach annually.

Dredging for maintenance of the navigation channel occurs annually at the mouth of the Fraser River, especially in Steveston Cut (**Figure 4.1-2**). Infrequent dredging of secondary channels occurs in Ladner Reach and Sea Reach to improve navigation for small vessels (FREMP 2006). Since 2004, the maximum vessel draft in the reaches downstream of Deas Island (Woodward Reach, Ladner Reach, Sea Reach, Canoe Passage, Steveston Cut, and Sand Heads Reach) has been increased from 10.7 m (in place since 1976) to 11.5 m (FREMP 2006).

Long-Term Changes in River Channel Configuration

Historically, the Fraser River estuary has been very active morphologically. The river transports large volumes of sand to the reach, where patterns of deposition, mobilization, and transport are heavily influenced by the tides. As a result, the configuration of channels at the river mouth is complex and in the absence of human intervention would be in constant flux. As late as 1898, Ladner Reach was considerably larger than its current size. Around 1827, the main channel occupied Ladner Reach and continued along Sea Reach to the mouth. Prior to this, the main flow path may have been along Canoe Passage via Ladner Reach. The Ladner Reach entrance was observed to have widened, and the deepest portion of the channel migrated from right to left bank at Deas Island in the years prior to Tunnel construction (Pretious and Thorne 1953).

Historic aerial photographs of the lower Fraser River, from 1938 to 2009, reflect increasing anthropogenic development over time along the river and on its floodplain. There has been no major shifting in the banklines over the 60-year period, due in large part to bank hardening (i.e., riprap) and river training works. Minor distinguishable changes are attributed to dredging of Deas Dock and some expansion of industrial water lots in the Steveston area.

Banklines of mid-channel islands, particularly of the Woodward Island complex, are largely unprotected, and therefore more likely to change over time. Mid-channel islands have expanded since 1949. In particular, expansion of Little Hart Island between 1949 and 1974 occurred due to dredge spoil dumping and transport by currents (Hay & Company Consultants Inc. 2010). This expansion appears to have forced the flow at the elbow of Ladner Reach north into Barber Island. The main channel of the reach has since shifted north of Little Hart and Big Hart islands, while the south channel has become constricted. Downstream in Sea Reach, the width of the southern portion of the channel has not changed appreciably, but the reach downstream of the confluence with Woodward Slough appears to have widened between 1949 and 2009.

A sand bar located approximately 1.5 km upstream of the Tunnel, at the downstream end of Tilbury Island, was first observed in the 1954 aerial photograph. Favourable tides allowed observation of it again in the 1984 photoset, by which time the bar/island had started to become colonized by vegetation, presumably due to vertical sediment accumulation. The bar/island is still present today, with roughly three-quarters colonized by marsh vegetation.

Between 1898 and 1953, the upstream end of Kirkland Island was subject to considerable erosion (Pretious and Thorne 1953). The bankline at the downstream end of Deas Island also receded mostly between 1948 and 1953. Since 1953, banklines upstream of Kirkland Island and Deas Marsh have largely stabilized.

Aboriginal Groups have noted that the Fraser River channel is shifting and causeway changes could have substantial effects, especially on saltwater marshes.

Long-Term Changes in River Profile

Changes in the profile of the riverbed within the LAA over time were assessed using historical PWGSC bathymetry survey data collected for the years 1988/89², 2000/01, 2008/09, and 2014³. In general, there has been a trend towards bed lowering. Riverbed profiles between the river mouth and Port Mann Bridge, and within one kilometre upstream and downstream of the Tunnel, show an average annual rate of lowering of around 10 cm/year (overall bed lowering by 1.5 m to 3.5 m) between 1988/89 and 2014. At the Lulu Island–Delta watermain crossing downstream of the Tunnel, the bed lowered by as much as 2.5 m between 1981 and 1997.

² Data are missing for the upstream portion of Ladner Reach and a section between Annacis Island and Tilbury Island.

³ Survey data from Ladner Reach were not available at the time of analysis.

Scour protection was added to the Tunnel in 2000, resulting in the profile appearing to have risen between 1997 and 2011. Degradation of 0.5 m to 1.0 m occurred again between 2011 and 2013. At the Tilbury watermain crossing upstream of the Tunnel, the bed scoured by 2.5 m to 3.0 m between 1990 and 1997. As a result of scour protection added in 2001/2002, the profile was higher in 2008 than in 1997. From 2002 to 2008, only about 0.5 m of scour was observed at this crossing.

The trend toward bed lowering is consistent with previous findings of long-term riverbed degradation downstream of New Westminster. Between 1951 and 1988, average bed levels in the channel lowered by two to three metres (NHC 2002), with the greatest bed lowering occurring in the 1980s. This is consistent with the period when the rate of sediment removal routinely exceeded the incoming bed material load. Since the mid-1990s the rate of bed lowering has slowed considerably, or actually reversed in some years at a few locations due to the reduced dredging effort (McLean et al. 2006). Since 2004, sediment removal volumes have increased in the lower reaches resulting in a 0.8 m decrease in bed level

A detailed description of changes in riverbed elevations over time within the assessment area is provided in **Section 5.2** of the technical volume, *River Hydraulics and River Morphology Study*, included under **Section 16.2** of the Application. Historical river profiles and cross-sections used to identify trends in river profile, as discussed above, are shown on **Figures 5-2 to 5-5** of this technical volume.

4.1.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with river hydraulics and river morphology, and potential effects of such interactions. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.1.4**. Potential for residual effects (i.e., effects remaining following the implementation of mitigation measures) is described in **Section 4.1.5**. A discussion of the potential for cumulative effects on river hydraulics and river morphology is presented in **Section 4.1.6**.

4.1.3.1 Project Interactions

An overview of potential interactions between Project activities and river processes during the construction and operation of the Project is provided in **Appendix A**. A preliminary evaluation of the potential effects of Project interactions on river hydraulics and river morphology, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: The new bridge will be a clear-span and as such there will be no impact to river hydraulics and river morphology from the new bridge.

Upgrading of the existing shoreline riprap protection may be required at completion of bridge construction. These upgrades would be limited to placement of clean rock on the existing armoured slope (i.e. no instream excavation and no river training works) and would have little or no effect on river hydraulics or river morphology.

On the Richmond side of the river the existing provincial dike will be reconstructed and upgraded to current standards where it is impacted by the Project. This work will be carried out on shore and as such there will be no impact to river hydraulics and river morphology from this activity.

Green Slough will be realigned to a configuration closer to its pre-Highway 99 alignment. Currently, the slough turns sharply north at the highway embankment, before connecting with Deas Slough south of the crossing. The realigned slough will continue east beneath the bridge and connect with Deas Slough east of the highway, similar to pre-highway conditions. Realignment of Green Slough is not expected to have any effects on hydraulics or morphology in Deas Slough or the South Arm of the Fraser River. Proposed enhancements to estuarine and riparian habitat would provide a net benefit compared with existing conditions.

Tunnel removal and associated activities are expected to involve temporary riverbed disturbance and consequent re-suspension of sediments in the Fraser River South Arm as well as potential local scour. Removal of the Tunnel from the river bed and infilling of the trench left behind could also influence current velocities, water levels, movement of salt water, and flow splits in the Fraser River South Arm. This is discussed further in **Section 4.1.3.2**.

Operation: Given that the new bridge will have a clear span across the Fraser River South Arm, activities associated with Project operation, including routine maintenance, have no interaction with river hydraulics and river morphology.

Removal of Tunnel segments would have a temporary influence on river processes for approximately 210 days during the operational phase of the Project, while the trench left by the Tunnel gets filled in by sediments carried naturally in the river. This is discussed further below.

4.1.3.2 Potential Effects

Potential effects of the Project on river hydraulics and river morphology in the lower Fraser River were investigated using the TELEMAC-MASCARET (TELEMAC) modelling system.

The accuracy and results of the hydraulic modelling needs to be viewed in the context of the very dynamic morphology of the Fraser River, interpretive nature of geomorphic studies and the limitations of the numerical methods used to model river hydraulics and river morphology. The dynamic nature of the river morphology is illustrated by the fact that records at the Tunnel show that temporary scour during freshet can be in the order of several meters and migrating sand dunes with heights of up to 4 m are not uncommon.

With numerical modelling, there is uncertainty with respect to predictions of river currents and sediment transport. In this context, results presented on projected bed-level evolution should be interpreted as one of the reasonably possible outcomes.

The TELEMAC system, made up of a suite of finite element computer programs developed by the Laboratoire National d'Hydraulique et Environnement (LNHE), is an internationally-recognized modelling tool, with more than 4,000 registered users including BC Hydro, Hydro-Québec, and Canadian Coast Guard, as well as universities, engineering schools, and research centres.

The TELEMAC programs utilized for this study include the following:

- TELEMAC3D – A three-dimensional hydrodynamic model that solves the time-dependent Navier-Stokes equations with an evolving free surface, under the assumption of hydrostatic or non-hydrostatic pressure distribution using the finite element method.
- SISYPHE – A sediment transport and morphodynamic model that computes bed-load and suspended load separately, and the resulting bed changes using the Exner equation.

The hydrodynamic program TELEMAC-3D was used to compute hydraulic conditions in the lower Fraser River. Scour and deposition around the Tunnel were computed by coupling the sediment transport and morphodynamic model SISYPHE to TELEMAC-3D. The new bed elevation computed by SISYPHE was then fed back into TELEMAC-3D to re-compute the flow hydrodynamics, as illustrated in **Figure 4.1-7**. The resulting model serves as a tool for understanding potential changes to river hydraulics and river morphology due to Tunnel removal.

Future changes in physical inputs, such as sea level rise, changes to hydrograph timing and shape, sediment supply, and alterations to the river channel, will influence future hydraulics and morphology in ways that cannot be predicted by the model. Rather, the model captures the most important physical processes in the lower Fraser River and assists in predicting the consequences of a specific change to the system, and model results are interpreted in the context of known river behaviour, using professional judgement.



Figure 4.1-7 TELEMAC Model Coupling Flow Diagram

Model analyses were conducted to examine the following two scenarios:

1. Trench infilling – Short-term channel response to the removal of the Tunnel, particularly trench migration and infilling including review of potential effects on nearby infrastructure and habitat.
2. Post-trench infilling – Potential long term effects of Tunnel removal on river hydraulics and sedimentation patterns after the trench has infilled by deposition of river sediments.

The results of these analyses are presented below. Details on modelling methodology, including model geometries, boundary conditions, and calibration and validation, as well as detailed results of model simulation are presented in the technical volume, *River Hydraulics and River Morphology Study*, included under **Section 16.2**.

Sediment Generation and Deposition

Tunnel removal will require removing the rock apron and concrete mattress, excavating the fill that was placed adjacent to the Tunnel segments when it was built, floating the pre-cast concrete Tunnel segments to the surface and towing the segments off site for recycling. It is expected that several months will be required to remove the four middle sections of the Tunnel.

The minor changes in current velocities during Tunnel removal are not expected to result in bank erosion, barriers to fish migration or impediments to marine traffic. Depositional changes resulting from re-suspension of sediments during Tunnel removal are expected to be minimal.

These activities will generate suspended sediment. The effect of sediment generation will depend on the ambient suspended sediment concentrations at the time of removal. It is assumed Tunnel removal will commence in mid-summer, after it is anticipated that freshet flows have receded, and will continue into the winter low-flow period.

Based on the volume and expected nature of the sediment and sand fill overlying the Tunnel, the temporary increase in suspended sediment volume due to the Tunnel removal activities is estimated to range from one per cent to nine per cent over ambient volumes between August and December. In the context of the natural seasonal and annual variability of suspended sediment, this expected increase in suspended sediment volume is considered low. Further detail on predicted increase in suspended sediment as a result of Tunnel removal is provided in Section 8.1.2.2 of the technical volume, *River Hydraulics and River Morphology Study*, included as **Section 16.2** of this Application.

Suspended fine sediments generated during Tunnel removal would be transported to the Strait of Georgia before deposition could occur. Since the incremental volume of suspended sediment generated during Tunnel removal is expected to be small in comparison with the ambient load, and washload is mostly transported beyond the tidal flats at the river mouth, no noticeable effects on deposition in the Strait of Georgia are expected.

Local scour and deposition are expected during Tunnel removal due to flow acceleration around exposed edges of Tunnel segments. The segments are expected to be removed in sequence. Flow will accelerate around the exposed ends and entrain sediment, which would then be deposited downstream. The degree of sediment transport associated with local flow accelerations during construction will depend on time of year and associated current velocities. These effects are expected to be temporary and small in scale compared with overall bed material transport.

With the implementation of standard best management practices, such as the use of washed rock with no fines or debris, upgrades to the existing riprap bank protection along the shorelines are not expected to generate noticeable amounts of suspended sediment.

Current Velocities

Tunnel removal is predicted to result in a minor reduction of surface water velocity of between 0.3 m/s and 0.5 m/s. The corresponding reduction in near-bed velocities (Elevation -12 m GSC) is expected to be between 0.1 m/s and 0.4 m/s. The region that will experience this reduction extends from the Tunnel to about 50 m downstream.

Further detail on modelled current velocity distributions following Tunnel removal is provided in **Section 7.4.1.1** of the technical volume, *River Hydraulics and River Morphology Study* included in **Section 16.2**.

Water Levels

Based on hourly water levels modelled at several stations upstream and downstream of the Tunnel, post-infilling water levels are indistinguishable from the natural variability of the river system.

Details on the modelling results for water levels are provided in **Section 7.4.1.2** of the technical volume, *River Hydraulics and River Morphology Study* included in **Section 16.2**.

Flow Splits

The Fraser River South Arm divides just below Deas Island (18 km upstream from the Strait of Georgia) into Ladner Reach, and then again into Canoe Passage. The flow split between Woodward Reach and Ladner Reach was calculated from the results of flow modelling. Results of these calculations indicate that the predicted change in the flow splits were within the range of natural variability and as such removal of the Tunnel is not expected to have an effect on the flow split between Woodward Reach and Ladner Reach. This suggests that Tunnel removal is not likely to result in the expansion of Ladner Reach through erosion of Deas Island or the nose of Kirkland Island.

Details on flow split calculations are provided in **Section 7.4.1.3** of the technical volume, *River Hydraulics and River Morphology Study* included in **Section 16.2**.

Trench Infilling and Migration

Hydraulic modelling indicates that there will be a decrease in river flow velocity and consequent sediment deposition over the deeper trench region when the Tunnel segments are removed. Modelling shows that the trench would be almost completely infilled in approximately 210 days.

Model results indicate that the trench will migrate downstream as it infills. **Figure 4.1-8** shows a time-series of the bed profile along the centreline of the navigation channel over a trench-infilling simulation period of 210 days. **Figure 4.1-9** shows the change in riverbed elevation 210 days after Tunnel removal as compared with existing conditions. At the end of 210 days the trench is mostly filled in, but the riverbed between the Tunnel and the Lulu Island–Delta watermain has lowered by one to two metres. This lowering is expected to be temporary. It is most likely caused by sediment being “trapped” by the trench, resulting in less sediment available to replenish the downstream bed.

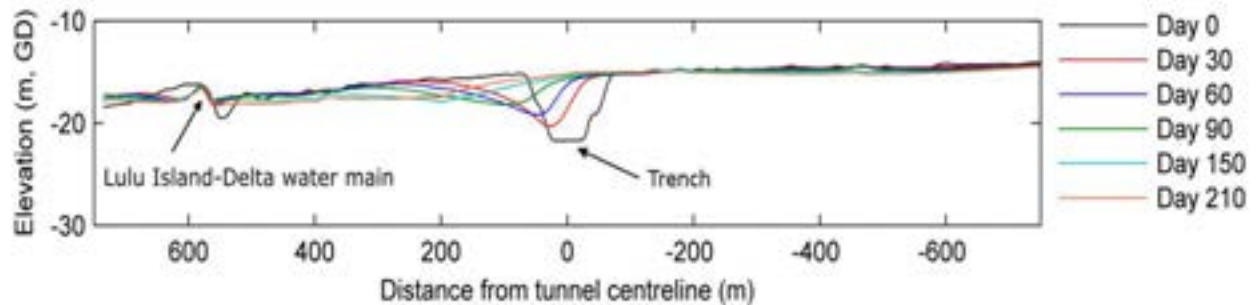


Figure 4.1-8 Riverbed profile along the centreline of the navigation channel after tunnel removal.

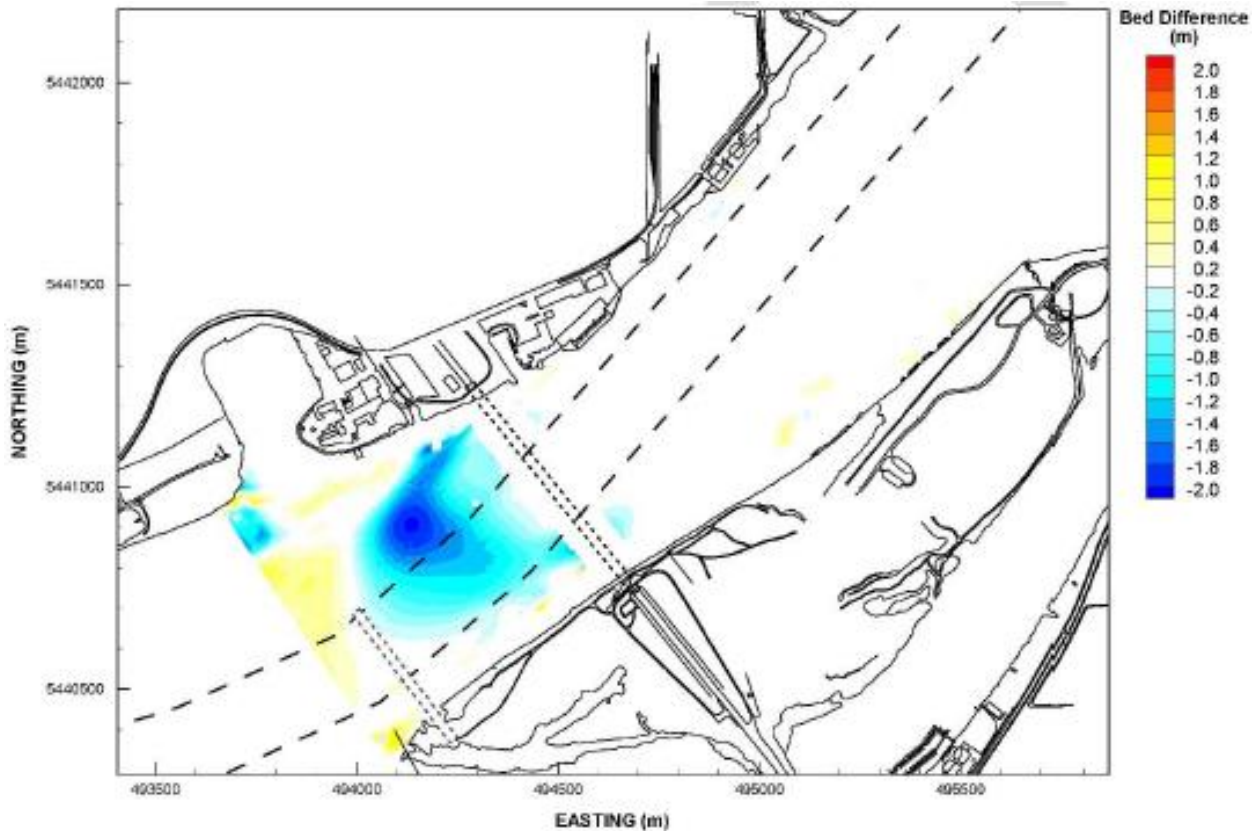


Figure 4.1-9 Change in riverbed elevation 210 days after Tunnel removal as compared with existing conditions

Expected changes in riverbed profile beyond the trench footprint are in the same order as normal variation in bed levels in the lower Fraser River.

Details on model simulations of riverbed elevations during trench infilling are provided in **Section 7.3.2** of the technical volume, *River Hydraulics and River Morphology Study* included in **Section 16.2**.

Post-Trench Infilling Morphological Changes

As noted under “Technical Boundaries” in **Section 4.1.1.3** there is uncertainty with respect to predictions of river currents and sediment transport given the limitations of numerical modelling, and the highly complex and dynamic nature of the Fraser River morphology at the Project site. In this context, results presented on projected bed-level evolution should be interpreted as one of several possible outcomes.

Near-field (fine resolution) modelling results indicated bed lowering 150 m upstream and downstream of the Tunnel for existing and post-trench infilling scenarios. However the magnitude of lowering was about 0.5 m to 1.0 m less for the post-trench infilling case. In other words, bed levels are expected to increase on average by 0.5 m to 1.0 m in this region (**Figure 4.1-10**). This change will likely result in less sediment available to be deposited in the channel downstream between the Tunnel and Lulu Island–Delta watermain, contributing to bed lowering in that segment.

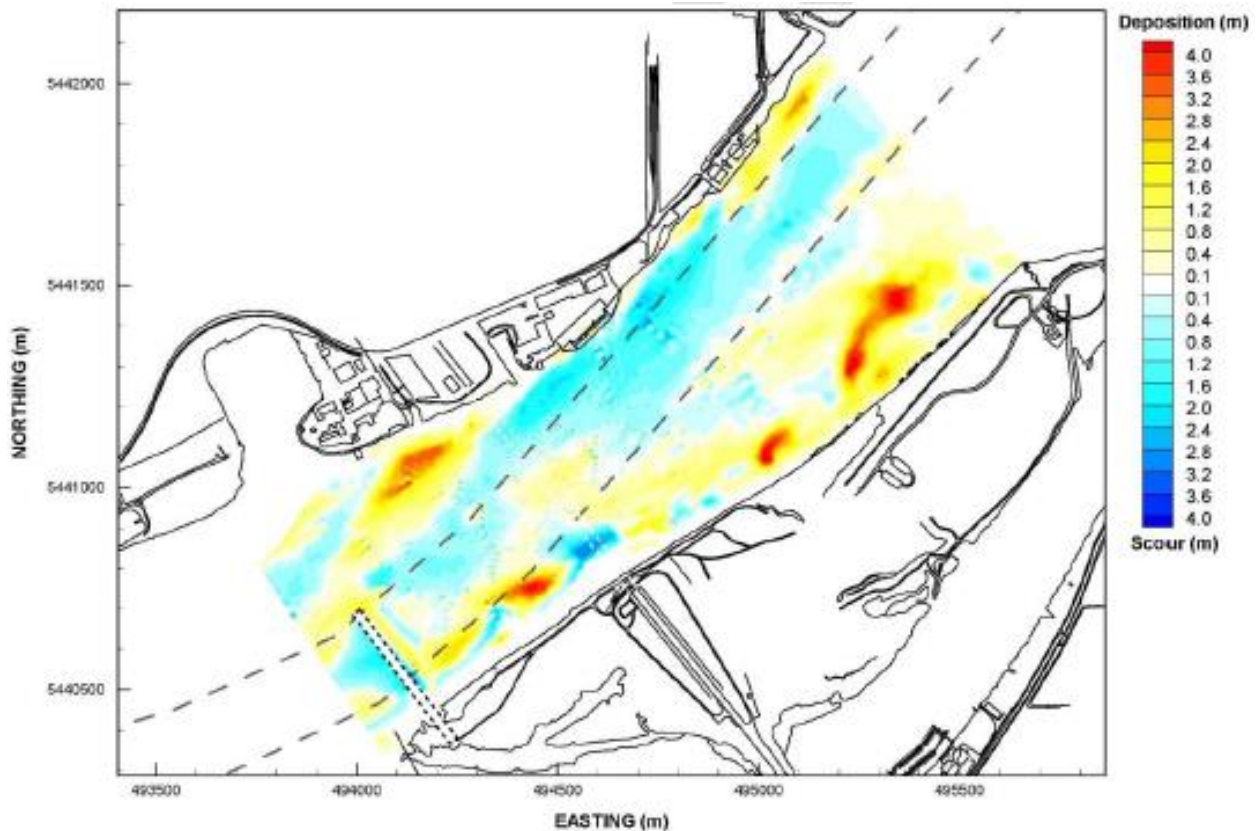


Figure 4.1-10 Change in river bed elevation during freshet after Tunnel removal as compared with existing conditions

Far-field modelling suggests river bed elevation changes as a result of Tunnel removal are limited to 500 m upstream and 1,500 m downstream of the Tunnel. In this region, deposition of about 0.5 m in the middle of the channel and scour of 0.5 m to 1 m at the margins could be expected. Negligible changes (less than ± 0.05 m) are predicted to occur to the bed levels adjacent to Tilbury Island.

The majority of suspended fine sediments generated during Tunnel removal would be transported to the Strait of Georgia before deposition could occur. Minor deposition could occur in slower moving areas such as channel margins and sloughs. Since the incremental volume of suspended sediment generated during Tunnel removal is small in comparison with the ambient load, and washload is mostly transported beyond the tidal flats at the river mouth, no noticeable effects on deposition in the Strait of Georgia are expected.

4.1.4 Mitigation Measures

Potential Project-related changes that require mitigation consideration are: anticipated minor increase in volume of suspended sediment during Tunnel decommissioning activities, and riverbed lowering between the Tunnel alignment and the Lulu Island-Delta watermain for one to two years after Tunnel removal. As discussed in **Section 4.1.3.1**, other potential Project-related changes in river flow and sedimentation patterns are negligible or minor.

Mitigation measures to address potential effects associated with increases in volume of suspended sediments are discussed in **Section 4.4 Fish and Fish Habitat**. Mitigation measures to address potential effects associated with temporary Project-related changes in river bed elevations are presented below.

Temporary changes to downstream river bed elevations after Tunnel removal have the potential to affect the Lulu Island-Delta watermain. The following measures are proposed to mitigate these effects:

- Early engagement and coordination, during planning of the proposed decommissioning works, with Metro Vancouver (owner of the watermain). Engagement would continue through the construction and post-construction periods until confirmation that potential effects on the existing watermain have not occurred or have been appropriately mitigated.
- Development of a mitigation plan in conjunction with Metro Vancouver, which is anticipated to include the following:
 - Monitoring of riverbed within 100 m upstream and downstream of the watermain. Regular monitoring at appropriate intervals will begin during Tunnel removal. Monitoring frequency may be revised following Tunnel removal, based on a review and evaluation of monitoring results by a qualified registered professional (QRP). If a lowering of the edges of the scour protection apron is noticed, the scour protection aprons will be upgraded under the direction of a QRP.
 - Stockpiling of appropriately-sized rock near the Project site, for priority scour protection repairs at the watermain crossing.

- Establishment of on-call contracts with a QRP and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice if required. The on-call QRP and contractor will have relevant experience in scour protection for water crossings.

The mitigation measures described above involve commonly applied methods that have proven to be effective in protecting the existing infrastructure against scour, and are expected to have a high degree of success in ensuring potential effects on the Lulu Island/Delta watermain are avoided.

4.1.5 Residual Effects

Residual effects are those that remain following implementation of mitigation measures. Potential residual effects on river hydraulics and river morphology considered further in this assessment are:

- Suspended sediment generation during Tunnel removal: Tunnel removal activities are expected to result in a temporary increase in the volume of suspended sediment in the Fraser River South Arm.
- Temporary bed lowering between the Tunnel alignment and the Lulu Island-Delta watermain: Based on results of modelling, temporary changes to the river bed elevation, which could persist for one or two freshets, are expected between the Tunnel and the Lulu Island–Delta watermain after Tunnel removal.

The above effects are characterized in terms of the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of each anticipated residual effect. Definitions for ratings applied to residual effects criteria, developed with specific reference to river hydraulics and river morphology are presented in **Table 4.1-2**. A summary of criteria ratings for the potential residual effects is provided in **Table 4.1-3** and **Table 4.1-4**.

Context: Context for the characterization of residual effects, i.e. sensitivity/resilience of hydraulics and morphology of the river to potential Project-related effects, based on existing conditions, has been taken into account in characterizing the residual effects. This includes the typically high volumes of sediment load transported by the Fraser River South Arm, wide variation in suspended sediment concentrations on a seasonal and annual timescale, and seasonal changes and the passage of dunes on the riverbed, which regularly induce changes in elevation greater than 2 m.

Table 4.1-2 Criteria Used to Characterize Residual Effects on River Hydraulics and River Morphology.

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|---|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project. |
| | | Positive | Beneficial effect as a result of the Project. |
| | | Neutral | Neutral effect as a result of the Project. |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible | No measurable change to river hydraulics or morphology |
| | | Low | A measurable change within the range of natural variability, but not affecting aquatic habitat, navigability, or infrastructure. |
| | | Moderate | A measurable change within or outside the range of natural variability, and may pose a moderate risk to aquatic habitat, navigability, or infrastructure. |
| | | High | A measurable change outside the range of natural variability and may affect long-term viability of aquatic habitat, navigability, or infrastructure. |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project alignment. |
| | | Local | Effect is restricted to the LAA. |
| | | Regional | Effect is restricted to the RAA. |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Duration | Length of time over which the residual effect is expected to persist | Transient term | Effect occurs once during Project construction or operation. |
| | | Short term | Effect occurs during a limited period of days to weeks during Project construction. |
| | | Moderate term | Effect persists over a period of weeks to months. |
| | | Long term | Effect persists over several years. OR Change is permanent. |
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor affects the IC) | Rare | Effect occurs once during Project construction or operation. |
| | | Uncommon | Effect occurs intermittently during Project construction or operation. |
| | | Frequent | Effect occurs frequently during Project construction or operation. |
| | | Continuous | Effect occurs continuously during Project construction or operation. |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Baseline conditions will be naturally restored after disturbance has ceased. |
| | | Irreversible | Baseline conditions will not be naturally restored after disturbance has ceased. |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance. |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 25%. |
| | | Moderate | Likelihood of residual effect is between 25% and 75%. |
| | | High | Likelihood of residual effect is greater than 75%. |

Residual Effect #1: Suspended sediment generation during Tunnel removal

Activities associated with Tunnel decommissioning, including removal of Tunnel segments and overlying sediment, will be undertaken under active flow conditions, which could limit the effective use of isolation or sediment control structures such as silt curtains in the area immediately down river from the works. Bed sediments that are re-suspended during Tunnel removal, therefore, could add incrementally to suspended sediment loads in the river. An overview of the criteria ratings for this residual effect is provided in **Table 4.1-3**.

Table 4.1-3 Criteria Ratings: Suspended Sediment Generation during Tunnel Removal.

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Suspended sediment concentrations in the river will be higher than background levels. |
| Magnitude | Low | Change will be within the range of natural variability and is not expected to adversely affect viability of receptor VCs. |
| Extent | Local | Spatial extent is expected to be restricted to the LAA. |
| Duration | Transient term | Effect will occur only during Tunnel removal. |
| Frequency | Rare | Effect will occur only in association with Tunnel removal. |
| Reversibility | Reversible | Suspended sediment concentrations are expected to return to baseline conditions following removal of each Tunnel segment. |
| Likelihood | High | The likelihood of increased suspended sediment during Tunnel removal is greater than 75%. |

Removal of the Tunnel and overlying material from the river bed will generate suspended sediment. Increased suspended sediment concentrations are considered an adverse effect since it has the potential to cause fish to avoid the area, or in severe cases, result in injury to fish. The magnitude of the effect will depend on the ambient suspended sediment concentrations at the time of removal, river discharge, tidal amplitude, and details of Tunnel removal methods. The study has assumed Tunnel removal will commence in mid-August, after freshet flows have receded, and continue into the winter low flow period (December). Suspended sediment concentrations in the low-flow period are typically low, so increases beyond background concentrations are considered likely.

The magnitude of the suspended sediment effect is considered low. The estimated volume of suspended sediment that could be generated by the Tunnel removal was compared to the typical ambient volumes of suspended sediment transported during the anticipated Tunnel removal period. Each Tunnel segment is overlain by approximately 28,000 m³ of sediment or sand fill material (**Figure 3-2**). Assuming this material has the same size gradation as the bed material in the lower Fraser River, approximately 10% (2,800 m³) of the overlying material would be smaller than 0.177 mm in diameter, and could therefore remain suspended in the water column (NHC 2002b). Assuming that removal of one Tunnel segment takes two weeks, the natural or ambient volume of suspended sediment transported through the study area during removal of one segment ranges from a maximum of 3x10⁵ m³ in August to a minimum of 3x10⁴ m³ in December. These estimates are based on analyses of seasonal flows and measured suspended sediment concentrations in the lower Fraser River (Milliman 1980, Kostaschuk, Luternauer, et al. 1989, Attard and Venditti 2014). Based on the above estimates, the increase in suspended sediment volume due to the Tunnel removal ranges from one per cent to nine per cent over ambient volumes. Considering the wide variation in suspended sediment concentrations in the Fraser River South Arm on a seasonal and annual timescale, the magnitude of the effect can be characterized as low.

Spatial extend of the suspended sediment increases is expected to be limited to within the LAA. After removal of each Tunnel segment, suspended sediment concentrations are expected to return to normal, so the effect is reversible. The generation of suspended sediment will occur only during Tunnel removal, and will return to normal after removal, so the frequency of the effect is rare and the duration is transient.

Depositional changes resulting from suspended sediment generation are expected to be minimal. Suspended fine sediments generated during Tunnel removal would be transported to the Strait of Georgia before deposition could occur in the main channel. Since the incremental volume of suspended sediment generated during Tunnel removal is expected to be small in comparison with the ambient load, and the depositional area at Sand Heads is large, no noticeable changes to deposition in the Strait of Georgia are expected. It is possible that some of the suspended sediment generated from removal of the southern Tunnel segments could deposit in low velocity environments such as Ladner slough or the margins of Ladner Reach, Canoe Passage or other side channels. If such deposition occurs, it is expected to be minor.

Residual Effect #2: Temporary bed lowering between the Tunnel alignment and the Lulu Island-Delta watermain

Removal of the Tunnel segments will leave a trench in the river bottom, and sediments transported from upstream will tend to be trapped in the trench as it fills and migrates downstream. During this time there will be less sediment available to replenish the river bed downstream of the Tunnel alignment. Model results suggest the river bed between the Tunnel and Lulu-Delta watermain will be temporarily lowered by 1 to 2 m compared with baseline conditions. Bed lowering is not expected to propagate upstream of the Tunnel or downstream of the watermain, and levels between the Tunnel and watermain are expected to return to normal after the trench has filled in (within one to two freshets). An overview of the criteria ratings for this residual effect is presented in **Table 4.1-4**.

Table 4.1-4 Criteria Ratings: Temporary Bed Lowering between the Tunnel Alignment and the Lulu Island-Delta Watermain

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Bed lowering could affect Metro Vancouver’s Lulu-Delta watermain. |
| Magnitude | Moderate | Change will be within the range of natural variability but may have a moderate effect on in-river infrastructure. |
| Extent | Local | Spatial extent is expected to be restricted to within 600 m downstream of the Tunnel alignment. |
| Duration | Short term | Effect expected to persist only until one or two freshets following Tunnel removal. |
| Frequency | Continuous | Effect will occur continuously during Tunnel removal and for the following 1-2 years. |
| Reversibility | Reversible | River bed levels between the Tunnel and Lulu-Delta watermain are expected to return to normal after the trench has filled in. |
| Likelihood | High | The likelihood of lower river bed levels between the Tunnel and Lulu-Delta watermain is greater than 75%. |

The lower bed levels are not expected to negatively impact fish habitat or navigability, but has the potential to dislodge rock at the edges of the existing scour protection apron at Lulu Island-Delta watermain, about 600 m downstream of the Tunnel. These types of rock aprons are designed to fall, or launch, into developing scour holes to prevent or delay further scour. However once this has occurred their ability to protect against further scour is compromised. The 1-2 m of bed lowering would not expose the watermain directly, but could diminish the future effectiveness of the scour protection.

The predicted 1-2 m of bed lowering is within the range of natural variability on the Fraser River. Seasonal changes and the passage of dunes on the riverbed regularly induce changes in elevation greater than 2 m; however given the potential for this bed lowering to affect the watermain, the magnitude of the effect is considered moderate.

4.1.6 Cumulative Effects

The combination of Project-related changes and changes from other certain and reasonably foreseeable projects and activities, as listed in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**, comprise the total cumulative changes in river hydraulics and river morphology. The only other project or activity that has the potential to have effects that could interact with those of the Project is the routine maintenance dredging of the Fraser River South Arm by the Vancouver Fraser Port Authority (VFPA), which overlaps spatially with the Project. It is anticipated that Tunnel decommissioning will be scheduled in consultation with VFPA such that there is no temporal overlap of potential effects of the two activities on river hydraulics and river morphology, and no construction-related cumulative effects are expected.

4.1.7 Follow-up Strategy

Frequent monitoring of riverbed within 100 m upstream and downstream of the Lulu Island-Delta watermain is proposed during and after Tunnel removal to ensure resultant temporary change in river bed profile does not impact the watermain. Regular monitoring at appropriate intervals will begin during Tunnel removal. Monitoring frequency may be revised following Tunnel removal, based on a review and evaluation of monitoring results by a qualified registered professional (QRP). If a lowering of the edges of the water main's scour protection apron is noticed, the apron will be upgraded under the direction of the QRP.

4.1.8 References

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APPENDIX A

Overview of Potential Project Interactions with River Hydraulics and River Morphology

Table 1 Overview of Potential Project Interactions with River Hydraulics and River Morphology

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|---|---|
| Pre-Construction / Site Preparation | | | |
| Pre-Construction / Site Preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Installing temporary roads, laydown areas, and site offices. • Relocating utilities • Preloading for embankment and highway construction • Acquiring property for the Project | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • Conducting additional site investigations (i.e., a geotechnical drilling program) • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities | <p>Nature of interaction: Works and activities within or along the shores of the Fraser River South Arm, Deas Slough, and Green Slough.</p> <p>Rationale: Activities not expected to have an effect on river hydraulics and river morphology.</p> |
| | Potential Effect | • N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • Ground improvements associated with new bridge piers. • Installing piers adjacent to Deas Slough and Green Slough, including pile installation. • Hoisting pre-assembled deck segments from barges in the river or land-based transport system. | <p>Nature of interaction: Activities with the potential to interact with river hydraulics and river morphology.</p> <p>Rationale: Activities not expected to have an effect on river hydraulics and river morphology.</p> |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|--|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|--|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> N/A | N/A |
| | No effect | <ul style="list-style-type: none"> Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | N/A |
| | Potential Effect | <ul style="list-style-type: none"> Removing electrical/mechanical/utilities equipment from the Tunnel Removing of Tunnel segments and associated scour protection Backfilling of onshore portions of Tunnel approaches | <p>Nature of interaction: Potential for the removal of the Tunnel to result in temporary change in river hydraulics and river morphology.</p> <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> Temporary minor increase in suspended sediments. Temporary change in riverbed elevations. |
| Decommissioning of Deas Slough Bridge | No interaction | <ul style="list-style-type: none"> Removal of Deas Slough Bridge including substructures. | Nature of interaction: No interaction anticipated |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|---|--|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges. Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.). | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Proposed activities will be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> N/A | N/A |
| New bridge | No interaction | <ul style="list-style-type: none"> N/A | N/A |
| | No effect | <ul style="list-style-type: none"> Operating the new bridge Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: Activities with the potential to interact with river hydraulics and river morphology.</p> <p>Rationale: As the new bridge will have a clear span across the Fraser River South Arm, it is not expected to have any effect on river hydraulics and river morphology. Normally, protection of banks with riprap could have a cumulative effect on both hydraulics and morphology, however, the banks within the Project Area are already protected, and any minor upgrading of the existing riprap required for the Project is not anticipated to alter existing conditions.</p> |
| | Potential Effect | <ul style="list-style-type: none"> N/A | N/A |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.2 Sediment and Water Quality Assessment Highlights:

- The new bridge will have a clear-span, which reduces potential Project-related effects on sediment and water quality in the Fraser River South Arm.
- Minor, temporary increases in turbidity in the Fraser River South Arm, as compared with baseline conditions, are expected during Tunnel decommissioning.
- No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.
- Applying mitigation, including timing windows for undertaking in-stream works, will avoid or minimize potential effects of Project-related changes in water quality on receptor components, including fish and fish habitat.
- Elements of the Project design, including the use of biofiltration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99.
- No Project-related post-construction residual effects or cumulative effects on sediment and water quality are expected.

4.2 Sediment and Water Quality

This section describes the existing conditions of sediment and water quality in waterbodies that could potentially be affected by the Project, and anticipated changes that may result from Project components and activities. Sediment and water quality comprises one of the ‘steps’ along the pathway of effects of the Project, with fish and fish habitat, marine mammals, vegetation, and at-risk amphibians being the ultimate receptors of Project-related effects. Sediment and water quality has therefore been studied as an intermediate component (IC), and information on predicted Project-related changes in sediment and water quality was used to support the assessment of Project-related effects on the following valued components (VCs): fish and fish habitat (**Section 4.4 Fish and Fish Habitat**), at-risk amphibians (**Section 4.5 At-risk Amphibians**), marine mammals (**Section 4.6 Marine Mammals**), and vegetation (**Section 4.7 Vegetation**).

This section focuses on the Fraser River South Arm, Deas Slough, and Green Slough, which are the major waterbodies that could be affected by the Project. Potential changes in sediment and water quality as a result of upland ditch construction and relocation to accommodate widening of Highway 99 are discussed in the assessment of Project-related effects on fish and fish habitat (**Section 4.4 Fish and Fish Habitat**).

The Project will include stormwater collection and treatment components (e.g. biofiltration ponds) to capture, detain, and treat stormwater runoff prior to discharging into water courses. These stormwater management components, and implementation of appropriate construction environmental management plans as described in **Section 12.0 Management Plans**, are

expected to avoid any potential effect due to stormwater runoff from the upgraded highway, including the new bridge. Proposed Project-related improvement in stormwater collection and management along the Highway 99 corridor is anticipated to result in an improvement in the quality of stormwater entering adjacent watercourses. As such, an assessment of Project-related change in water or sediment quality in upland ditches and streams was not undertaken as part of this assessment.

Standard best management practices such as development and implementation of a Fish and Fish Habitat Management Plan and compliance with the B.C. *Water Act*, are expected to prevent potential changes to sediment and water quality in upland ditches during Project construction and operation. These are discussed in more detail in **Section 4.4 Fish and Fish Habitat**, and are not considered further in this section.

4.2.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on sediment and water quality in terms of Project setting and defines the spatial and temporal assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

4.2.1.1 Assessment Context

The Project alignment crosses the Fraser River South Arm, Deas Slough, and Green Slough, which support an important ecosystem. A clear span is proposed over the Fraser River and Deas Slough to minimize impacts to this ecosystem; however construction-related activities—specifically, installation of bridge foundations along the edge of Deas Slough, Tunnel removal, and decommissioning of the Deas Slough Bridge—have the potential to temporarily influence the quality of water and sediment in these water bodies through the introduction of turbidity and resuspension of bed sediments. Predicting the anticipated nature and magnitude of such changes is important for assessing Project-related effects on receptor VCs (fish and fish habitat, marine mammals, vegetation, and at-risk amphibians). Sediment and water quality has therefore been selected as an intermediate component in the assessment of Project-related effects on receptor VCs. Input received through consultation with government agencies, Aboriginal Groups, and the general public also informed the decision to undertake an assessment of sediment and water quality. During pre-Application consultation on the Project, water quality in the Fraser River was identified as an area of specific interest by Aboriginal Groups.

Additional information on the selection of VCs, and the link between water and sediment quality and receptor VCs is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.2.1.2 Methodology

Changes in riverbed sediment characteristics that have the potential to affect receptor VCs include changes in sediment composition and organic carbon content, and changes in sediment quality in terms of contaminant concentrations. Similarly, changes in the water column that have the potential to affect receptor VCs include changes in total suspended solids (TSS) and turbidity levels, or changes in ambient water chemistry. Therefore, Project-related study of water and sediment quality was designed to focus on these aspects.

A literature review, gap analysis, and field program, as outlined in **Table 4.2-1**, were undertaken to establish existing conditions, and sediment fate predictions described in **Section 4.1 River Hydraulics and River Morphology** were used to identify potential Project-related effects on water quality and sediment quality in the Fraser River South Arm, Deas Slough, and Green Slough.

Table 4.2-1 Sediment and Water Quality Studies to Support the Assessment

| Study Name | Study Description |
|------------------------------------|--|
| Literature Review/ Gap Analysis | Information from historic studies and data collected during previous field work in 2013 were reviewed to describe existing conditions of sediment and water quality and to identify information gaps. |
| Field Study | Project-specific sampling and analyses were conducted in September 2014 to describe sediment and water quality conditions in Fraser River South Arm in the vicinity of the Tunnel, and Deas Slough and Green Slough. |

4.2.1.3 Assessment Boundaries

The assessment boundaries for sediment and water quality are defined below.

Spatial Boundaries

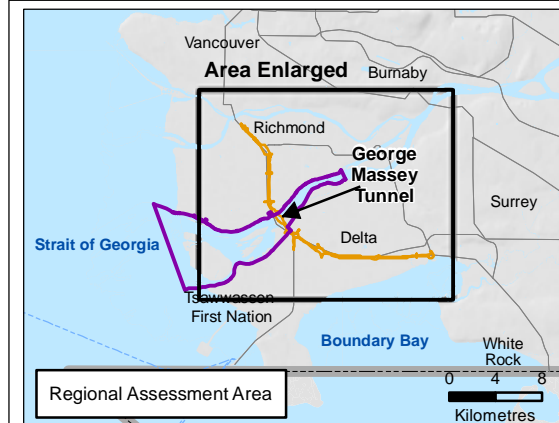
Changes in sediment and water quality in the Fraser River South Arm due to Project activities are expected to be most prominent within the Project alignment, immediately adjacent to instream or near-shore activities such as installation of bridge foundations along the edge of Deas Slough, Tunnel removal, and decommissioning of the Deas Slough Bridge. However, due to tidal influences and river hydrology, there could be Project-related effects to water quality, suspended sediment characteristics, or riverbed sediment characteristics some distance

downstream and upstream of the Tunnel. A local assessment area as defined in **Table 4.2-2** and shown on **Figure 4.2-1** was selected, taking these factors into account. Spatial extent of the LAA was refined to include Ladner Reach and South Arm Marshes based on feedback received from Aboriginal Groups and regulatory agencies during pre-Application consultation.

A regional assessment area (RAA), which comprises the river reach extending approximately seven kilometres upstream from the Tunnel, and downstream from the Tunnel to the river mouth (**Figure 4.2-1**), has been defined to provide regional context.

Table 4.2-2 Spatial Boundaries for Sediment and Water Quality Assessment

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local Assessment Area (LAA) | Fraser River South Arm extending approximately seven kilometres downstream from the Tunnel (including Ladner Reach and South Arm Marshes) and 1.5 km upstream of the Tunnel; Deas Slough and Green Slough; and upland water courses within the Project alignment plus 30 m buffer. |
| Regional Assessment Area (RAA) | Fraser River South Arm extending seven kilometres upstream from the Tunnel, and downstream from the Tunnel to the river mouth (past Westham Island). |

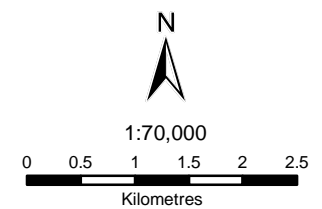


Legend

- Sediment and Water Quality Local Assessment Area
- Sediment and Water Quality Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

SEDIMENT AND WATER QUALITY LOCAL AND REGIONAL ASSESSMENT AREAS

Figure 4.2-1

13/05/2016

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects were established based on the potential for each phase of the Project to interact with and have an effect on water and sediment quality. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect the quality of water and sediments in the Fraser River South Arm, and Deas and Green Sloughs; therefore, the following temporal boundaries were defined for sediment and water quality assessment:

- Existing conditions
- Project construction, which includes Tunnel decommissioning
- Project operation, including maintenance

Temporal characteristics (timing) of the Project construction phase (including decommissioning of temporary construction-related facilities and the Tunnel), and operation phases are defined in **Section 1.1.3 Project Phases and Schedule**. Specific temporal considerations for the assessment of water and sediment quality are discussed in the context of Project interactions and potential effects in **Section 4.2.3**.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on water and sediment quality have been identified; therefore no administrative boundaries are defined.

Technical Boundaries

The technical boundaries for water and sediment quality assessment are associated primarily with the amount of location-specific data on sediment and water quality under existing conditions, including variations across space, depth in the water column or riverbed, and over time. The processes known to influence sediment and water quality within the LAA and RAA are well-understood, and the observations and interpretations that underpin this assessment are entirely consistent with expectations based on the greater theoretical understanding.

4.2.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data and describes the existing conditions of sediment and water quality within the assessment areas. An overview of the regulatory context for management of water and sediment quality as relevant to the Project is also provided.

4.2.2.1 Baseline Data Collection

In early 2014, the Ministry initiated desktop and field studies to support the environmental assessment of the proposed Project. The studies were designed to build on existing information and address known data gaps.

The information on existing sediment and water quality presented here is based on a review of multiple historical documents, previous sample data collected in 2013, and a field sampling program specific to the Project. The interpretation of existing conditions in relation to sediment and water quality is grounded in a contemporary theory regarding the relationships between river hydrology and sediment supply (as discussed in **Section 4.1 River Hydraulics and River Morphology**) and sediment fate, including contaminant hydrogeochemistry.

A Project-specific field program was conducted in September of 2014 to collect sediment and water quality data. While this limited field program does not capture temporal variations that are associated with river discharge stage or dry periods in comparison with extended periods of precipitation, fulsome historic data exists to address this gap. Seasonal variations in riverine conditions and in local runoff are expected to influence the characteristics of finer-grained sediments that are entrained in the river water, as well as the contaminants associated with them. Fine-grained sediments tend to be routinely transported through the Project Area without appreciable deposition (described as washload in **Section 4.1 River Hydraulics and River Morphology**), and therefore, are considered less relevant to an assessment of changes to sediment and water quality in the context of bed sediment re-suspension during Project construction activities. An exception to this is the accumulation of fine-grained sediments in Deas and Green Sloughs.

Literature Review

Background information was reviewed and data that pertain to the following were collected:

- Substances and conditions for which observed concentrations approach or exceed Canadian sediment quality guidelines (SQG) for the protection of aquatic life (CCME 2014a), the water quality guidelines (WQG) for the protection of aquatic life (CCME 2014b), or the B.C. WQGs (B.C. MOE 2006).

- Temporal trends in sediment and water quality parameters in the Fraser River South Arm, specifically within the LAA and RAA, where available.
- Causal relationships between environmental variables and water quality parameters (e.g., relationship between fine-grained sediment and chromium concentrations).

Field Studies

Field studies were undertaken within the LAA (**Figure 4.2-2**), to characterize surficial sediment and assess water quality. Sampling was conducted on September 11 and 12, 2014, during low-flow conditions in the Fraser River.

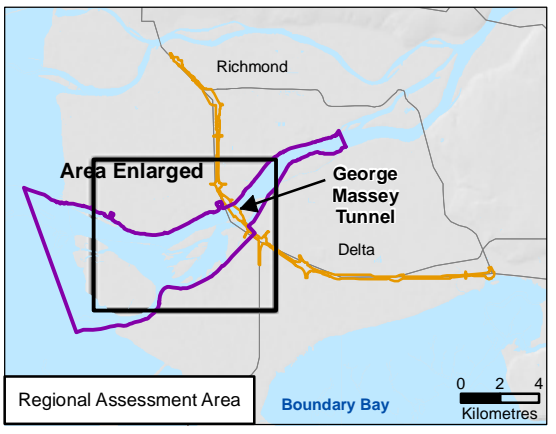
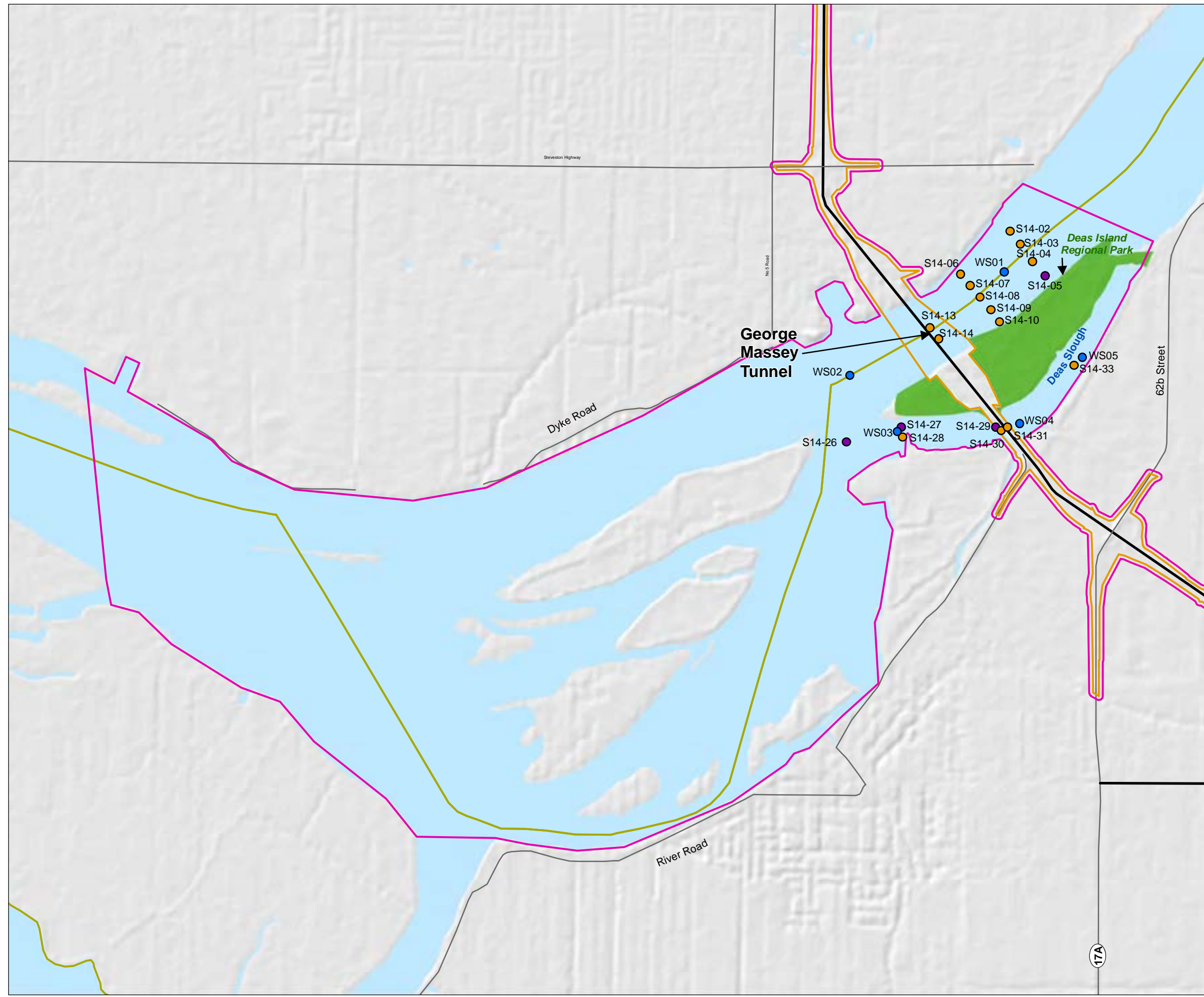
Sediment Characterization

Sediment samples were collected using a combination of surface grabs from the top ~25 to 30 cm of the riverbed using a 0.1 m² stainless steel Van Veen grab and vibracoring to obtain information on vertical distribution of contaminants. The maximum sample depth achievable was approximately 2 m below the riverbed.

Information from historic studies and previous field work were reviewed to describe existing conditions of sediment and water quality. To supplement this existing data, samples were collected at representative locations in the Fraser River near the Tunnel and in Deas Slough. The samples were handled in accordance with the *B.C. Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* (B.C. MWLAP 2003). Samples were stored in the appropriate non-contaminating containers provided by a commercial analytical laboratory (ALS Environmental Services). Samples were analyzed for particle size distribution, total organic carbon, trace elements, extractable petroleum hydrocarbons (EPH), polycyclic aromatic hydrocarbons (PAH), and polychlorinated biphenyls (PCB).

Water Quality Sampling and Analyses

Water samples were collected at five locations within the LAA (**Figure 4.2-2**): one mid-channel reference site upstream of the Tunnel, two mid-channel sites downstream of the Tunnel, and two sites in Deas Slough. Water samples were collected and analyzed in accordance with the *B.C. Field Sampling Manual for Continuous Monitoring and the Collection of Air, Air-Emission, Water, Wastewater, Soil, Sediment, and Biological Samples* (B.C. MWLAP 2003).



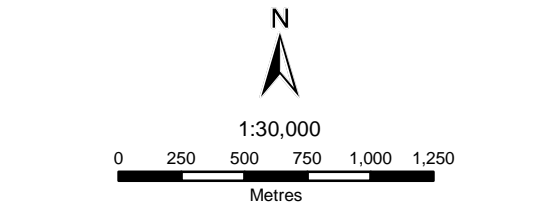
Legend

Hemmera 2014 Sample(s)

- Van Veen Sample Location
- Vibracore Sample Location
- Water Sample Location
- Sediment and Water Quality Local Assessment Area
- Sediment and Water Quality Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SEDIMENT AND WATER QUALITY
SAMPLE LOCATIONS**

| | |
|--------------|------------|
| Figure 4.2-2 | 13/05/2016 |
|--------------|------------|

17A

4.2.2.2 Regulatory Context

Federal

In the context of sediment and water quality, the federal *Fisheries Act*, R.S.C. 1985, c. F-14 is relevant to the Project. Section 35 (1) of the *Fisheries Act* regulates any work, undertaking, or activity that results in serious harm to fish (defined as the death of fish or any permanent alteration or destruction of fish habitat) that are part of or support a commercial, recreational or Aboriginal fishery. Section 36 (3) regulates the deposition of a deleterious substance of any type in water frequented by fish. A deleterious substance may include excess concentrations of suspended sediment.

The Canadian Environmental Quality Guidelines (CEQG) of the Canadian Council of Ministers of the Environment (CCME) define numerical concentrations recommended as levels that should result in negligible risk to biota and fish habitat function. Specific CCME CEQG that apply to the Project include sediment quality guidelines for the protection of aquatic life (CCME 2014a) and the CCME water quality guidelines for the protection of aquatic life (CCME 2014b).

Provincial

The B.C. Ministry of Environment develops ambient WQGs to promote healthy ecosystems and protect human health. Water quality guidelines are science-based levels of physical, biological, and chemical parameters for the protection of water uses such as aquatic life, wildlife, agriculture, drinking water, and recreation. Approved WQGs are policy statements and applied generically province wide, providing the basis for water quality assessments and informing decision-making in the natural resource sector.

Section 9 of the B.C. *Water Act* R.S.B.C. 1996, c. 483 regulates changes in and about a stream. The Act defines “changes in and about a stream” as:

- a) any modification to the nature of a stream including the land, vegetation, natural environment or flow of water within a stream
- b) any activity or construction within the stream channel that has or may have an impact on a stream.

4.2.2.3 Existing Conditions

Sediment Texture

Sediments within the Fraser River South Arm comprise grain sizes dominated by sand ranging in diameter from 0.25 to 0.5 mm (Swain and Walton 1991, McLaren and Tuominen 1999, Phippen 2001). In contrast, sediments in and near Deas Slough shift to a more diverse and smaller particle size (McLaren and Tuominen 1999, Phippen 2001). In general, sloughs, side-channel areas, or nearshore eddies of the Fraser River South Arm tend to accumulate finer-textured clayey and silty sediments, while the higher current areas in the main river channel (and in the designated navigational channel) are characterized by sandy sediments with very limited fines. Grain size distribution from sediment core samples extracted from Deas Slough and the Fraser River South Arm during field studies conducted for the Project is illustrated in **Appendix A, Figure 1**. Grain size composition is consistent across all depths (**Appendix A, Figures 2 and 3**).

Sediment Quality

Bed sediments in some areas of the Fraser River South Arm contain trace elements, PAHs, and other organic contaminants at levels that may exceed Canadian SQGs. Historically, samples collected in the South Arm have routinely exceeded Canadian SQGs for arsenic, chromium, and copper (Swain and Walton 1991, 1993, Brewer et al. 1998). These trace elements occur at higher concentrations in the finer-textured (silt and clay) fractions of bed sediments (**Appendix A, Figure 4**). Fine-grained (<0.063 mm), organic-rich sediments, such as those occurring in Deas Slough and Green Slough, preferentially adsorb metals due to higher adsorption capacity and higher surface area compared with coarse-grained sediments (Ackermann 1980, Salomons and Förstner 1984, Horowitz et al. 1989, Tyson 1995). Arsenic, chromium, and copper concentrations that exceed Canadian interim SQGs were found in sediment samples collected from Deas Slough as part of the field studies completed for the Project in 2014 (**Appendix A, Figure 5**). There was no apparent variation in trace element concentrations within the sampling depth of two metres (**Appendix A, Figure 6**).

Sediment within the LAA that currently comprises the riverbed material directly adjacent to the Tunnel (except near the river banks) can be described as coarse-grained, with very low concentrations of chemical constituents. Annual dredging takes place in the Fraser River South Arm with associated disturbance to sediments and water in the LAA and RAA.

Water Quality

Data collected during Project-related field studies in 2014 indicate that water in the Fraser River South Arm is of good quality, with parameters such as pH, temperature, dissolved oxygen, and electrical conductivity falling within CCME WQGs for the protection of aquatic life (CCME 2014b).

Given that the river naturally carries large loads of suspended sediments, high turbidity/TSS concentrations are often observed during surface water sampling in the Fraser River South Arm. Turbidity levels can range widely, from 1.8 to 87.8 NTUs (nephelometric turbidity units), which reflects the influence of tides and freshwater outflow on silt loads and levels of sediment re-suspension. At the time of sampling for the Project (September 2014), TSS concentrations ranged between 8.8 mg/L and 28.4 mg/L, which reflects wind and tidal interaction rather than turbid freshwater outflow.

Instances of elevated concentrations of aluminum, chromium, and copper, which correlated with TSS concentrations at the same locations, were noted. Increased total levels of naturally occurring trace elements are typical in waters with increased TSS levels, with trace elements being more mobile and more bioavailable.

PAHs, EPH, oil, or grease were detected in any water sample. Concentrations of total and dissolved aluminum, chromium, and copper from grab samples collected during the 2014 field studies conducted for the Project are shown in **Appendix A, Figure 7**.

4.2.3 Potential Effects

This section provides a summary of potential changes to sediment and water quality related to the construction and operation of the Project, and describes the methodology used to assess potential project-related effects. An overview of potential interactions of Project components and activities with water and sediment within Fraser River South Arm, Deas Slough, and Green Slough is presented, and potential effects of such interactions on water and sediment quality are discussed. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.2.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 4.2.5**. A discussion of the potential for cumulative effects on water and sediment quality is presented in **Section 4.2.6**.

4.2.3.1 Project Interactions

An overview of potential interactions between Project activities and water and sediment during the construction and operation of Project components is provided in **Appendix B**. A preliminary evaluation of the potential effects of Project interactions on sediment and water quality, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: Potential interactions of Project-related construction activities with water and sediment include the following:

- Disturbance of river bed material during removal of sediment, rock apron, and concrete mattress in preparation for Tunnel removal, removal of Tunnel segments, installation of bridge piers along the edge of Deas Slough, and removal of the Deas Slough Bridge.
- Movement of construction vessels and equipment along the Fraser River during installation of bridge components, transportation of Tunnel elements for offsite disposal, and operating support vessels for that activity.

Operation: Potential interactions of Project-related operation activities with sediment and water include the following:

- Maintenance of stormwater management ponds and drainage facilities during operations.

4.2.3.2 Potential Effects

Construction

Localized disturbance of surficial sediments is expected to occur during installation of temporary barging facilities, and removal of Tunnel segments.

Potential effects of activities associated with Tunnel removal on sediment generation, or re-suspension, are discussed in **Section 4.1 River Hydraulics and River Morphology**. The impact of sediment generation will depend on ambient suspended sediment concentrations at the time of removal. It is assumed that Tunnel removal will commence in mid-summer, after freshet flows have receded, and extend into the winter low-flow period. Suspended sediment volume is predicted to temporarily increase between one per cent and nine per cent over ambient levels during the course of disturbance. The impact of this increase is considered low, given the natural variability of suspended sediment seasonally and annually in the river main channel. Fine sediments are anticipated to remain in suspension and be carried downstream to the Strait of Georgia (for details see **Section 4.1 River Hydraulics and River Morphology**).

During Tunnel decommissioning, water velocity is expected to decrease over the Tunnel trench as segments are removed in sequence, resulting in temporary, localized re-distribution of bed sediments through scouring and deposition, with entrained sediment deposited immediately downstream. Potential changes to sediment and water quality are therefore expected to be temporary and small in scale compared with overall bed material transport, as described in **Section 4.1 River Hydraulics and River Morphology**.

Project-related construction activities along the edge of Deas Slough and Green Slough that have the potential to induce turbidity include runoff, ground improvements, realignment of Green Slough to its historic location, and pile driving and construction of piers for the new bridge south approach. Temporary, localized disturbance of surficial sediments is also expected to occur during geotechnical investigations along the edges of Deas Slough and Green Slough and demolition of the Deas Slough Bridge.

Concentrations of metals (arsenic, chromium, copper) greater than those found in the sandy sediments of the Fraser River South Arm in the vicinity of the Project have been documented in the fine-grained sediments of Deas Slough historically, and were noted during field sampling conducted in September 2014 for the Project (see **Section 4.2.2**). This aligns with findings of historical reports, which show that fine-grained sediments preferentially adsorb organic particles and metals due to higher adsorption capacity and higher surface area compared with coarse-grained sediments. There is potential for temporary re-suspension of these materials into the water column in Deas Slough during Project construction.

The main channel of the Fraser River South Arm consists primarily of coarser-grained sediment, with metal concentrations not exceeding Canadian SQGs. Therefore no potential change in water quality due to re-suspended sediment contaminants is expected during construction-related activities in the Fraser River South Arm, including Tunnel decommissioning.

Accidental spills of toxic or hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete), or potential failure of sediment containment measures could affect sediment and water quality during Project construction. The magnitude of such changes would vary as a function of the proximity of the disturbed areas to the river, its tributaries or stormwater collection points, or the extent and slope of exposed and erodible soils. Potential changes in surface water quality resulting from accidents or malfunctions during Project construction are assessed in **Section 8.0 Accidents and Malfunctions**.

Operation

Project-related widening of the highway and installation of the new bridge will result in an increase in impervious surface area and consequent increase in the rate of stormwater runoff that may enter the river and sloughs. An increase in peak flow rates has the potential to affect water quality in the receiving aquatic environment due to increased concentrations of nutrients, organics, metals, chlorides, bacteria, and hydrocarbons (Erickson et al. 2013), especially during first flush and peak storm events.

4.2.4 Mitigation Measures

This section describes the mitigation measures that will be implemented to avoid or reduce potential Project-related effects on sediment and water quality as discussed in **Section 4.2.3.2**.

4.2.4.1 Mitigation Selection Approach

Selection of mitigation measures has been informed by a review of standard industry and best management practices; consideration of mitigation measures and follow up programs undertaken for past developments by the Ministry; input from regulators, public, and Aboriginal Groups; and internal evaluation of technical and economic feasibility. Consideration was given to the following standards and guidelines:

- *2012 Standard Specifications for Highway Construction* (B.C. MOTI 2012)
- *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010)
- *Measures to Avoid Causing Harm to Fish and Fish Habitat* (DFO 2013)
- *Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck et al. 1993)
- *Environmental Management Strategy for Dredging in the Fraser River Estuary* (FREMP 2006)
- *Dredge Management Guidelines* (FREMP 2005)
- *Standards and Best Practices for Instream Works* (B.C. MWLAP 2004)
- *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (B.C. MOE 2014)

Proposed mitigation considerations were informed by feedback received from Aboriginal Groups and stakeholders during pre-Application consultation, including interest expressed in use of bioengineering techniques on land (e.g. biofiltration areas) to prevent direct runoff into the Fraser River.

A hierarchical approach, based on avoidance of potential effects first followed by minimization or reduction of unavoidable effects, was used in identifying strategies to mitigate potential Project-related effects on water and sediment quality.

Measures to avoid potential effects have been/will be incorporated into project considerations such as site and route selection, scheduling, design, construction, and operation procedures and practices. Where potential effects cannot be avoided through project considerations, standard mitigation measures, Best Management Practices (BMPs), and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels. These measures are described in general terms below.

4.2.4.2 Avoidance

The bridge design will incorporate a stormwater collection and distribution system that conveys stormwater runoff to appropriate upland infrastructure for proper treatment (e.g., stormwater detentions ponds or biofiltration swales) before discharging to the Fraser River or adjacent streams, thereby avoiding potential impacts on the water and sediment quality. These enhanced stormwater management approaches are expected to result in an improvement in water and sediment quality in the Fraser River when compared to existing conditions

4.2.4.3 Minimization

Project Design

The new bridge will have a clear span over the Fraser River and over Deas Slough to minimize construction-related effects including effects on water quality and disturbance to the river bed.

Best Management Practices and Environmental Management

Specific environmental protection measures that will be implemented during Project construction and operation to prevent or minimize environmental effects will be identified in a CEMP, and subsequently in an Operation Environmental Management Plan (OEMP), as described in **Section 12.0 Management Plans**.

Control of Suspended Sediment during Tunnel Decommissioning

Construction methods that minimize levels of Project-induced turbidity in the Fraser River main channel will be employed where feasible and appropriate. To the extent technically feasible and viable, removal of fill materials adjacent to the Tunnel will be conducted in a manner that minimizes re-suspension of sediments—using hydraulic (hopper or cutter) suction for example.

Removed material is expected to be transported off-site using spoil barge(s) equipped with a sediment containment system (e.g., filter cloth, concrete lock blocks, straw bales).

Control of Suspended Sediment during Project Construction in and adjacent to Deas and Green Sloughs

Sediment control measures (e.g., turbidity curtains) will be used to control the dispersion of re-suspended sediments in Deas Slough generated by physical bed disturbance during ground improvements, pier construction activities on the edge of Deas Slough, and demolition of existing infrastructure. Measures to control suspended sediment during Project construction in Deas and Green Sloughs will be described in the Erosion and Sediment Control Plan within the CEMP. Erosion prevention and sediment control measures that will be implemented during construction may include, but be limited to:

- Development of temporary drainage systems to receive, filter, and direct stormwater and runoff during construction
- Installation of sediment control measures
- Development of sediment settlement ponds, if required
- Re-stabilization of vegetated areas that are cleared or disturbed during construction
- Careful storage of waste material and soil to prevent possible entry into the aquatic environment

Water Quality Monitoring during Construction

To assess the effects of Project-specific construction activities on sediment and water quality, and evaluate the effectiveness of mitigation measures, water quality monitoring will be conducted during Project-related construction activities that have the potential to induce turbidity (e.g., Tunnel removal, construction along the edges of Deas Slough and Green Slough). In general, water quality monitoring will include frequent collection of samples at established monitoring stations in the Fraser River main channel within proximity to the Tunnel crossing, as well as downstream of deployed sediment containment measures in Deas Slough, especially during higher risk construction activities. Water quality data will be evaluated in relation to the CCME (2002) and B.C. (B.C. MOE 2006) water quality guidelines (see **Section 4.2.2.2**).

Measures proposed to avoid or minimize Project-related effects on water and sediment quality as discussed above, including collection and treatment of stormwater runoff prior to discharge into streams, and sediment control during Project construction, were identified based on standard best practices and proven methodologies. Accordingly, there is a high level of confidence in the effectiveness of these measures and their ability to prevent Project-related effects on water and sediment quality.

4.2.5 Residual Effects

As discussed in **Section 4.2.4.2**, the Project has been designed with appropriate stormwater runoff collection and management features that prevent direct road runoff into the Fraser River. These enhanced stormwater management approaches are expected to result in an improvement in water and sediment quality in the Fraser River when compared to existing conditions, and no residual adverse effects on water or sediment quality are expected post construction.

Implementation of best practices and proven sediment and erosion control measures as discussed in **Section 4.2.4.3** are expected to avoid any potential effects on water and sediment quality during Project construction. Undertaking Project-related construction activities in Deas Slough within sediment containment structures or other measures will prevent any potential adverse effects to sediment and water quality in the slough due to re-suspension. The very limited extent of in-water or near-water activities are anticipated to be sufficiently small that introduction of suspended sediments into the larger water course can be avoided effectively through the isolation of works using multiple silt curtains or other sediment control measures. Therefore no residual effects on water and sediment quality related to construction within or adjacent to Deas Slough are expected.

Given the anticipated scale and nature of activities associated with Tunnel decommissioning, it is expected that standard best practices and mitigation measures, including use of equipment and methods that minimize sediment resuspension for removal of Tunnel segments and overlying material, will reduce, but not eliminate sediment resuspension. Sediment resuspension and entrainment in active Fraser River flows during Tunnel removal could, therefore, result in temporary increases in TSS and turbidity levels in the overlying water, especially near the river bed. This potential construction-related residual effect on water and sediment quality is characterized below in terms of the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of the effect. Definitions for ratings applied to residual effects criteria, developed with specific reference to water and sediment quality, are presented in **Table 4.2-3**. A summary of criteria ratings for the potential residual effect is provided in **Table 4.2-4**. Context for the characterization of the residual effect, i.e. sensitivity/resilience of water and sediment quality to potential Project-related effects, based on existing conditions, is also provided.

Table 4.2-3 Criteria Used to Characterize Residual Effects on Sediment and Water Quality

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|--|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project. |
| | | Positive | Beneficial effect as a result of the Project. |
| | | Neutral | Neutral effect as a result of the Project. |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible | No measurable change in water or sediment quality |
| | | Low | A measurable change within the range of natural variability, but not expected to directly impact receptor VCs (e.g. fish, including sensitive life stages or aquatic invertebrates). |
| | | Moderate | A measurable change outside the range of natural variability, but not expected to result in substantive effects on receptor VCs. |
| | | High | A measurable change outside the range of natural variability and potentially harmful to receptor VCs. Such changes could be driven either by measurable water quality changes or the associated changes in sediment characteristics following re-deposition. |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project alignment. |
| | | Local | Effect is restricted to the LAA. |
| | | Regional | Effect extends beyond the LAA |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Duration | Length of time over which the residual effect is expected to persist | Transient term | Effect occurs once during Project construction. |
| | | Short term | Effect occurs during a limited period of days to weeks during Project construction. |
| | | Moderate term | Effect persists over a period of weeks to months. |
| | | Long term | Effect persists beyond construction phase. OR Change is permanent. |
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor affects the IC) | Rare | Effect occurs once during Project construction or operation. |
| | | Uncommon | Effect occurs intermittently during Project construction or operation. |
| | | Frequent | Effect occurs frequently during Project construction or operation. |
| | | Continuous | Effect occurs continuously during Project construction or operation. |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Baseline conditions will be naturally restored after disturbance has ceased. |
| | | Irreversible | Baseline conditions will not be naturally restored after disturbance has ceased. |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance. |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 5%. |
| | | Moderate | Likelihood of residual effect is between 5% and 25%. |
| | | High | Likelihood of residual effect is greater than 25%. |

Activities associated with Tunnel decommissioning, including removal of Tunnel segments and overlying material, will be undertaken under active flow conditions, which could limit the effective use of isolation or sediment control structures such as silt curtains in the area immediately down river from the works. Bed sediments that are re-suspended during Tunnel removal, therefore, could add incrementally to suspended sediment loads in the river. **Table 4.2-4** presents a summary of the criteria ratings for this residual effect.

Context: Bed sediments and suspended sediments potentially influenced by the Project comprise a minute fraction of the estimated 12 to 31 million tonnes/year of suspended sediment transported by the Fraser River, and the anticipated scale of disturbance to bed sediments is comparable to that associated with maintenance dredging routinely undertaken in the Fraser River South Arm. In addition, the physical and chemical characteristics of sediment likely to be suspended during Tunnel removal are consistent with sediments transported in the Fraser River in general, without any discernible influence of local contaminant source inputs. Sensitivity of water and sediment quality in the river to temporary changes resulting from activities associated with Tunnel removal is therefore considered to be low.

Table 4.2-4 Criteria Ratings: Change in Water Quality during Tunnel Decommissioning

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|-----------|-----------------|---|
| Direction | Adverse | Tunnel decommissioning has the potential to result in a temporary increase in TSS and turbidity in the Fraser River South Arm. |
| Magnitude | Low | Change will be within the range of natural variability, given the high sediment loads transported by the Fraser River South Arm. It is likely that measurable increases in TSS/turbidity will be evident for short periods of time during Tunnel removal within the immediate vicinity of the works; however, influence of this localized change in water quality on fish would be limited, given avoidance behaviours. The re-suspended sediment will be of similar textural and chemical quality to the downriver sediments therefore, deposition of re-suspended sediments in downriver areas is not expected to measurably alter riverbed habitat quality or characteristics. |
| Extent | Site | Spatial extent will be restricted to the area of disturbance. |
| Duration | Short term | Effect will occur only during specific Tunnel removal activities that will unavoidably re-suspend sediments. It is anticipated that there will be periodic instances of sediment re-suspension over several weeks to several months during sequential removal of each of the four Tunnel sections. |

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Frequency | Frequent | Effect will occur only in association with Tunnel removal, which comprises a small portion of the overall construction and post-construction project window. Nonetheless, a number of different types of activities are anticipated during the overall Tunnel removal phase, including excavation of adjacent sediments, and various in-river works. As a result there might be relatively frequent bouts of sediment re-suspension that could affect TSS/turbidity levels in the immediate vicinity of the Tunnel. |
| Reversibility | Reversible | Water quality is expected to return to baseline conditions within a few hours, and generally less than one day, following cessation of activities that could result in re-suspension |
| Likelihood | High | There is provisionally estimated to be a greater than 25% probability that a measurable change in TSS or turbidity in the water immediately above and down river from the Tunnel removal work will occur. |

When examining the characteristics of residual effects of Tunnel removal on water and sediment quality, it is important to appreciate that the characterization criteria as discussed above are applied to sediment and water quality as an intermediate component, and may not be relevant to the receptor VCs such as fish. The likelihood rating defines the likelihood of detecting a change in water quality (based on TSS) at a given point in space and time. The likelihood rating does not describe the associated probability of adverse effects to any VC. Characterization of residual adverse effects of construction-related sediment re-suspension on fish and fish habitat is provided in **Section 4.4 Fish and Fish Habitat**.

4.2.6 Cumulative Effects Assessment

The combination of Project-related changes, and changes from other certain and reasonably foreseeable projects and activities, as listed in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**, comprise the total cumulative changes in sediment and water quality. The only other project or activity that has the potential to have effects that could interact with those of the Project is the routine maintenance dredging of the Fraser River South Arm by the Vancouver Fraser Port Authority (VFPA), which overlaps spatially with the Project. It is anticipated that Tunnel decommissioning will be scheduled in consultation with VFPA such that there is no temporal overlap of potential sediment and water quality effects of the two activities, and no construction-related cumulative effects are expected.

4.2.7 Follow-up Strategy

Water quality monitoring will be undertaken during Project-related construction activities that have the potential to induce turbidity (e.g., Tunnel removal, construction within or along the edges of Deas Slough and Green Slough) to assess the influence of such activities on sediment and water quality, and evaluate the effectiveness of mitigation measures.

As no Project-related effects are predicted beyond the construction phase, no post-construction follow-up strategy is proposed.

4.2.8 References

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APPENDIX A

Results from Sediment and Water Quality Field Studies Conducted in September 2014 for the Project

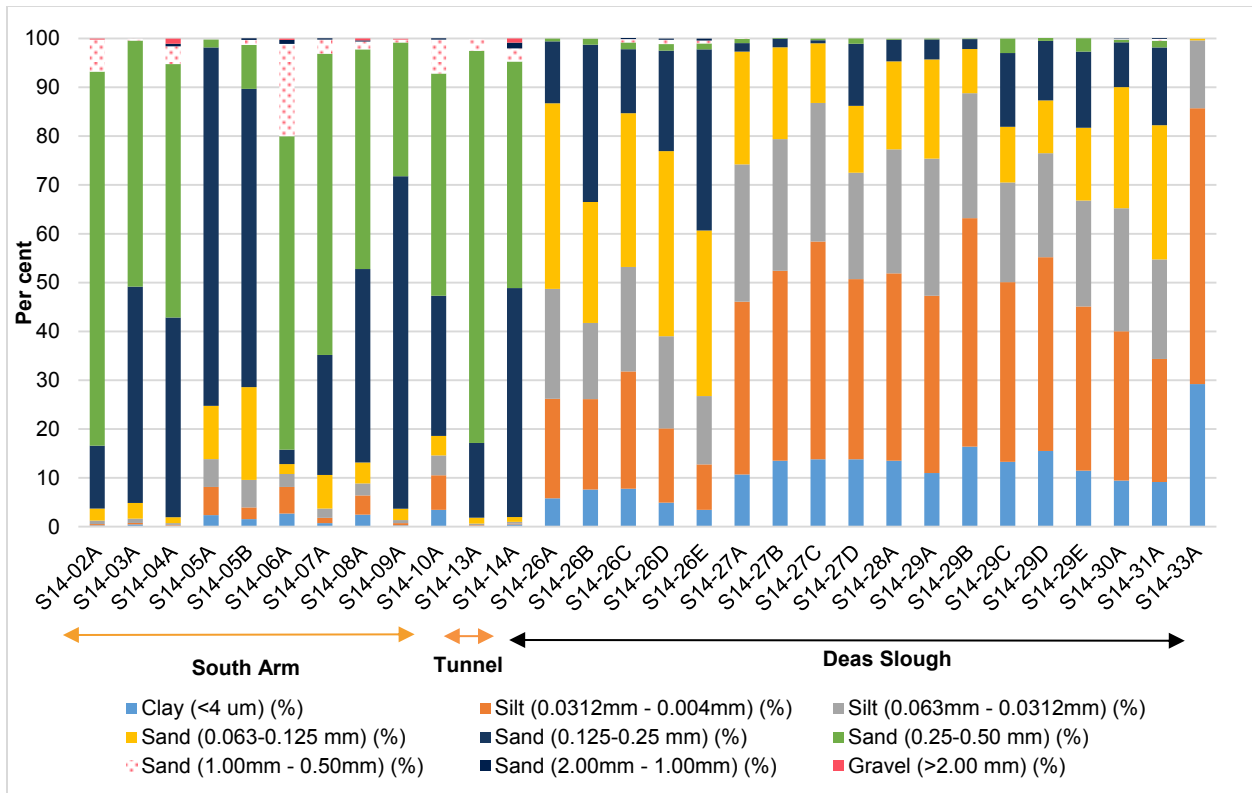


Figure 1 Per Cent Grain Size in Sediment Core Samples from Deas Slough and the Fraser River South Arm, including the Tunnel

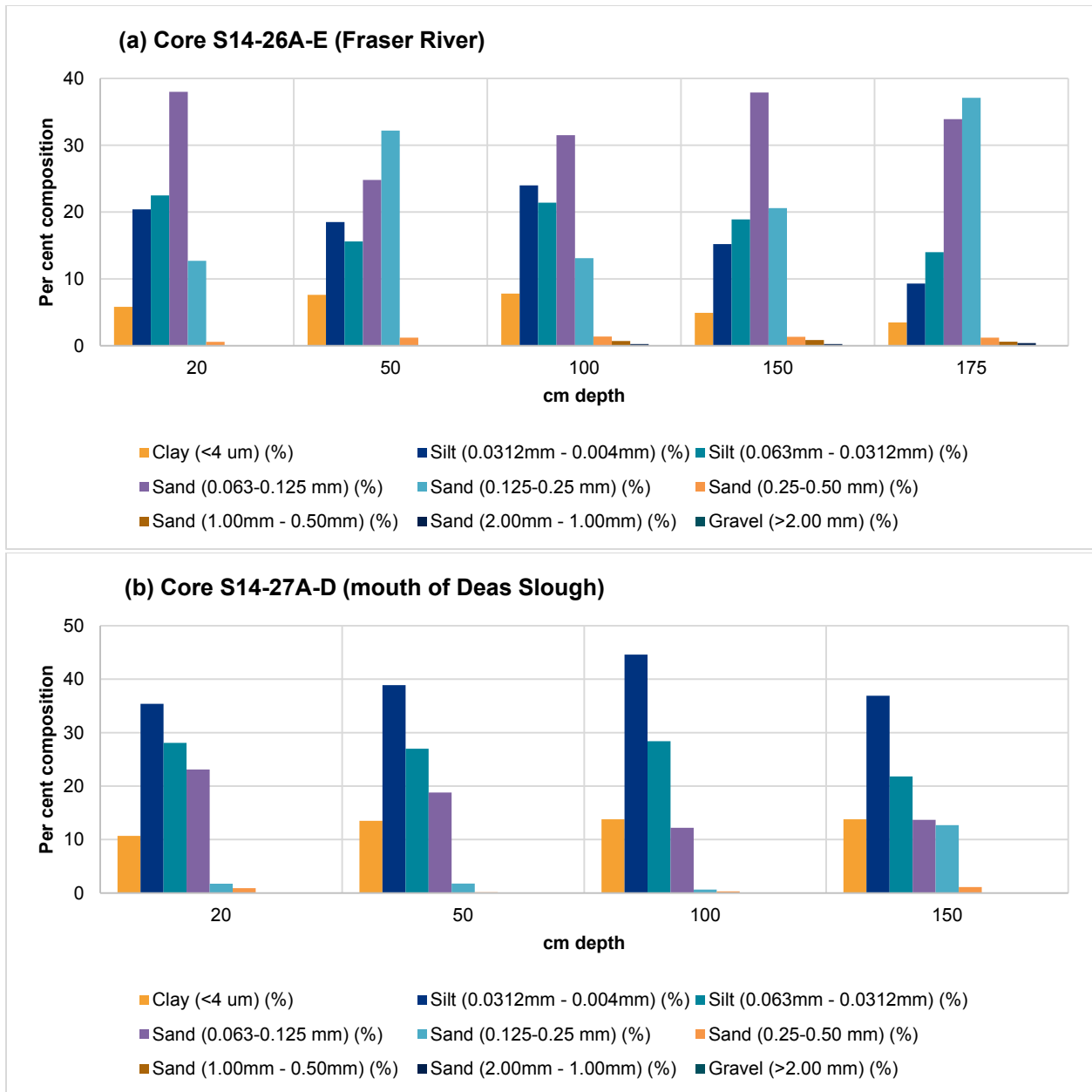


Figure 2 Grain Size Distribution for Core Samples (a) S14-26A-E (Fraser River) and (b) S14-27A-D (Deas Slough)

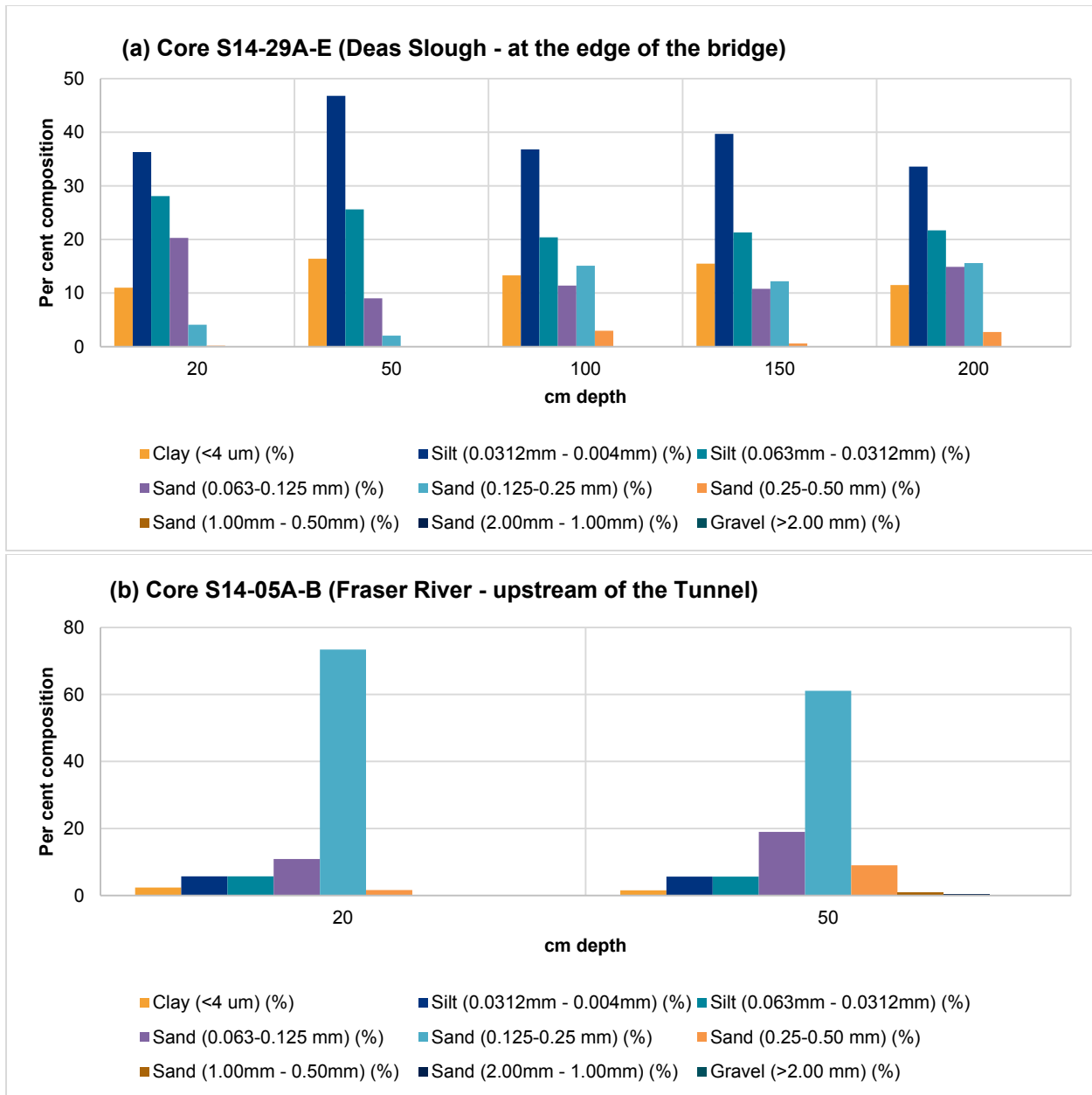


Figure 3 Grain Size Distribution for Core Samples (a) S14-29A-E (Deas Slough) and (b) S14-05A-B (Fraser River)

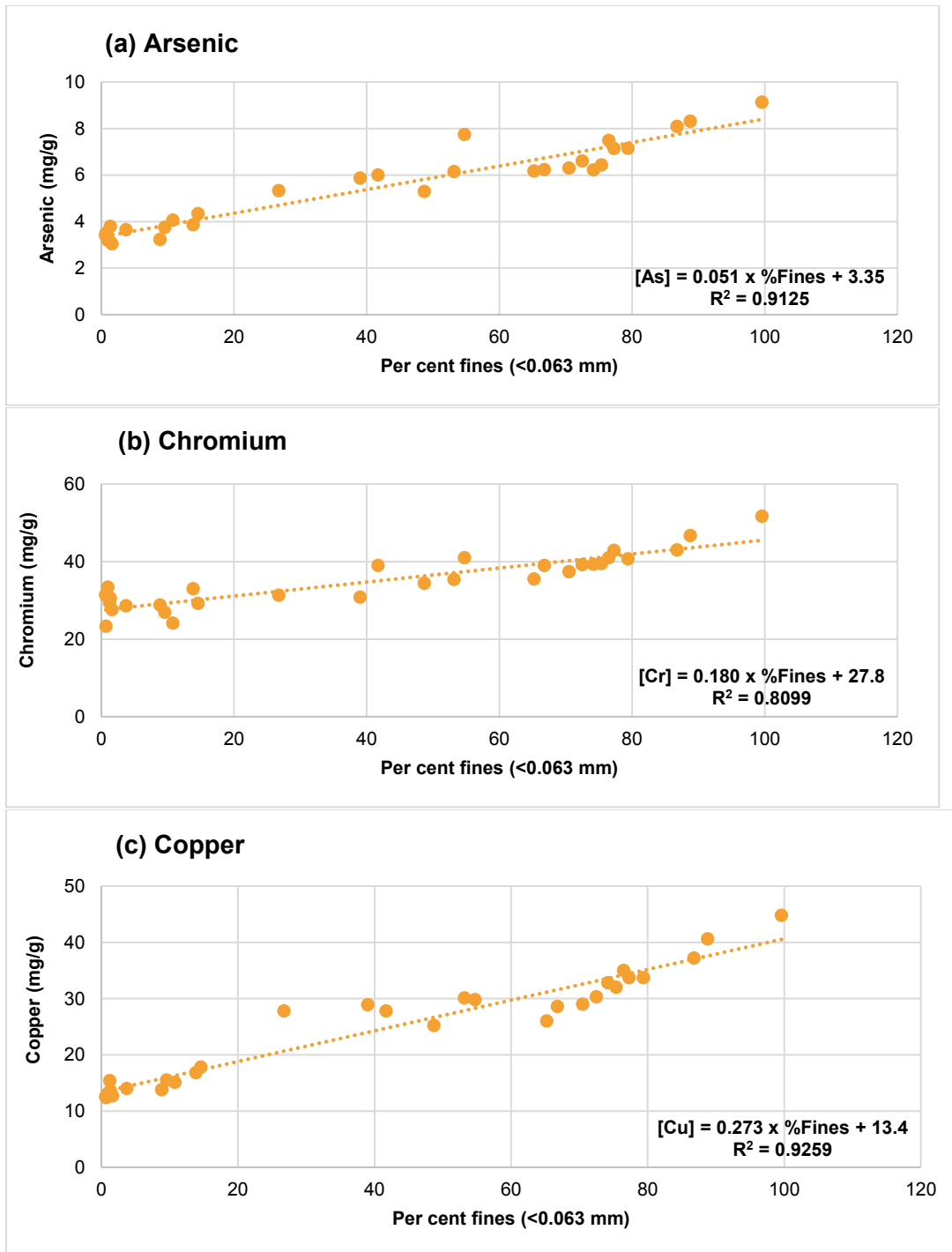


Figure 4 Linear Regression Analysis between Per Cent Fines (<0.063 mm) and Concentrations of (a) Arsenic, (b) Chromium, and (c) Copper

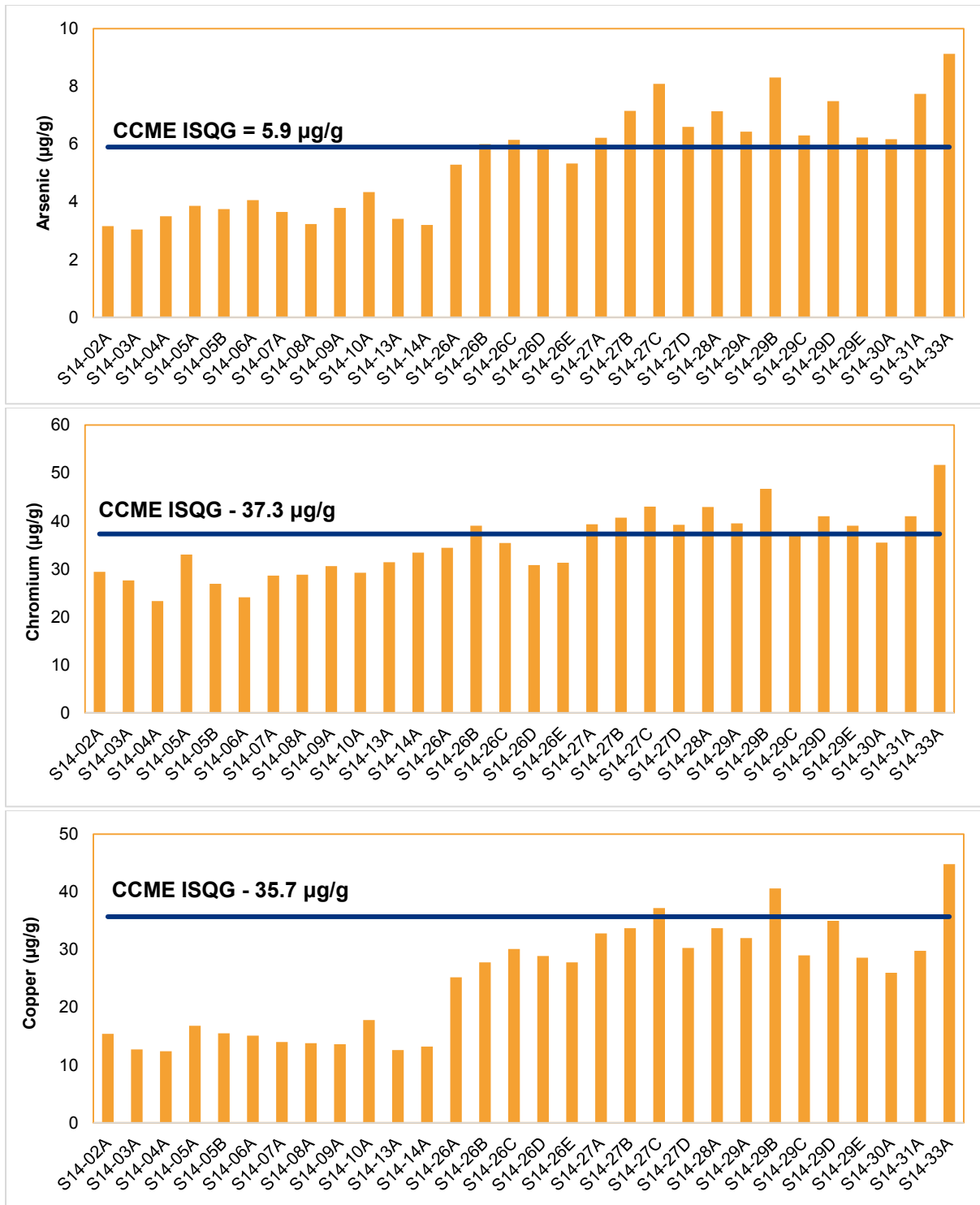


Figure 5 Concentrations of Arsenic, Chromium, and Copper in September 2014 Sediment Samples

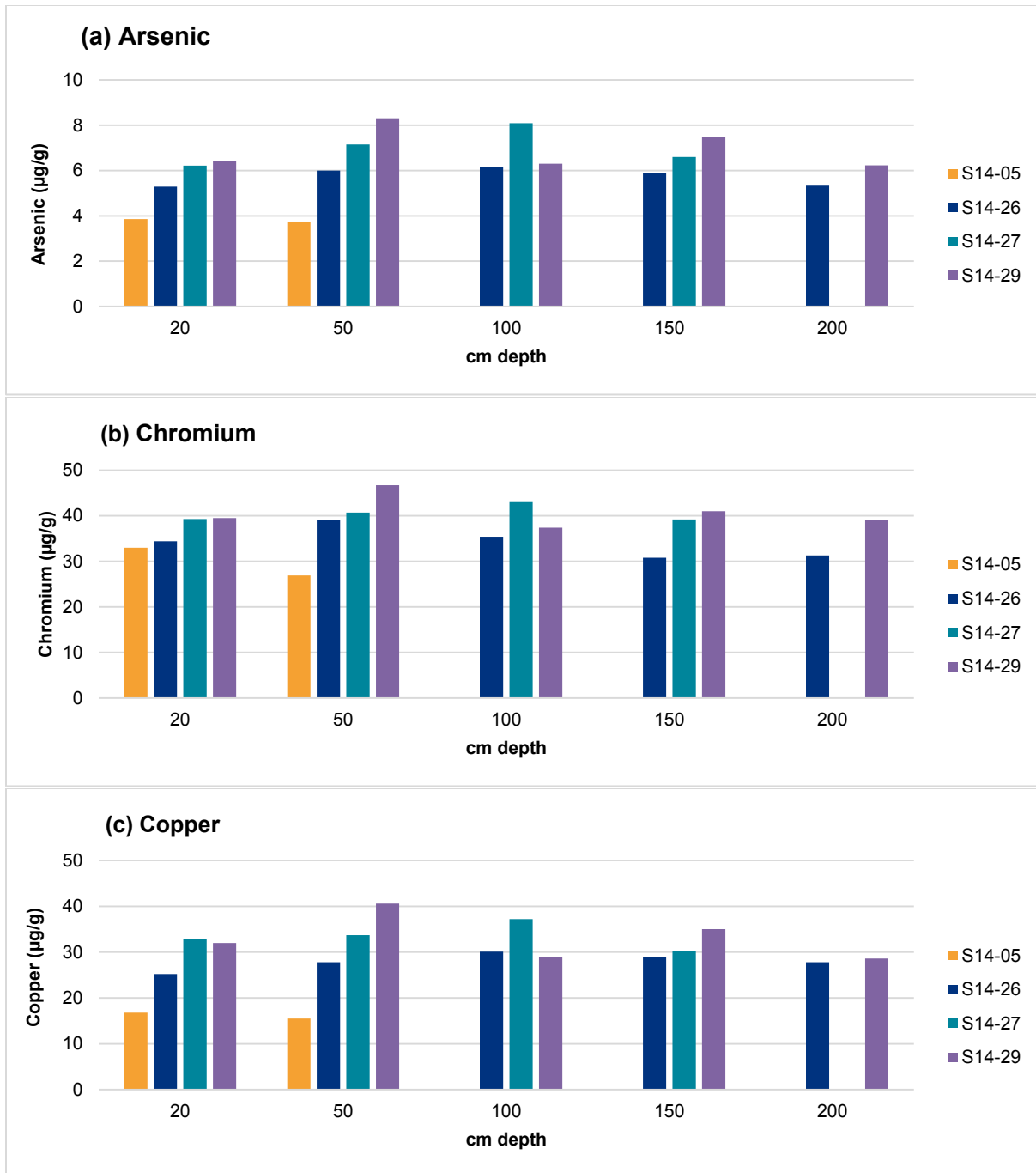


Figure 6 Distribution of (a) Arsenic, (b) Chromium, and (c) Copper by Depth in Deas Slough Sediment Cores

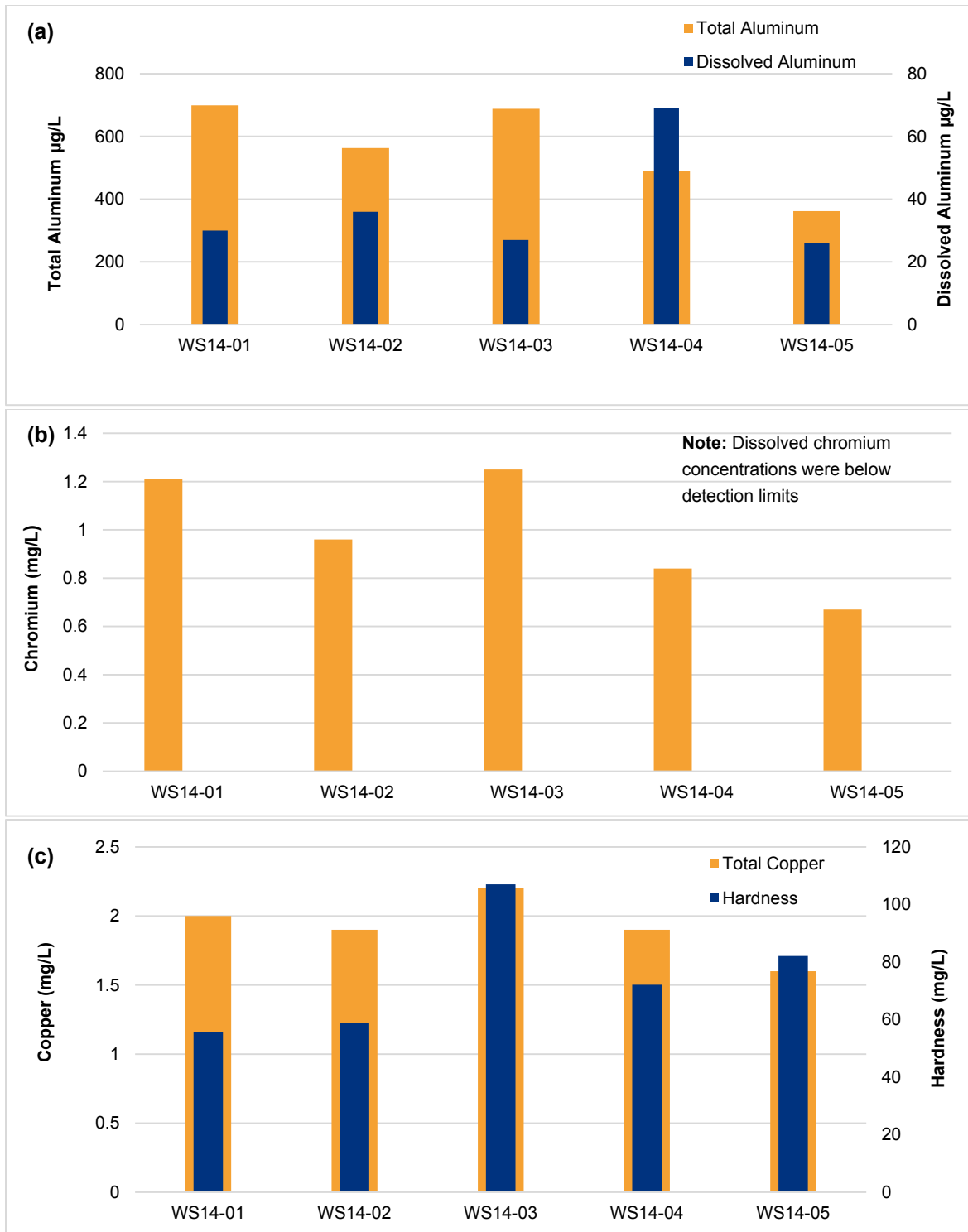


Figure 7 Concentrations of (a) Total and Dissolved Aluminum, (b) Total Chromium, and (c) Total Copper and Hardness in September 2014 Water Samples

APPENDIX B

Overview of Potential Project Interactions with Sediment and Water Quality

Table 1 Overview of Potential Project Interactions with Sediment and Water Quality

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|--|
| Pre-Construction / Site Preparation | | | |
| Pre-Construction / Site Preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Installing temporary drainage structures and diversions • Relocating utilities • Preloading for embankment and highway construction • Acquiring land for the Project | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • Installing temporary roads, laydown areas, and site offices | <p>Nature of interaction: Activities with the potential to interact with surface water and sediment quality.</p> <p>Rationale: All activities to be land-based</p> |
| | Potential Effect | <ul style="list-style-type: none"> • Restoration of Green Slough to its historic alignment • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Increased turbidity within Green and Deas Sloughs. • Accidental spills of toxic or hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete; see Section 8.0 Accidents and Malfunctions) • Temporary re-suspension of existing contaminants into the water column during Project construction. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • Hoisting pre-assembled deck segments from barges in the river or land-based transport system | <p>Nature of interaction: Activities with the potential to interact with surface water and sediment quality</p> <p>Rationale: Activities to be land-based, or will not have potential to impact sediment and water quality</p> |
| | Potential Effect | <ul style="list-style-type: none"> • Ground improvements associated with new bridge piers • Installing piers on the edge of Deas Slough and Green Slough, including pile installation | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Increased turbidity within Green and Deas Slough. • Temporary re-suspension of existing contaminants into the water column during Project construction. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | N/A | N/A |
| | Potential Effect | N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|---|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> Removing electrical/mechanical/utilities equipment from the Tunnel Backfilling of onshore portions of Tunnel approaches | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> Removing of four Tunnel segments and associated scour protection Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> Re-distribution of bed sediments through scouring as a result of flow acceleration around exposed tunnel ends (as described in Section 4.2 River Hydraulics and River Morphology) Accidental spills of toxic or hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete; see Section 8.0 Accidents and Malfunctions) |
| Decommissioning of Deas Slough Bridge | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> Removal of Deas Slough Bridge including substructures | <p>Nature of interaction: Activities with the potential to interact with surface water and sediment quality</p> <p>Rationale: All activities to be land-based</p> |
| | Potential Effect | N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|--|--|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.). | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | N/A | N/A |
| | Potential Effect | N/A | N/A |
| New bridge | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> Operating the new Bridge. Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.). | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> An increase of impervious surface area and stormwater runoff entering the river could increase concentrations of nutrients, organics, metals, chlorides, bacteria, and hydrocarbons (Erickson et al. 2013), if untreated. |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.3 Underwater Noise Assessment Highlights:

- The Project area is highly developed and existing underwater noise levels in the Fraser River, dominated by noise from vessels transiting the river, are relatively high.
- The proposed bridge will have a clear-span over the Fraser River and Deas Slough, minimizing instream works and the potential for underwater noise effects associated with construction.
- Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide when work can be completed under shallow water conditions or in the dry, thereby minimizing potential effects.
- Applying mitigation, including underwater noise monitoring and management during construction, will minimize the potential for Project-related changes in underwater noise conditions to affect fish or marine mammals.
- No post-construction residual effects or cumulative effects on underwater noise conditions are expected.

4.3 Underwater Noise

This section describes the existing conditions of underwater noise in the Fraser River South Arm, and Deas and Green Sloughs, and anticipated changes that may result from Project-related construction and operational activities. Underwater noise comprises one of the ‘steps’ along the pathway of effects of the Project, with fish and fish habitat and marine mammals being the ultimate receptors of Project-related effects. Underwater noise was therefore assessed as an intermediate component (IC) and information on estimated Project-related changes in underwater noise levels was used to support the assessment of Project-related effects on the following valued components (VCs): fish and fish habitat (**Section 4.4 Fish and Fish Habitat**) and marine mammals (**Section 4.6 Marine Mammals**).

4.3.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on underwater noise in terms of Project setting, and defines the spatial, temporal, administrative and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

4.3.1.1 Assessment Context

The Project includes on-shore installation of stone columns and driven piles, localized instream stone column and pile installation along the edges of Deas Slough to support the piers for the clear span over Deas Slough, restoration of Green Slough to its historic alignment, and removal of the four central segments of the Tunnel. Some of these activities have the potential to generate underwater noise that could affect marine mammals and fish in the Fraser River South Arm and Deas Slough. Therefore, predicting the anticipated change in underwater noise conditions during Project construction will support the assessment of Project-related effects on these valued components (VCs). Additional information on the selection of VCs, and the link between underwater noise and the VCs listed above is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.3.1.2 Methodology

The assessment of underwater noise followed the general methodology described in **Section 3.0 Assessment Methodology**.

In early 2014, the Ministry initiated field and desktop studies to support planning and environmental assessment of the Project. The studies were designed to build on existing information and address known data gaps.

The objectives of the underwater noise studies were to:

- Measure background (ambient) underwater noise levels in areas that could potentially be affected by the Project to establish a baseline for evaluation of Project activities.
- Estimate areas where Tunnel decommissioning and construction activities might elevate underwater sound levels above the baseline.
- Estimate spatial zones where fish and marine mammals could potentially be affected by underwater noise generated by Project-related construction.

These objectives were addressed through completion of specific studies outlined in **Table 4.3-1**.

Table 4.3-1 Underwater Noise Studies to Support the Assessment

| Study Name | Study Description |
|-----------------|---|
| Field Survey | Existing levels of background (ambient) underwater noise were measured in the Fraser River South Arm and Deas Slough. |
| Modelling Study | Acoustic models were used to predict the noise footprint of Tunnel decommissioning and proposed bridge construction activities. |

4.3.1.3 Assessment Boundaries

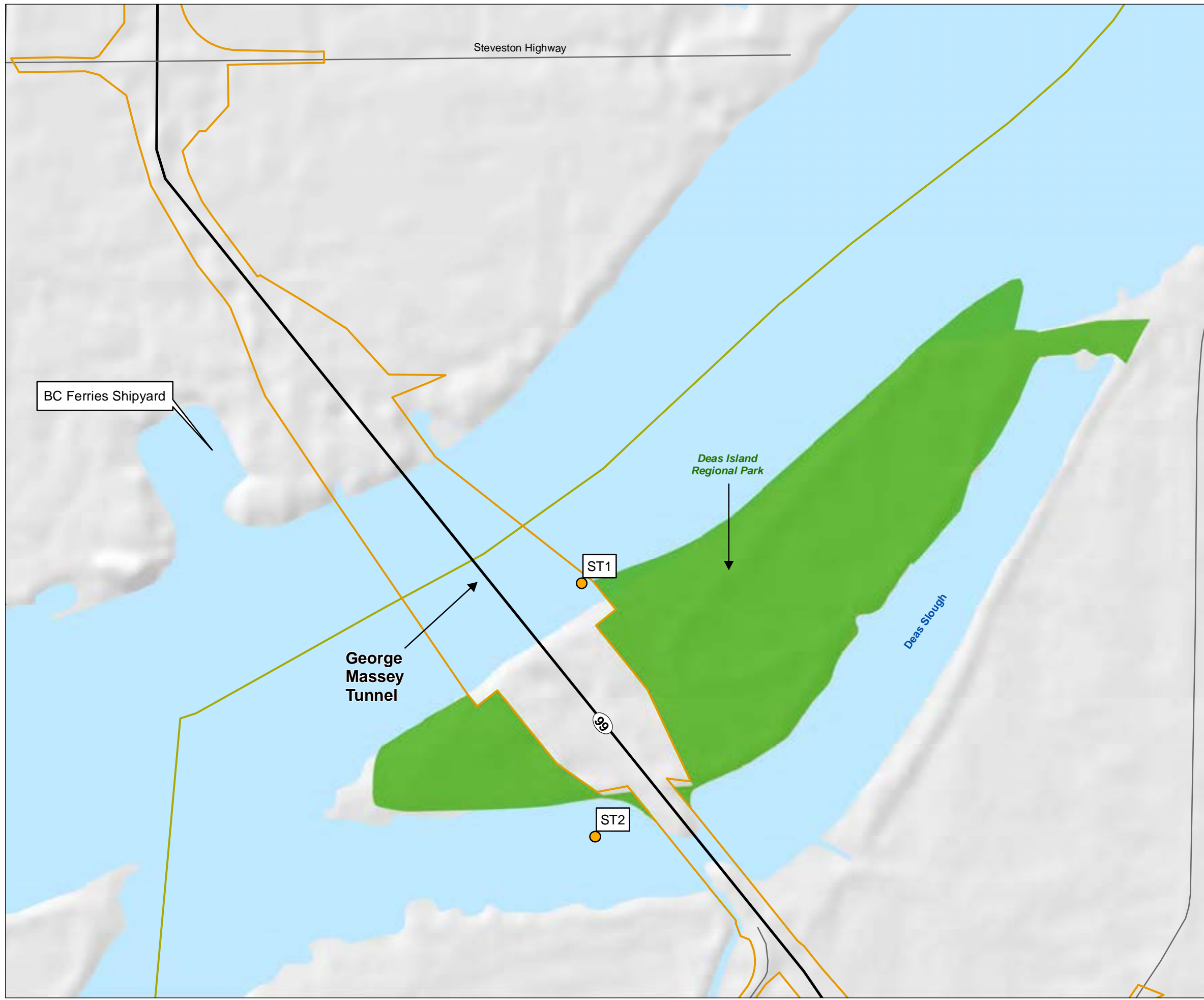
The assessment boundaries for underwater noise are defined below.

Spatial Boundaries

The assessment area includes those areas of the Fraser River South Arm, Deas Slough and Green Slough where noise generated by Project construction activities could potentially exceed background noise levels. Determination of the spatial extent of this zone is informed by the results of underwater sampling and modelling. The predicted extent of areas where potential Project-related change in underwater noise levels could influence receptor VCs (fish and marine mammals), based on results of modelling, is discussed in **Section 4.3.3**.

Underwater noise sampling at two locations, one in the Fraser River South Arm (ST1) and the other in Deas Slough (ST2) as shown on **Figure 4.3-1**, was undertaken to determine baseline noise levels in the identified zone. The sampling sites were selected based on proposed locations of Project-related activities that are likely to generate underwater sound that exceeds existing background ambient noise levels. Sampling stations were located near the banks of the river, off the main traffic routes, to prevent possible damage to instruments by passing vessels. Riverbed bathymetry of both the Fraser River South Arm and Deas Slough is fairly uniform close to the Tunnel construction site; therefore mean sound levels are not expected to vary substantially across the channels.

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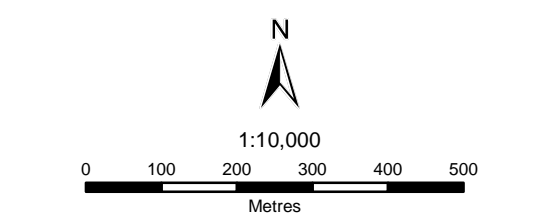


Legend

- Underwater Noise Sampling Location
- Project Alignment
- Municipal Boundaries
- Waterbody
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| UNDERWATER NOISE SAMPLING LOCATIONS | |
| Figure 4.3-1 | 13/05/2016 |
| | |

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on underwater noise were established based on the potential for the construction phase of the Project to interact with and have an effect on underwater noise. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, the construction phase of the Project includes components and activities that could interact with and affect underwater noise; therefore, the following temporal boundaries were defined for underwater noise assessment:

- Existing conditions
- Construction phase (including decommissioning of the Tunnel)
- Operations phase (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of Proposed Project**.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on underwater noise have been identified; therefore, no administrative boundaries are defined.

Technical Boundaries

Due to logistical considerations, underwater noise sampling locations were placed away from the marine traffic routes, closer to the riverbanks. This is not expected to influence the baseline measurements, since mean ambient noise levels are not expected to vary substantially across the width of the channel at either of the sampling locations.

4.3.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing underwater noise conditions within the assessment area. An overview of the regulatory context for management of underwater noise as relevant to the Project is also provided. A brief overview of acoustic fundamentals and terminology that is relevant to the discussion of underwater noise is presented below.

Acoustic Fundamentals and Terminology

The terms noise level and sound level refer to sound pressure level (SPL)¹. As sound volume increases, there is a logarithmic increase in noise level. Therefore, to adequately express the very large range of pressure fluctuations, SPL is expressed on a logarithmic scale in decibels (dB), where an increase in sound energy by a factor of 10 corresponds to a 10 dB increase in sound level.

Several acoustic metrics are typically used to characterize the SPL of underwater sounds. These metrics, which may be presented in the form of graphs, tables, or maps, include root mean square (rms) SPL, peak SPL, and Sound Exposure Level (SEL).

The time-average sound pressure (expressed as rms SPL) quantifies the average pressure in a given time window of noise. The maximum instantaneous sound pressure is expressed as peak SPL. The total sound exposure, expressed as SEL, measures the total sound energy contained in one or more sound pulses.

4.3.2.1 Baseline Data Collection

To measure baseline underwater noise levels prior to any Project construction activities, an Autonomous Multichannel Acoustic Recorder (AMAR; JASCO Applied Sciences) was deployed in the Fraser River South Arm channel (ST1; **Figure 4.3-1**) and in Deas Slough (ST2; **Figure 4.3-1**) from May 9 to 11, 2014. The AMAR was precisely calibrated to accurately measure noise levels continuously for 48 hours over the frequency range of 10 to 64 kHz. The objective of measuring baseline noise levels was to provide a quantitative description of underwater ambient noise in the Project Area.

4.3.2.2 Regulatory Context

There are no regulatory thresholds for the management of underwater noise in Canada. Thresholds for marine mammals and fish recommended by the U.S. National Marine Fisheries Service (NMFS) and DFO have been adopted for this Project. These recommended thresholds are described below.

¹ SPL is equal to 10 times the logarithm of the square of the sound pressure, in units of Pascals, divided by the square of a standard reference sound pressure.

Auditory Injury Thresholds

Beyond certain thresholds, underwater noise has the potential to injure marine mammals and fish. Auditory injury thresholds, or the levels at which injury to hearing organs can occur, are provided in **Table 4.3-2** and **Table 4.3-3** and discussed in the following.

Based on a review of data on hearing, and physiological and behavioural responses of marine mammals to anthropogenic sound, Southall et al. (2007) proposed species-specific mathematical functions (referred to as M-weighting functions) to filter sounds so as to reduce the parts of the frequency spectrum that the species of interest do not hear well (**Table 4.3-2**). Harbour seals, Steller sea lions, and California sea lions, all of which are pinnipeds, are the main species of concern in the assessment area. The M-weighting function specific to pinnipeds has been applied in this analysis. Southall et al. (2007) recommended dual thresholds for auditory injury based on peak SPL and M-weighted 24-hour SEL (i.e., the total sound exposure level for animals exposed to sounds generated in a 24-hour period).

The U.S. National Marine Fisheries Service (NMFS) has applied an auditory injury threshold for pinnipeds based on the rms SPL of a single pulse (**Table 4.3-2**).

Table 4.3-2 Auditory Injury Thresholds for Pulsed Sounds from the U.S. National Marine Fisheries Service (NMFS) and Southall et al. (2007) for Pinnipeds in Water

| NMFS Level A Take Threshold rms SPL (dB re 1 µPa) | Southall et al. (2007) Peak SPL Threshold (dB re 1 µPa) | Southall et al. (2007) M-weighted 24-Hour SEL Threshold (dB re 1 µPa ² s) |
|---|---|--|
| 190 | 218 | 186 |

Note: dB re 1 µPa = Units for decibels for underwater noise

Table 4.3-3 summarizes the Interim Criteria for Injury to Fish from Pile Driving Activities (AIP) developed by the U.S. Fisheries Hydroacoustic Working Group (FHWG 2008) and Fisheries and Oceans Canada (DFO) (B.C. MPDCA 2003).

Table 4.3-3 FHWG (2008) and DFO (B.C. MPDCA 2003) Auditory Injury Thresholds for Fish

| Reference | Peak SPL (dB re 1 µPa) | SEL (dB re 1 µPa ² s) |
|-----------------------|------------------------|----------------------------------|
| FHWG (2008) fish ≥2 g | 206 | 187 |
| FHWG (2008) fish <2 g | 206 | 183 |
| DFO (2003) fish | 210 | - |

Behavioural Disturbance Criteria

For marine mammals, the area of potential disturbance is often taken as the zone where underwater noise levels exceed 120 dB rms SPL (NOAA 2015, Southall 2007). Behavioural disturbance, however, is complex and depends on factors such as exposure duration, noise source type, habituation, and exposure context.

Underwater noise does not have the potential to cause behavioural effects when it falls below the background ambient noise level.

4.3.2.3 Existing Conditions

Characterization of existing conditions of underwater noise within the study area is based on the results of the underwater acoustic field measurements. The ambient measurements from acoustic recordings show that shipping traffic is the dominant source of variability in the data above 100 Hz frequency band in the Fraser River South Arm (**Appendix A, Figure 1**) and above 1,000 Hz in Deas Slough (**Appendix A, Figure 2**).

Constant machinery noise, possibly originating from shore, is present in the background of the recordings. For both monitoring locations, a small number of relatively high-amplitude noise events (e.g., passing vessels) contribute most of the sound energy. Intermittent low-frequency (less than 50 Hz) noise was observed at both recording locations during two six-hour periods. The source of this low frequency noise could not be identified.

Distributions of the total SPL measured over a wide frequency range (broadband sound levels) in the Fraser River South Arm and in Deas Slough are presented in **Table 4.3-4**. Ambient measurements in the Fraser River South Arm exceed 120 dB re 1 μPa^2 , 20% of the time. The higher sound levels are primarily due to larger vessels, such as tugs and container ships, transiting the river. Ambient measurements in Deas Slough are substantially lower than in the main channel because vessel traffic in the slough consists primarily of smaller, slow-moving boats transiting to and from the marinas.

Table 4.3-4 Existing Distribution of the Broadband Sound Levels Measured in the Fraser River South Arm and Deas Slough

| Sampling Location | 5% Exceedance Level (dB re 1 μPa) | Median Level (dB re 1 μPa) | 95% Exceedance Level (dB re 1 μPa) |
|------------------------|---|--|--|
| Fraser River South Arm | 126.6 | 108.7 | 93.6 |
| Deas Slough | 99.3 | 91.9 | 82.4 |

² dB re 1 μPa is the standard unit of decibel measurement for underwater noise.

4.3.3 Potential Effects

This section provides a summary of anticipated changes to underwater noise related to the construction and operation of the Project. It also describes the methodology used to assess potential Project-related effects.

4.3.3.1 Project Interactions

A preliminary review of the potential effects of Project interactions on underwater noise, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: Key Project-related construction activities with the potential to interact with underwater noise include the following:

- On shore ground improvements and pile driving for the new bridge piers.
- Localized in-stream ground improvement and pile installation for the clear span over Deas Slough.
- Removal of the four central Tunnel segments.
- Transportation of Tunnel segments for offsite recycling.

Operation: As the new bridge will have a clear span across the Fraser River South Arm, Project activities (including routine maintenance) are expected to have minimal influence on underwater noise.

An overview of potential interactions between Project activities and underwater noise during the construction and operation of Project components is provided in **Appendix B**.

4.3.3.2 Potential Effects

Project effects on underwater noise were assessed by modelling the expected underwater noise levels generated by Project activities. An overview of the underwater acoustic modelling that was completed is presented in this section. Further detail, including construction activities selected for modelling and the rationale for the selection, assumptions made regarding construction scenarios, equipment types, and source noise levels are provided in the technical volume, **Underwater Noise Modelling Study** included under **Section 16.3**.

The Marine Operations Noise Model was used to estimate the underwater sound levels associated with the following Project activities:

- Scenario 1: Pile driving along the edge of Deas Slough
- Scenario 2: Vibratory installation of piles along the edge of Deas Slough
- Scenario 3: Vibrodensification along the edge of Deas Slough
- Scenario 4: Cutter suction dredging to remove sediment overlying the Tunnel
- Scenario 5: Tug and barge activity when Tunnel segments are being removed
- Scenario 6: Simultaneous removal of sediment and riprap, and tug and barge activity during Tunnel removal

The results of the Marine Operations Noise Model were used to generate visual maps of peak SPL, rms SPL, and SEL for each of the six scenarios. The reported sound levels were applied as the maximum levels over all depths that were modelled.

Potential Effects

Human-generated noise, referred to as anthropogenic noise, is commonly categorized as pulsed or non-pulsed sounds. Pulsed sounds are brief (less than few seconds) and intermittent, with rapid changes of sound pressure (e.g. an impact-hammer strike). Non-pulsed sounds are characterized by gradual changes in sound pressure over time (e.g., marine vessels transiting and a vibratory pile driver in operation).

Effects from Pulsed Noise Sources

The highest level of pulsed noise is anticipated to be generated by pile driving along the edge of Deas Slough. Results of underwater noise modelling of the scenario involving 100 minutes (3,500 blows) of impact pile-driving along the edge of Deas Slough indicate that the potential extent of acoustic injury zone (defined by the two FHWG SEL threshold criteria, FHWG 2008) associated with this activity will be within 700 m for fish weighing less than two grams, and approximately 600 m for fish weighing two grams or more. Modelling results also indicate that underwater noise levels generated by the modelled scenario would be lower than the thresholds recommended for preventing auditory injury in pinnipeds, as per Southall et al. (2007), beyond 600 m from the source. These predictions are considered conservative because in arriving at them, the model assumes that the receiver (i.e., fish or marine mammal) is stationary for the duration of the sound exposure. Avoidance behaviour by marine mammals and fish would lessen their overall sound exposure and thus reduce the duration of time they would spend in the injury zone for impact pile-driving.

The modelling scenario assumed pile driving along the edge of Deas Slough through a maximum water depth of five metres, which corresponds to a high tide. Much of the actual Project-related construction along the edge of Deas Slough would occur under lower water conditions or in the dry with low tide. As such, actual underwater noise levels generated by pulsed sources associated with Project construction are expected to be lower than the values predicted through modelling.

Effects of Non-Pulsed Noise Sources

Of the non-pulsed noise sources modelled, cutter suction dredging was found to generate the highest levels of underwater noise. The extent within which the behavioural disturbance threshold for marine mammals (120 dB re 1 μ Pa SPL zone) was reached was smallest (0.44 km) for tug and barge activities associated with crane lift of the Tunnel segments. Noise generated by tug and barge traffic associated with the Project was found similar to existing ambient noise levels in the Fraser River South Arm, where the behavioural disturbance threshold for marine mammals is exceeded 20% of the time, primarily due to larger vessels such as tugs and container ships transiting in the river. Of the non-pulsed noise sources modelled, a combination of cutter suction dredging, rip rap removal, and tug and barge operations was found to create the largest zone (3.45 km) where the behavioural disturbance threshold for mammals is exceeded.

Although vibratory pile driving was identified as the source of highest level of non-pulsed noise, modelling results indicated that noise from this activity was concentrated at low frequencies (< 200 Hz), which dissipate rapidly in the shallow sediments of Deas Slough, confining the zone where the marine mammal behavioural disturbance threshold is reached to a relatively small (0.6 km) extent within Deas Slough.

Sound is strongly attenuated in shallow water such as Deas Slough because of increased bottom loss due to absorption of sound energy by sediments. Furthermore, bottom loss is enhanced by soft sediments such as silt and clay, which are more absorptive than harder materials like sand and gravel. As a result, noise from construction activities is expected to attenuate more rapidly with distance in Deas Slough than in the Fraser River South Arm. In Deas Slough, sound propagation is further restricted by Deas Island and the surrounding riverbank.

4.3.4 Mitigation Measures

A hierarchical approach, based on avoidance of potential effects followed by minimization or reduction of unavoidable effects, was used in identifying strategies to mitigate potential Project-related effects on underwater noise.

Measures to avoid potential effects have been/will be incorporated into project considerations such as site and route selection, scheduling, design, and construction and operation procedures and practices. Where potential effects cannot be avoided through project considerations, standard mitigation measures, best management practices (BMP), and construction and operational environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels. These measures are described in general terms below.

4.3.4.1 Avoidance

The new bridge will span the Fraser River from bank to bank without the need for any permanent works below the high water level. This approach has been taken to avoid, as much as possible, Project-related effects on the river and sloughs, including generation of underwater noise during construction and operation. Similarly, a clear span is proposed over Deas Slough as well.

Propagation of underwater noise from activities such as driving piles along the edges of Deas Slough, which are the primary sources of Project-related underwater noise, can be mitigated effectively by avoiding undertaking them in water. Scheduling such activities during periods of low tide, when work can be completed under shallow water conditions or in the dry, is expected to minimize potential effects on underwater noise.

4.3.4.2 Minimization

In instances where avoidance of underwater noise propagation cannot be achieved through scheduling, environmental protection measures will be implemented to avoid or minimize the effect of Project-related change in underwater noise conditions on receptors (fish and marine mammals). These measures, which will involve monitoring and mitigation of underwater noise, will be outlined in a Marine Mammal Management Plan included under the Construction Environmental Management Plan (CEMP) for the Project as described in **Section 12.0 Management Plans**.

The Marine Mammal Management Plan will include a description of standard best practices and mitigation measures that will be implemented to minimize the effects of underwater noise generated during marine-based construction activities. Mitigation and monitoring measures for underwater noise described in the plan will include, but will not be limited to:

- Limited use of engines and propellers on stationary vessels, whenever possible.
- Maintaining consistent navigation courses and speeds.
- Conducting land-based pile driving whenever possible.
- Conducting activities with the potential to generate underwater noise as efficiently as possible.
- Avoiding unnecessary idling of marine-based equipment.
- Implementation of marine mammal monitoring during activities anticipated to generate underwater noise, including an underwater noise monitoring program.
- Underwater noise monitoring conducted during Project construction activities that have the potential to generate underwater sound levels that may exceed auditory thresholds that can cause physical injury to fish or marine mammals.

Underwater noise monitoring will be conducted using a hydrophone at the onset of pile driving activities to confirm the results of this assessment and ensure underwater noise levels do not exceed auditory injury thresholds as described in **Section 4.3.2.2**. If warranted by the results of monitoring, additional mitigation measures (e.g., bubble curtains or sound-damping sleeves) will be deployed.

Measures identified above are standard best practices proven to be effective in managing underwater noise levels during in- or near-water construction. Specific mitigation measures such as deployment of bubble curtains and sound-damping sleeves are proven techniques shown to reduce underwater pile driving sound levels by 10 dB or more (ICF Jones and Stokes, and Illingworth and Rodkin Inc. 2009).

4.3.5 Residual Effects

As discussed in **Section 4.3.3.1**, the new bridge will have a clear span across the Fraser River South Arm and Deas Slough, and post-construction activities (including routine maintenance) are expected to have minimal influence on underwater noise. Therefore, no residual adverse effects on underwater noise are expected post construction.

Implementation of mitigation measures during pile driving, as discussed in **Section 4.3.4**, including construction scheduling that allows noise-generating activities to be undertaken in shallow water or in the dry, are expected to avoid or minimize the potential to generate pulsed sounds at levels capable of inducing auditory injury in marine mammals and fish.

In-water construction activities, specifically those associated with Tunnel decommissioning, are expected to generate temporary, localized increases in non-pulsed noise levels during Project construction. Implementation of mitigation measures discussed in **Section 4.3.4** are expected to minimize the potential to generate underwater noise levels above the baseline condition.

Unavoidable temporary construction-related effects on underwater noise are categorized as follows, and characterized below in terms of the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of the effect:

- Residual effect #1: Effects from pulsed noise sources (e.g. impact pile driving)
- Residual effect #2: Effects from non-pulsed noise sources (e.g. removal of Tunnel segments and overlying material)

Definitions for ratings applied to residual effects criteria, developed with specific reference to underwater noise, are presented in **Table 4.3-5**. Summary of criteria ratings for the potential residual effects is provided in **Table 4.3-6** and **Table 4.3-5**. Context for the characterization of the residual effect, i.e. sensitivity/resilience of underwater noise conditions to potential Project-related effects, based on existing conditions, is also provided. Given the close link between Potential Project-related changes in underwater noise conditions and effects on receptor VCs—i.e. fish and fish habitat, and marine mammals—characterization of residual effects is presented in the context of their influence on receptor VCs. Specifically, the magnitude of potential residual effects is discussed in terms of potential for increase in underwater noise levels to cause behavioural disturbance or auditory injury in fish or marine mammals.

Table 4.3-5 Criteria Used to Characterize Residual Effects on Underwater Noise

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|--|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project. |
| | | Positive | Beneficial effect as a result of the Project. |
| | | Neutral | Neutral effect as a result of the Project. |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible | No measurable change in underwater noise level |
| | | Low | A measurable change within natural variability, and not expected to affect receptor VCs (i.e. fish and marine mammals) |
| | | Moderate | A measurable change outside the range of natural variability, but not expected to result in substantive effects on receptor VCs. |
| | | High | A measurable change outside the range of natural variability and potentially harmful to receptor VCs. |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project alignment. |
| | | Local | Effect is restricted to the LAA. |
| | | Regional | Effect extends beyond the LAA |
| Duration | Length of time over which the residual effect is expected to persist | Short term | Effect occurs for a limited period during Project construction and does not persist beyond several hours at a time. |
| | | Moderate term | Effect persists over a period of days to weeks during construction. |
| | | Long term | Effect persists beyond construction phase, or Change is permanent. |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor affects the IC) | Rare | Effect occurs for a limited number of times during Project construction or operation. |
| | | Uncommon | Effect occurs intermittently during Project construction or operation. |
| | | Frequent | Effect occurs frequently during Project construction or operation. |
| | | Continuous | Effect occurs continuously during Project construction or operation. |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Baseline conditions will be naturally restored after disturbance has ceased. |
| | | Irreversible | Baseline conditions will not be naturally restored after disturbance has ceased. |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance. |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 10%. |
| | | Moderate | Likelihood of residual effect is between 10% and 25%. |
| | | High | Likelihood of residual effect is greater than 25%. |

4.3.5.1 Residual Effect #1: Effects from Pulsed Noise Sources

After implementing mitigation measures discussed in **Section 4.3.4**, potential impact pile driving along the edges of Deas Slough is not expected to expose fish or marine mammals to pulsed noise levels capable of inducing auditory injury. Nonetheless, residual pulsed noise at lower levels (including sediment-borne vibration) has the potential to temporarily cause behavioural disturbance and mask sounds used for foraging and communication of marine mammals and fish. **Table 4.3-6** presents a summary of the criteria ratings for this residual effect.

Table 4.3-6 Criteria Ratings for Construction-related Effects from Pulsed Noise Sources

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Noise-generating construction activities (specifically pile driving) near the shoreline have the potential to result in a temporary increase in underwater noise levels. |
| Magnitude | Moderate | Majority of noise-generating activities near the shoreline are expected to be undertaken in shallow water or in the dry. With monitoring and mitigation, the resulting changes will be below levels that injure fish or marine mammals. |
| Extent | Local | Spatial extent will be restricted to the LAA. |
| Duration | Short term | Effect will occur only during specific noise-generating construction activities undertaken in water, and is not expected to persist beyond the duration of such activities. |
| Frequency | Rare | Effect will occur only in the rare instance where undertaking a noise-generating activity in water cannot be avoided through management of the construction schedule. |
| Reversibility | Reversible | Underwater noise conditions will return to baseline conditions as soon as the contributing activity ceases. |
| Likelihood | Low | Noise-generating activities near the shoreline are expected to be undertaken in shallow water or in the dry, during low tides, minimizing the probability of a measurable change in underwater noise. |

4.3.5.2 Residual Effect #2: Effects from Non-Pulsed Noise Sources

In-water activities associated with construction, including removal of Tunnel segments and overlying material, and vibrodensification, will add to underwater noise levels in the river. Noise from these activities has the potential to cause behavioural disturbance and mask sounds used for foraging and communication of marine mammals and fish. **Table 4.3-7** presents a summary of the criteria ratings for this temporary, construction-related residual effect.

Table 4.3-7 Criteria Ratings for Effects from Non-Pulsed Noise Sources

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|--|
| Direction | Adverse | Noise-generating construction activities in or immediately adjacent to water have the potential to result in a temporary increase in underwater noise levels. |
| Magnitude | Low to Moderate | Noise from construction activities are expected to be temporary and localized, and fall within the present range of sound levels generated by vessel traffic in the river. |
| Extent | Local | Spatial extent will be restricted to the LAA. |
| Duration | Short term | Effect will occur only during specific noise-generating construction activities undertaken in water, and is not expected to persist beyond the duration of such activities. |
| Frequency | Uncommon | Effect will occur only during specific noise-generating construction activities undertaken in water, including removal of Tunnel segments and overlying material, and vibrodensification |
| Reversibility | Reversible | Underwater noise conditions will return to baseline conditions as soon as the contributing activity ceases. |
| Likelihood | High | There is estimated to be a greater than 25% probability that a measurable change in underwater noise will occur during in-water construction and Tunnel decommissioning activities. |

Context: The Fraser River South Arm is an active marine transportation corridor, and existing underwater noise levels in the Project area, dominated by noise from vessels transiting the river, are relatively high. Sensitivity of underwater noise conditions in the river to temporary, short-term changes resulting from in-water construction activities, including Tunnel decommissioning, is therefore considered to be low.

When examining the characteristics of residual effects of construction, including Tunnel removal, on underwater noise, it is important to appreciate that the characterization criteria as discussed above are applied to underwater noise as an IC. Characterization of potential effects of changes in underwater noise conditions on receptor VCs is included in the respective VC effects assessment sections (i.e. **Section 4.4 Fish and Fish Habitat** and **Section 4.6 Marine Mammals**).

4.3.6 Cumulative Effects Assessment

Where Project-related construction results in a temporary, short-term increase in underwater noise levels in the Fraser River South Arm, Deas Slough, or Green Slough, such changes are not anticipated to overlap spatially or temporally with other projects or activities and result in cumulative effects.

4.3.7 Follow-up Strategy

Underwater noise monitoring will be conducted using a hydrophone at the onset of pile driving activities to confirm the results of this assessment and ensure underwater noise levels do not exceed applicable auditory injury thresholds for marine mammals and fish.

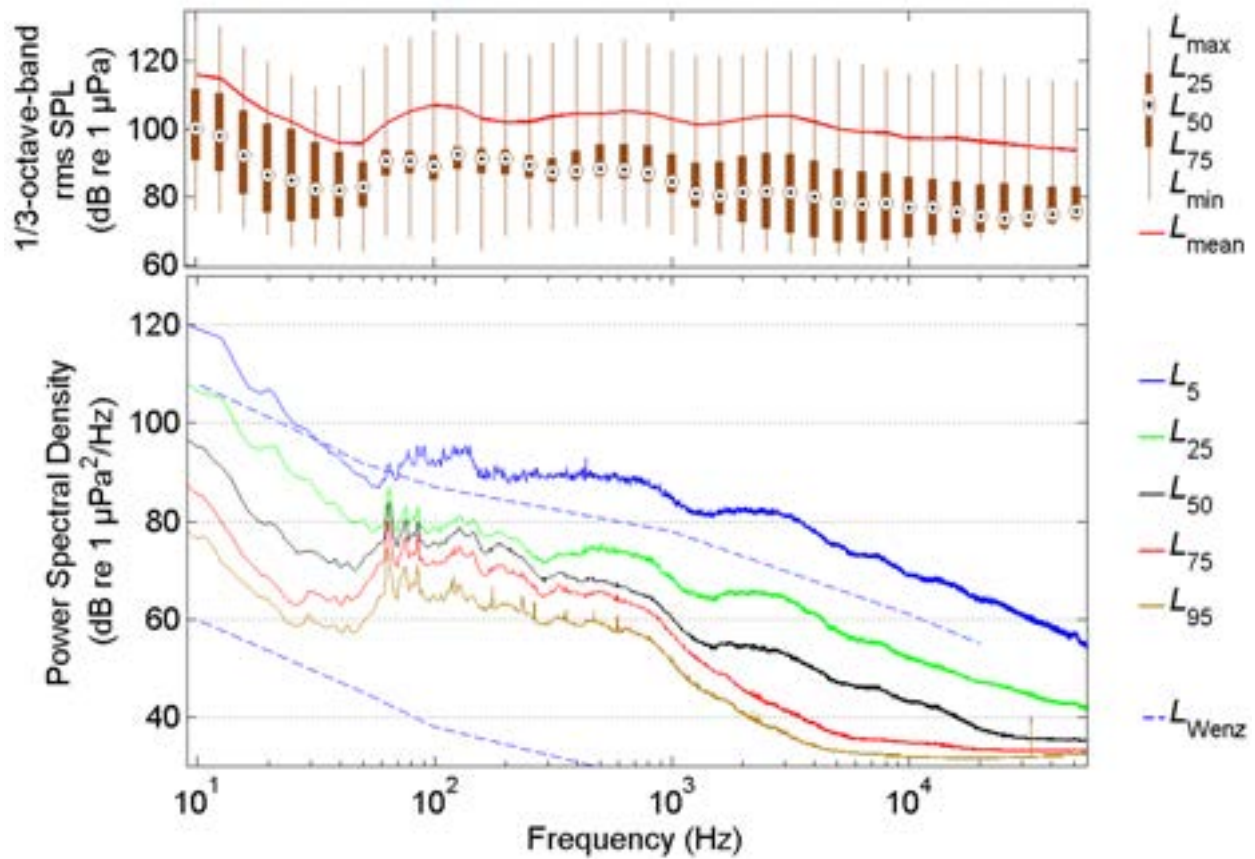
No post-construction underwater noise monitoring or follow-up is proposed as no potential Project-related effects on underwater noise is anticipated after completion of construction.

4.3.8 References

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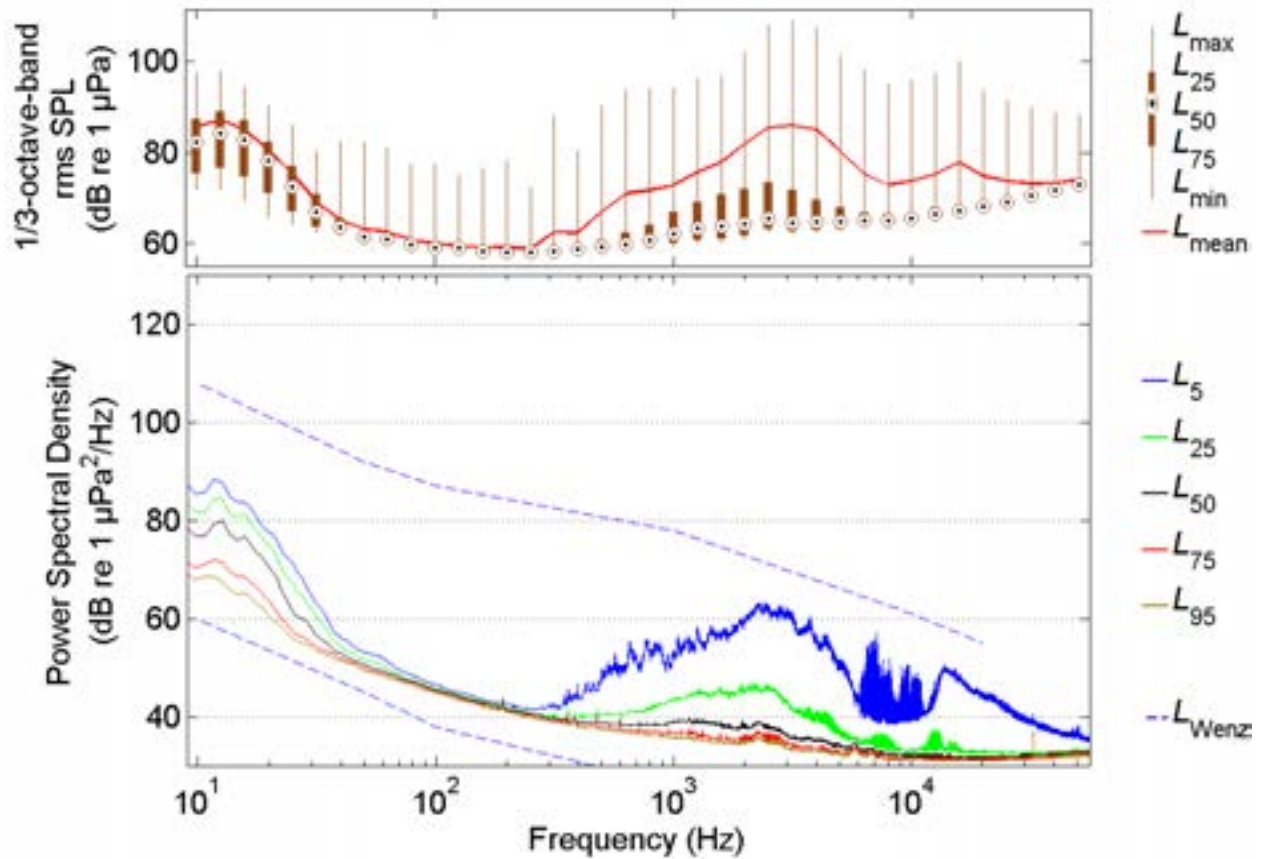
APPENDIX A

Statistical Distribution of Ambient Noise Measured in the Fraser River South Arm and Deas Slough



Notes: Top: The boxes indicate the first (25%), second (50%), and third (75%) quartiles. The red line indicates the linear mean. Bottom: The N th percentile corresponds to the sound level that was exceeded by $N\%$ of the data.

Figure 1 Station 1, Fraser River South Arm. Top: Statistics of 1/3-octave-band rms Sound Pressure Levels (1-minute average) over a 24-hour Recording Period. Bottom: Exceedance Percentiles of Ambient Noise Power Spectral Density Levels (1-minute Average) over the Recording Period.



Notes: Top: The boxes indicate the first (25%), second (50%), and third (75%) quartiles. The red line indicates the linear mean. Bottom: The Nth percentile corresponds to the sound level that was exceeded by N% of the data.

Figure 2 Station 2, Deas Slough. Top: Statistics of 1/3-octave Band rms Sound Pressure Levels (1-minute Average) over the 24-hour Recording Period. Bottom: Exceedance Percentiles of Ambient Noise Power Spectral Density Levels (1-minute Average) over the Recording Period.

APPENDIX B

Overview of Potential Project Interactions with Underwater Noise

Table 1 Overview of Potential Project Interactions with Underwater Noise

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|--|
| Pre-Construction / Site Preparation | | | |
| Pre-Construction / Site Preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Installing temporary drainage structures and diversions • Relocating utilities • Preloading for embankment and highway construction • Acquiring property for the Project | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Conducting additional site investigations (i.e., a geotechnical drilling program) | <p>Nature of interaction: Works and activities within or along the shores of the Fraser River South Arm, Deas Slough, and Green Slough.</p> <p>Rationale: Activities not expected to have an effect on underwater noise.</p> |
| | Potential Effect | <ul style="list-style-type: none"> • Installing temporary bridges and barging facilities | <p>Nature of interaction: Works and activities within or along the shores of the Fraser River South Arm.</p> <p>Rationale: If activities include in-river construction, some level of underwater noise may be generated.</p> |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|--|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • Ground improvements associated with new bridge piers • Hoisting pre-assembled deck segments from barges in the river or land-based transport system | <p>Nature of interaction: Activities with the potential to interact underwater noise.</p> <p>Rationale: Activities not expected to have an effect on underwater noise.</p> |
| | Potential Effect | <ul style="list-style-type: none"> • Installing piers adjacent to Deas Slough and Green Slough, including pile installation | <p>Nature of interaction: Localized ground improvements and pile installation at the edge of Deas Slough.</p> <p>Rationale: Noise could be propagated to water through sediment-borne vibration.</p> |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|---|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> N/A | N/A |
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> Backfilling of onshore portions of Tunnel approaches | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: All activities to be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> Removing electrical/mechanical/utilities equipment from the Tunnel | <p>Nature of interaction: Potential for interaction.</p> <p>Rationale: All activities are enclosed in the existing Tunnel and have low potential for noise.</p> |
| | Potential Effect | <ul style="list-style-type: none"> Removing of four Tunnel segments and associated scour protection Transporting Tunnel elements for offsite recycling and operating support vessels for that activity | <p>Nature of interaction: Dredging, tug and barge operations and removal of rip rap.</p> <p>Potential Project-related effects include: Disturbance to fish and mammals.</p> |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|--|
| Decommissioning of Deas Slough Bridge | No interaction | <ul style="list-style-type: none"> • N/A | Nature of interaction: No interaction anticipated. |
| | No effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | Nature of interaction: Removal of bridge including substructures with limited instream activities and low potential for underwater noise generation. Potential Project-related effects include: none. |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | N/A |
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | Nature of interaction: No interaction anticipated. Rationale: Proposed activities will be land-based. |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-----------------------------|------------------------|---|--|
| New bridge | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • Operating the new bridge • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | Nature of interaction: No interaction anticipated. Rationale: Proposed activities will be land-based. |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | N/A |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.4 Fish and Fish Habitat Assessment Highlights:

- The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat.
- The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, resulting in a net environmental benefit for fish and fish habitat.
- Mitigation, including timing windows for undertaking in-stream works and other measures outlined in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed.
- Given the disturbed nature of much of the Project alignment, revegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by:
 - Improvements to local water quality through Project-related improvements in stormwater management
 - Removal of non-native species
 - Replanting with species that provide habitat value for fish and wildlife.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

4.4 Fish and Fish Habitat Assessment

This section presents the results of the assessment of potential Project effects on fish and fish habitat and includes the rationale for selecting fish and fish habitat as a valued component (VC), identification of Project-related effects, proposed approaches to mitigation, and evaluation of residual Project-related and cumulative effects. Monitoring to be conducted with respect to fish and fish habitat is also described.

Project-related changes in other environmental components along the pathway of effects of the Project—specifically, river hydraulics and morphology, sediment and water quality, and underwater noise—have the potential to affect fish and fish habitat. These intermediate components (ICs) and potential effects of the Project on them are discussed in the following sections: **Section 4.1 River Hydraulics and River Morphology**, **Section 4.2 Sediment and Water Quality**, and **Section 4.3 Underwater Noise**.

4.4.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on fish and fish habitat in terms of Project setting, and defines the assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

4.4.1.1 Assessment Context

The lower Fraser River and estuary provide habitat for fish species of high ecological, social, cultural, and commercial value. Fish species important to the viability of commercial, recreational, and Aboriginal (CRA) fisheries¹ include salmonids (family Salmonidae), eulachon (*Thaleichthys pacificus*), and sturgeon (*Acipenser* spp.). Salmonids use the lower Fraser River during adult spawning migration, and juvenile outmigration to marine environments. Juvenile salmonids and sturgeon rear and overwinter in brackish habitats. Eulachon migrate upstream to spawning habitats in the lower Fraser River and the mouths of large tributaries. Additional information supporting the selection of fish and fish habitat as a VC is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.4.1.2 Methodology

The assessment of fish and fish habitat follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Building on this approach, the assessment of fish and fish habitat was designed to focus on specific species considered most appropriate in the context of existing conditions in the Project alignment. In this context, the assessment of fish and fish habitat focuses on five sub-components as presented in **Table 4.4-1**. Life history requirements and status of sub-components are summarized in **Section 4.4.2.3** and described in detail in the technical volume, ***Fish and Fish Habitat Study*** included under **Section 16.4**.

¹ As defined under the *Fisheries Act* R.S.C. 1985, c. F-14 (as amended on February 26, 2015), “commercial” in relation to a fishery, means that fish is harvested under the authority of a licence for the purpose of sale, trade or barter; “recreational”, in terms of a fishery, means that fish is harvested under the authority of a licence for personal use of the fish or for sport; and “Aboriginal”, in relation to a fishery, means that fish is harvested by an Aboriginal organization or any of its members for the purpose of using the fish as food, for social or ceremonial purposes or for purposes set out in a land claims agreement entered into with the Aboriginal organization;

Table 4.4-1 Sub-components for Fish and Fish Habitat

| Sub-component | Rationale for Selection |
|--|--|
| Salmon Chinook salmon Chum salmon Coho salmon Pink salmon Sockeye salmon | Pacific salmon are important to Aboriginal Groups and are also harvested commercially and recreationally. Pacific salmon and their habitat are managed by DFO under the <i>Fisheries Act</i> and are listed within the B.C. Conservation Framework with a goal of preventing the species from becoming at risk. |
| Sturgeon Green sturgeon White sturgeon | Sturgeon are protected under the <i>Fisheries Act</i> and are of traditional importance to Aboriginal Groups. White sturgeon support a Fraser River catch-and-release recreational fishery. They are also important for conservation. White and green sturgeon are listed as Endangered and of Special Concern, respectively, under SARA Schedule 1, and both are provincially Red-listed. |
| Eulachon | Eulachon are protected under the <i>Fisheries Act</i> and are of traditional importance to Aboriginal Groups. Eulachon are also important for conservation as they are provincially Blue-listed and designated as Endangered by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC). |
| Trout Coastal cutthroat trout Rainbow/steelhead trout | Trout are protected under the <i>Fisheries Act</i> , are of importance to Aboriginal Groups, and support recreational fisheries in the Fraser River. Coastal cutthroat trout are also important for conservation as they are provincially Blue-listed. |
| Char Dolly Varden Bull trout | Char are protected under the <i>Fisheries Act</i> and are of traditional importance to Aboriginal Groups. Char support recreational fisheries in the Fraser River. Bull trout are also important for conservation as they are provincially Blue-listed and designated as Special Concern by COSEWIC. |

Likelihood of injury or mortality, and change in habitat conditions were used as indicators to assess fish and fish habitat trends within the assessment area and evaluate potential Project-related effects. The indicators chosen for the assessment of Project-related effects on fish and fish habitat and the rationale for their selection are presented in **Table 4.4-2**.

Table 4.4-2 Indicators for Fish and Fish Habitat

| Indicator | Rationale for Selection |
|---|--|
| Likelihood of injury or mortality of fish | <p>This indicator will be used to assess Project-related physical injury or direct mortality to fish.</p> <p>Causing death of fish is prohibited under the <i>Fisheries Act</i> based on the definition of serious harm to fish.</p> <p>Killing or harming of listed fish species is prohibited under <i>SARA</i>.</p> |
| Total suspended solid (TSS) levels (mg/L) and Turbidity (nephelometric turbidity units (NTU)) | <p>This indicator will be used to assess the potential for physical injury or direct mortality to fish resulting from elevated TSS levels, and changes in fish habitat quality from induced turbidity.</p> <p>Increase in TSS and turbidity levels will be evaluated against Canadian Council of Ministers of the Environment (CCME) <i>Water Quality Guidelines for the Protection of Aquatic Life</i> (CCME 2002) and B.C. <i>Approved Water Quality Guidelines 2006 Edition</i> (B.C. MOE 2006a).</p> |
| Underwater sound levels (SPL _{peak} and SEL _{cum}) | <p>This indicator will be used to assess Project-related physical injury (including direct mortality) to fish, and changes in fish habitat quality associated with elevated underwater sound levels.</p> <p>Increase in underwater sound levels will be evaluated against the Fisheries Hydroacoustic Working Group (2008) thresholds and the B.C. Marine and Pile Driving Contractors Association (2003) thresholds, as recommended by DFO.</p> |
| Loss of habitat area (ha) | <p>This indicator will be used to assess Project-related changes in habitat availability.</p> <p>Permanent alteration or destruction of fish habitat is defined and governed under the <i>Fisheries Act</i>, based on the definition of serious harm to fish.</p> |

4.4.1.3 Assessment Boundaries

Spatial and temporal boundaries identified for the assessment of Project-related effects on fish and fish habitat and the rationale for selecting them are discussed below. No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on fish and fish habitat, or accessibility constraints or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore administrative and technical boundaries have not been defined for this VC and are not discussed further.

Spatial Boundaries

The local assessment area (LAA) and regional assessment area (RAA) for fish and fish habitat are defined in **Table 4.4-3** and shown in **Figure 4.4-1**.

Table 4.4-3 Spatial Boundary Definitions for Fish and Fish Habitat

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local Assessment Area (LAA) | Fraser River South Arm extending from approximately the middle of Shady Island to 500 m upstream of the Project alignment, and Project alignment plus 30 m on either side of the Project alignment in upland areas. |
| Regional Assessment Area (RAA) | Section of the Fraser River South Arm (including Canoe Pass) extending from the river mouth to 1,000 m upstream of the Project alignment, and Project alignment plus 500 m on either side of the Project alignment in upland area. |

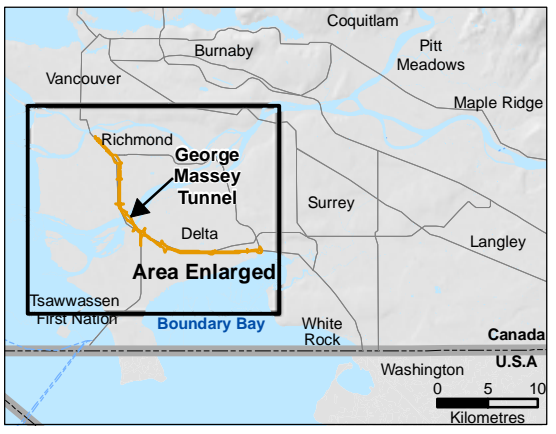
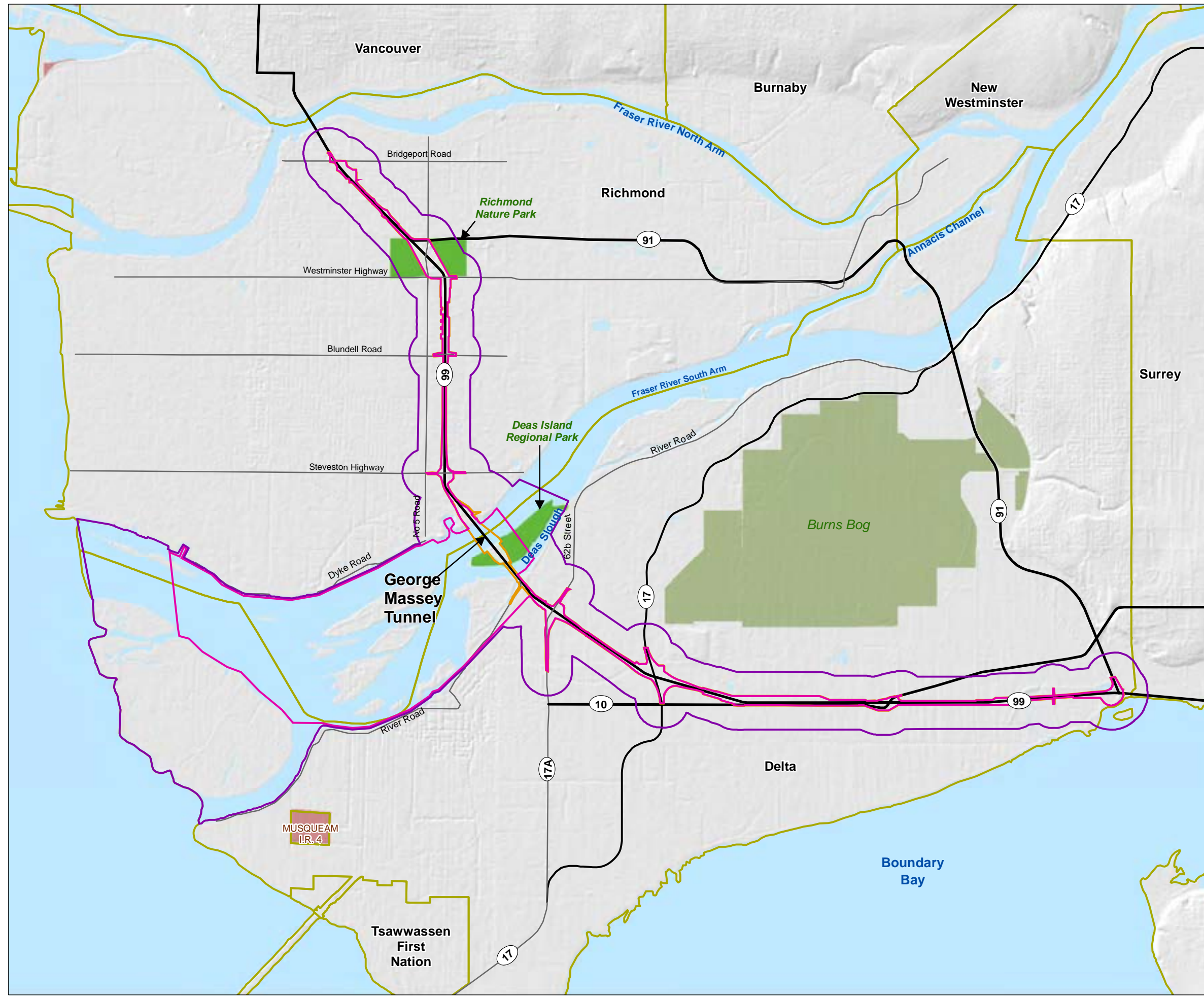
The LAA was established to encompass the area within which the Project is expected to most likely interact with, and potentially have an effect on, fish and fish habitat. In determining the LAA boundaries, consideration was given to the nature and characteristics of fish and fish habitat, potential exposure of fish and fish habitat to various influences (e.g., elevated total suspended solids (TSS), underwater noise), and the maximum extent of potential Project-related effects on fish and fish habitat.

The RAA was established to provide a regional context for the assessment of Project-related effects. The RAA was also established to encompass the area within which the residual effects of the Project on fish and fish habitat may combine with the effects of other projects and activities to result in potential cumulative effects.

Temporal Boundaries

The temporal boundaries for the assessment of fish and fish habitat include the existing conditions of the LAA and RAA, the Project construction phase (including decommissioning of the Tunnel), and the Project operations phase (i.e., the new bridge and upgraded highway in operation). Temporal characteristics of the Project’s construction phase, including decommissioning of temporary construction-related facilities, and the operations phase are defined in **Section 1.1 Description of Proposed Project**.

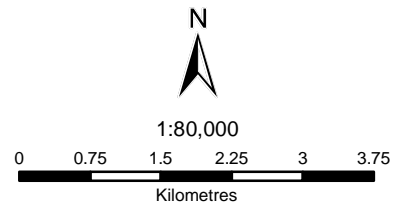
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- Legend**
- Fish and Fish Habitat Local Assessment Area
 - Fish and Fish Habitat Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|--|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| FISH AND FISH HABITAT LOCAL AND REGIONAL ASSESSMENT AREAS | |
| Figure 4.4-1 | 14/07/2016 |
| | |

Project-related construction activities are likely to occur during sensitive life periods of sub-components. For juvenile fish (e.g., Pacific salmon and white sturgeon), these life periods include rearing, foraging, and overwintering. For adult fish, sensitive periods include adult spawning migration (e.g., Pacific salmon and eulachon).

4.4.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of fish and fish habitat within the assessment areas. An overview of the regulatory context for management of fish and fish habitat as relevant to the Project is also provided.

4.4.2.1 Baseline Data Collection

In 2014, the Ministry initiated studies on fish and fish habitat to support Project planning and assessment. Building on available information, these studies were designed to address known data gaps. Desktop and field studies conducted with respect to fish and fish habitat are summarized in **Table 4.4-4**.

Table 4.4-4 Desktop and Field Studies Related to Fish and Fish Habitat

| Study Name | Purpose of Study |
|---------------------------|--|
| Desktop literature review | <ul style="list-style-type: none">• Determine fish habitat values and fish species use of watercourses within the study area• Identify key data gaps and areas of uncertainty within the study area |
| Freshwater fish sampling | <ul style="list-style-type: none">• Verify and update available information on fish species use of watercourses within the study area, focusing on data gaps |
| Fish habitat assessment | <ul style="list-style-type: none">• Assess the quality of fish habitat in watercourses within the study area, focusing on data gaps |

In addition, the results of modelling conducted to evaluate potential Project-related changes to river hydraulics and morphology (see **Section 4.1 River Hydraulics and River Morphology**) and underwater noise using a Marine Operations Noise Model (see **Section 4.3 Underwater Noise**) were used to assess potential effects of the Project on fish and fish habitat.

Information provided by Aboriginal Groups during pre-Application consultation has been provided, where applicable, in the discussion of existing conditions.

Given that existing conditions and trends of fish and fish habitat in the lower Fraser River are well-known, field sampling efforts focused on channelized watercourses along existing highway infrastructure (referred to hereafter as upland ditches, for sake of consistency) where fish presence and fish habitat values are less well studied and less documented. Fish and fish habitat sampling was conducted in watercourses that parallel or intersect the Highway 99 right-of-way (ROW) within the LAA. Descriptions of fish and water quality sampling, aquatic habitat assessment methods, data management and analysis are provided in the technical volume, ***Fish and Fish Habitat Study*** included under **Section 16.4**.

Based on the results of the desktop and field studies, watercourses within the LAA were classified for the purposes of this assessment based on CRA fisheries values as follows:

- Red: year-round habitat for CRA or listed fish species
- Dashed-red: seasonal (e.g., overwintering) habitat for CRA or listed fish species
- Orange: significant upstream source of food or nutrients to Red or Dashed-red habitat
- Yellow: non-CRA fish bearing and with no value to CRA or listed fish species
- Green: no value for fish (CRA, listed, or other fish species)

4.4.2.2 Regulatory Context

Regulation and management of fish and fish habitat in B.C. occurs primarily through the following federal and provincial legislation:

- Federal *Fisheries Act*, R.S.C. 1985, c. F-14 (as amended on February 26, 2015)
- Federal *Species at Risk Act (SARA)*, S.C. 2002, c. 29
- B.C. *Water Sustainability Act*, SBC 2014, c. 15
- B.C. *Wildlife Act*, RSBC 1996, c. 488

The *Fisheries Act*, administered by Fisheries and Oceans Canada (DFO), protects the ongoing productivity and sustainability of CRA fisheries. Any work, undertaking, or activity that results in serious harm to fish² that are part of, or support, CRA fisheries is prohibited. The *Fisheries Act* also prohibits the deposition of deleterious substances in water frequented by fish, unless authorized by regulations under the *Fisheries Act* or other federal legislation.

² The *Fisheries Act* defines “serious harm to fish” as “the death of fish or any permanent alteration to, or destruction of, fish habitat”. “Fish”, in turn, is defined as (a) parts of fish, (b) shellfish, crustaceans, marine animals and any parts of shellfish, crustaceans or marine animals, and (c) the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals.

DFO is responsible for the protection of fish and fish habitat, including fish species listed under SARA. At-risk fish species that occur in the vicinity of the Project include white sturgeon (*Acipenser transmontanus*; SARA Schedule 1: Endangered) and green sturgeon (*A. medirostris*; (SARA Schedule 1: Special Concern) (Government of Canada 2006). At present, Endangered and Special Concern status is being considered for Fraser River and central Pacific coast populations of eulachon (DFO 2014a), and south coast populations of bull trout (*Salvelinus confluentus*) (DFO 2014b), respectively.

Changes in and about a stream require notification or approval under Section 11 of the B.C. *Water Sustainability Act*, administered by the B.C. Ministry of Forests, Lands, and Natural Resource Operations (FLNR). Under this Act, the term “stream” applies to natural and manmade watercourses, including channelized streams and constructed ditches.

Enacted under Section 12 of the B.C. *Fish Protection Act*, the Riparian Area Regulations (RAR), outlines requirements for establishment of development setbacks from streams, lakes, and wetlands and applies to lands under the jurisdiction of municipalities. The Ministry’s ROW is exempt from the RAR, and the regulation does not apply directly to the Project.

The B.C. *Wildlife Act* provides for the conservation and management of wildlife populations (including fish) and habitat. The Act also provides for assignment of species and ecological communities at risk in B.C. to one of three lists (Red, Blue, Yellow) by the B.C. Conservation Data Centre (CDC) based on provincial Conservation Status Rank³. Further explanation regarding the assignment of Conservation Status Rank by the CDC to species and ecosystems at risk is provided in **Section 4.7 Vegetation**.

Provincially-listed fish species occurring in the vicinity of the Project include the Red-listed white sturgeon and green sturgeon, and the Blue-listed coastal cutthroat trout (*Oncorhynchus clarkii clarkii*).

³ Red-listed species and ecological communities are Extirpated, Endangered, or Threatened in B.C., Blue-listed species and ecological communities are of Special Concern, and Yellow-listed species are considered to be secure. The legal designation as Endangered or Threatened under the Act increases the penalties for harming a species and enables the protection of habitat in a Critical Wildlife Management Area.

4.4.2.3 Existing Conditions

Fish Habitat

Fraser River South Arm

The Project is located approximately 18 km upstream of the Fraser River mouth, within a section of the Fraser River South Arm that is influenced by a tidally-driven salt water wedge that penetrates near the river bottom (Kostaschuk 2002). Annual maintenance dredging occurs at several locations within the South Arm (FREMP 2006, PMV 2014). Downstream of New Westminster, the river has deepened in response to dredging, training, and confinement by bridges and dikes. Further information on the lower Fraser River hydraulics and morphology is provided in **Section 4.1 River Hydraulics and River Morphology**.

Shoreline of the Fraser River South Arm is characterized by extensive industrial activity. A high proportion of habitat, including that in the Project alignment, is classified as of low (green-coded) or moderate (yellow-coded) productivity (**Figure 4.4-2**; BIEAP - FREMP 2014). Productive (red-coded) shoreline habitat is generally confined to a narrow band of intertidal marshes, mud- and sand-flats around Tilbury and Annacis islands (**Figure 4.4-2**; BIEAP - FREMP 2014). With respect to shoreline conditions in the Fraser River South Arm, during pre-Application consultation, Aboriginal Groups expressed concern regarding lack of shade from trees or areas for juvenile salmon to hide. For a detailed description of the lower Fraser River shoreline habitats in the LAA, and their respective FREMP designations, refer to the technical volume, **Fish and Fish Habitat Study** included under **Section 16.4**.

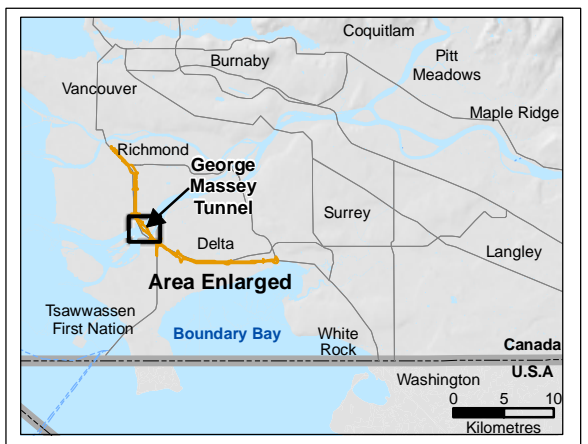
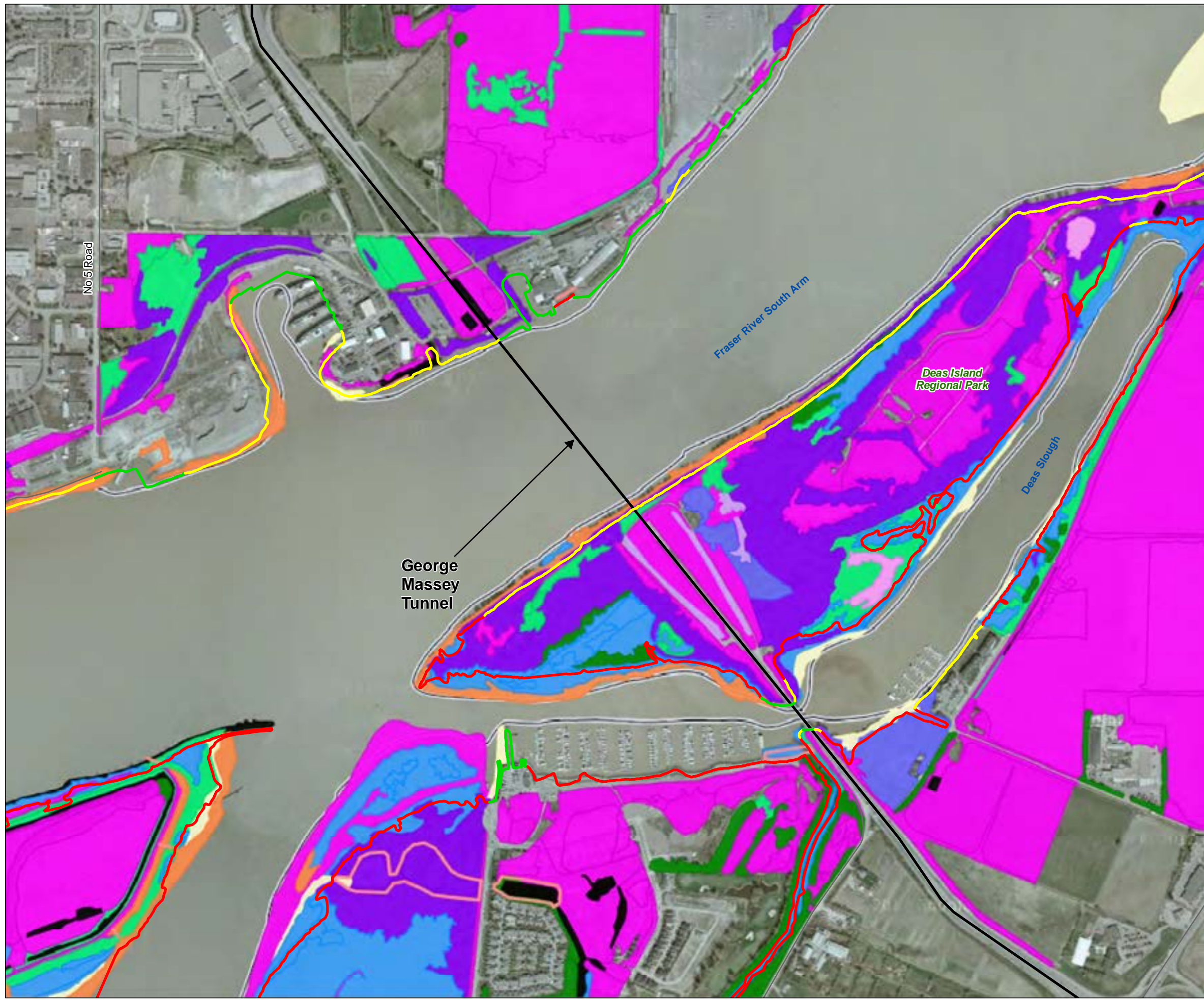
The lower Fraser River supports 42 species of fish (Richardson et al. 2000). Anadromous CRA species that rely on aquatic habitats in the Fraser River estuary include salmonids, sturgeon, and eulachon. Common non-CRA fish species that inhabit the lower Fraser River mainstem, sloughs, backwaters, and tributaries include: prickly sculpin (*Cottus asper*), peamouth (*Mylocheilus caurinus*), redbelt shiner (*Richardsonius balteatus*), northern pikeminnow (*Ptychocheilus oregonensis*), starry flounder (*Platichthys stellatus*), lamprey (*Lampetra* sp.), and threespine stickleback (*Gasterosteus aculeatus*) (Richardson et al. 2000).

Deas Slough

Deas Slough, a backwater feature of the Fraser River South Arm, is approximately 2,700 m long and 250 m wide, with an average depth of 5 m. Deeper sections exist in the vicinity of the two marinas on the slough's south bank, which are dredged to maintain boat access (FREMP 2006). In contrast to sandy sediments in the South Arm, substrate in the slough consists predominantly of silt and clay (Birtwell et al. 1987a). Deas Slough is tidally-influenced; however, a sill on the slough's bed at the mouth prevents salt water penetration in depths greater than 4 m (Birtwell et al. 1987a).

The slough's shoreline is designated primarily as highly productive (red-coded) habitat. In contrast, riprap-armoured shoreline in the vicinity of the Deas Slough Bridge is characterized as low (green-coded) to moderate (yellow-coded) productivity habitat (BIEAP - FREMP 2014). A detailed description of tidal foreshore habitats, riparian vegetation, and upland land uses surrounding Deas Slough is included in the technical volume, ***Fish and Fish Habitat Study*** included under **Section 16.4**.

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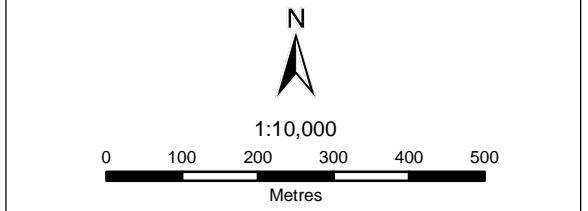


Legend

- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road
- High Productivity Habitat
- Moderate Productivity Habitat
- Low Productivity Habitat

- deciduous tree woodland
- coniferous tree woodland
- mixed tree woodland
- low shrub woodland
- tall shrub woodland
- meadow, vascular
- meadow, non-vascular
- marsh
- eel-grass
- macroalgae
- mud
- sand
- rock
- other
- habitat compensation site

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. All other data obtained from the Fraser River Estuary Management Program & Burrard Inlet Environmental Action Program Habitat Atlas available online through the Community Mapping Network (http://www.cmnbc.ca/atlas_gallery/fremp-bieap-habitat-atlas). Data was accessed in November 2014. Productivity data was digitized at a scale of 1:5000 and is an approximate representation only.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| FRASER RIVER ESTUARY MANAGEMENT PROGRAM HABITAT INVENTORY | |
| Figure 4.4-2 | 13/05/2016 |
| | |

Deas Slough is used by a number of rearing and overwintering fish species. Rearing habitat has been documented for underyearling sockeye salmon (*Oncorhynchus nerka*), which are present in the slough from April to October, with numbers peaking in late June to late July (Birtwell et al. 1987b). Underyearling starry flounder also rear in the slough in spring and summer, and adult starry flounder are present in the slough in autumn and winter (Birtwell et al. 1993). Other fish species recorded in Deas Slough include, but are not limited to, chinook (*O. tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), and pink salmon (*O. gorbuscha*), prickly sculpin, and threespine stickleback (FISS 2014).

Green Slough

Green Slough flows northeast along River Road West and then parallels Highway 99 before flowing into Deas Slough. Green Slough is 15 to 20 m wide along most of its length, but the channel narrows to about 9 to 10 m wide near the pump station at Crescent Slough. The channel is a low gradient glide, with silty substrates and uniform depths that range from about 0.9 to 1.5 m at low water.

Green Slough is tidally-influenced and drains into the lower reaches of Deas Slough and ultimately into the Fraser River South Arm, with unimpeded flows. Through the Green Slough Pump Station (5596 River Road), it drains agricultural and residential runoff from Crescent Slough in autumn and winter for flood protection, and irrigates agricultural lands in spring and summer (LGL et al. 2009). The pumps are not screened to prevent fish entrainment, and no fish deflection devices are employed at the station (LGL et al. 2009).

Green Slough is classified as an environmentally sensitive area under Delta's Official Community Plan (Delta 2014). The slough's shoreline is classified as habitat of high productivity (red-coded) (BIEAP - FREMP 2014). Marsh and riparian habitats of Green Slough are described in detail in the technical volume, ***Fish and Fish Habitat Study*** included under **Section 16.4**.

Green Slough provides perennially wetted rearing and overwintering habitat for salmonids (LGL et al. 2009). It is also used by non-salmonid species, such as threespine stickleback, prickly sculpin, and reidside shiner. Non-native fish species, such as carp (*Cyprinus carpio*) and black crappie (*Pomoxis nigromaculatus*), have also been reported in Green Slough (FISS 2014).

Upland Ditches

Of the 43.5 km of assessed ditches that parallel or intersect Highway 99 within the LAA, 5.2 km (12%) are coded as dashed-red, and 10.0 km (23%) as orange. The remaining ditches are of low or no value to CRA fish; 26.9 km are coded as yellow (62 %), and 1.5 km (3 %) are coded as green. A description of watercourse classification codes specific to this assessment is provided in **Section 4.4.2.3**.

Ditches within the LAA are low-gradient straight runs, with fine sediments, but without pools or riffles. In general, these ditches are poorly connected to the tidal waters of the lower Fraser River (e.g., located upland of flood control infrastructure, included floodgates and pump stations), which limits access for CRA fish. Instream vegetative cover is generally limited and riparian vegetation consists mainly of grassed roadside shoulders, shrubs lining ditch banks, backed by agricultural fields. A detailed assessment of upland ditch habitat within the LAA is included in the technical volume, ***Fish and Fish Habitat Study*** included under **Section 16.4**.

Previous sampling in upland ditches has resulted in the capture of non-CRA fish, including native (e.g., brassy minnow (*Hybognathus hankinsoni*), peamouth, redbelly darter, and threespine stickleback), and introduced fish species (FISS 2014). Only one CRA fish species (i.e., cutthroat trout) has been historically documented in Crescent Slough; however, these observations date back to 1983 (FISS 2014). No salmonids have been detected in the slough since then. Crescent Slough is generally considered to have low values for rearing salmon, especially within reaches close to the Highway 99 ROW (Hemmera 2006). Species captured in upland ditches during field sampling, conducted for the Project, include brassy minnow and threespine stickleback, as well as brown bullhead (*Ameiurus nebulosus*), goldfish (*Carrasius auratus*), and pumpkinseed (*Lepomis gibbosus*).

Fish

Fish species of CRA importance that rely on aquatic habitats throughout the lower Fraser River during different life history stages include Pacific salmon, sturgeon, eulachon, trout, and char. As discussed in **Section 4.4.1**, these species were selected as sub-components to facilitate assessment of potential effects of the Project on fish and fish habitat. Life history requirements, status, and limiting factors for each sub-component are summarized in this section, and described in greater detail in the technical volume, ***Fish and Fish Habitat Study*** included under **Section 16.4**.

Pacific Salmon

Chinook Salmon: Chinook salmon is the largest of the Pacific salmon species that return to the Fraser River and tributaries to spawn. The Fraser River estuary provides important rearing habitats for juvenile chinook. Stream-type chinook, (i.e. fish from the interior Fraser River) generally rear in estuarine habitats with greater marine influence, whereas ocean-type chinook (i.e. ocean-type fish from the Harrison River) occupy tidal channels and brackish marshes of the lower Fraser River, such as the Woodward Island complex and Ladner Marsh just downstream of the Project (Levy and Northcote 1982, Northcote et al. 2007). Adult chinook use the lower Fraser River as a migratory corridor during their return to spawn (DFO 2011). Generally,

stream-type chinook migrate upriver from March to September, while ocean-type chinook migrate upriver from September to November (Fraser et al. 1982). Aboriginal Groups noted that during return migration a natural funnel is created so that fish are held in the lower reaches before they run up river.

Fraser River chinook salmon stocks are not federally or provincially listed.

Chum Salmon: Chum salmon spawn in streams and the lower Fraser River mainstem between Chilliwack and Hope (Ryall et al. 1999). In the Fraser River, chum salmon consist of autumn run stocks that migrate upstream to spawn from September to December, with peak spawning migration occurring in October (Grant and Pestal 2009). The majority of chum salmon spawning habitat is located in Fraser River tributaries downstream of Hell's Gate (near Hope) such as the Harrison, Chehalis, Chilliwack, and Stave rivers (Ryall et al. 1999, Holtby and Ciruna 2008).

Upon emergence, chum fry promptly migrate downstream to the estuary, including the brackish marshes and tidal channels of the lower Fraser River, where they linger as they transition to higher salinity waters (Salo 1991). Chum fry outmigration occurs from February to June, with a peak between mid-March and the end of April (Beacham and Starr 1982, Salo 1991).

Chum salmon stocks of the Fraser River are not federally or provincially listed.

Coho Salmon: Adult coho salmon typically return to spawn in autumn and early winter, and discrete seasonal runs do not generally exist (Holtby and Ciruna 2008). Fry emerge from mid-March to late June and remain in the spawning stream for a year or more (Fraser et al. 1982, Sandercock 1991). Coho smolt outmigration in the Fraser River generally occurs from mid-April to mid-June, with a peak observed in mid-May (Fraser et al. 1982). Coho smolts remain for a few weeks in rearing habitats of Sturgeon and Roberts Banks while adapting to higher salinity conditions. They are scarce in brackish marshes and tidal channels of the lower Fraser River (Fraser et al. 1982).

Coho salmon is not federally or provincially listed; however, the Interior Fraser populations were designated in 2002 as Endangered (COSEWIC 2002). The status of the Interior Fraser coho salmon is anticipated to be re-assessed by COSEWIC and an updated status report is expected to be produced in 2015 (Decker and Irvine 2013). Declines in coho salmon catches in south coastal B.C. have been attributed largely to overharvesting, as well as implementation of conservation measures (e.g., limited exploitation, fisheries closures, non-retention; DFO 2012).

Pink Salmon: Pink salmon have the shortest life cycle of all Pacific salmon, since they always mature as two-year-old fish. In the Fraser River, pink salmon return in odd years. Aboriginal Groups noted that pink salmon populations cycle in two- year periods of relative abundance (i.e., high run years). Spawning is concentrated in tributaries downstream of Hope, but significant spawning also occurs in the Thompson River (Labelle 2009). Spawning migration through the lower Fraser River peaks in late August to early September (Heard 1991).

Outmigration of pink fry occurs from late February through to mid-May (Heard 1991). On average, the time pink fry spend rearing in sloughs and backwater features of the lower Fraser River appears to be negligible (Dunford 1975, Godin 1981, Levy and Northcote 1982).

Pink salmon is numerically the most abundant salmon species in B.C. and is not federally or provincially listed (B.C. CDC 2015).

Sockeye Salmon: Sockeye salmon typically return as four-year-old adults, and populations have characteristic return timings, classified into four groups or runs. Return migrations extend from mid-June through to September (Gable and Cox-Rogers 1993). During consultation on the Project, Aboriginal Groups noted that sockeye salmon populations cycle in four-year periods of relative abundance (i.e., high run years), and that during return migration a natural funnel is created so that fish are held in the lower reaches before they run up river.

Smolt outmigration generally occurs from early April to the end of May (Beamish et al. 2010). One notable exception is the Harrison sockeye stock. Harrison sockeye fry migrate to the estuary shortly after emergence, and rear in Fraser River estuarine habitats, including Deas Slough and Ladner Reach, before entering the Strait of Georgia (Dunford 1975, Levy and Northcote 1981, 1982, Birtwell et al. 1987b). In Deas Slough, sockeye underyearlings have been caught from April to October, with peak abundance from late June to early July (Birtwell et al. 1987b).

Sockeye salmon is not a federally or provincially listed species, however, the Cultus Lake population was designated in 2003 as Endangered (COSEWIC 2003a). On average, sockeye is the most important of the Pacific salmon species in terms of commercial landed value, followed by chinook and chum (DFO 2012). Sockeye salmon is also caught in sport fisheries and in Aboriginal active food drift gillnet fisheries on the lower Fraser River.

Sturgeon

White Sturgeon: White sturgeon, a demersal species resident in the lower Fraser River downstream of Hell's Gate (km 211), are genetically distinct from the rest of the Fraser River system (Nelson et al. 1999, Smith 2002). Spawning occurs during peak freshet (typically from May to July), from the confluence of the Sumas River upstream to the Coquihalla River, with no evidence of spawning in the tidally-influenced river mainstem (Levings and Nelson 2003, Perrin et al. 2003).

Important spring and summer feeding areas for adult sturgeon include the Matsqui Channel and Hatzic Eddy upstream of Mission, as well as the mouth of the Pitt River, and the waters at the Port Mann Bridge, Barnston, Douglas, and Annacis Islands (Glova et al. 2010). During consultation on the Project, Aboriginal Groups noted that adult sturgeon are present seasonally, and identified two main sturgeon staging areas in the lower Fraser River—one in the direct vicinity of the Tunnel and the other in Ladner Reach (Deas Slough, downstream of Canoe Pass). Aboriginal Groups also indicated that sturgeon feed on dead eulachons and herring in April and May, especially within Ladner Reach through to Sea Reach.

During winter, white sturgeon migrate to overwintering areas, where they become sedentary and congregate in densely spaced groups in slow-moving pools as water temperatures drop below 7°C (Neufeld et al. 2010, Ghilarducci and Reeve 2012). Overwintering habitat is widely scattered from Deas Island to the Sumas River confluence, but mainly concentrated in the waters near Annacis Island, the Port Mann Bridge, the mouth of the Pitt and Stave rivers, and Matsqui. Overwintering typically occurs in slow moving water and depths greater than 10 m (Neufeld et al. 2010, Ghilarducci and Reeve 2012).

Juvenile white sturgeon disperse downstream to feed and overwinter, and rear in the lower reaches of tributaries, large backwaters, side-channels, and sloughs throughout the lower Fraser River (Fraser River White Sturgeon Working Group 2005). Rearing of juveniles occurs in tidally-influenced, slow-moving, turbid water, at least five metres deep, over substrates consisting mainly of sand, silt and clay, mixed with gravel (Lane and Rosenau 1995).

In the vicinity of the Project, individual juvenile white sturgeon have been reported from the BC Ferries Fraser Shipyards, immediately downstream of the Project alignment, and in the main channel off Deas Island, immediately upstream of the Project alignment. However, aggregations of up to five overwintering juveniles have also been reported upstream of the Annacis Channel (Glova et al. 2008, 2009). In general, the influence of the salt wedge in estuarine and brackish environments precludes use by smaller juveniles, as the ability of white sturgeon to tolerate brackish and saline waters increases with size (Parsley and Beckman 1994).

Aboriginal Groups have relayed historic declines in numbers of sturgeon in the lower Fraser River. At the federal level, the COSEWIC status of the lower Fraser River white sturgeon population was downgraded in 2012 to Threatened, from the 2003 designation of Endangered (COSEWIC 2003b). Provincially, white sturgeon is Red-listed (B.C. CDC 2015).

Green Sturgeon: Green sturgeon are found in BC along the entire coast (Scott and Crossman 1973). They are rarely observed in freshwater and the extent of freshwater habitat use is unknown. Since 1985, there have been about 15 to 20 reports of green sturgeon in the lower Fraser River, from the river mouth to 90 km upstream. Spawning is known to occur in only three rivers in North America from Oregon to California; there is no evidence that spawning has ever occurred in Canadian rivers (COSEWIC 2004).

Although rare, sub-adult and adult green sturgeon may occur in the Fraser River estuary and lower reaches throughout the year. Habitat requirements in brackish environments are thought to resemble those of white sturgeon (COSEWIC 2004).

At the federal level, COSEWIC re-assessed the status of green sturgeon in 2013 and maintained its designation as species of Special Concern (COSEWIC 2014). Green sturgeon is listed as Special Concern under SARA Schedule 1 (Government of Canada 2006), and is provincially Red-listed (B.C. CDC 2015).

Eulachon

Eulachon return every year to the lower Fraser River to spawn when they are three to four years of age (Cambria Gordon Ltd. 2006). Spawning migration begins in mid-March and continues to mid-May (Hay and McCarter 2000, LGL and Terra Remote Sensing 2009). Within the lower Fraser River, spawning occurs from Deas Island upstream to Mission, however, spawning locations vary considerably among years (Hay and McCarter 2000, Hay et al. 2002).

Historically, most spawning has occurred upstream of New Westminster, and on occasion, in the mouths of large tributaries such as the Pitt River (Hay and McCarter 2000), where the influence of lower salinity water is greater. Due to inter-annual variation in spawning locations, the entire lower Fraser River is considered to contain areas with suitable eulachon spawning habitat (B. Ennevor, Fisheries Resource Manager, DFO, personal communication, January 6, 2014).

Preferred spawning habitat is in areas of relatively slow current (<0.7 m/s), on plateaus or edges composed of stable fine-medium and coarse sand, pebbles, and gravel, in depths of less than seven metres (LGL and Terra Remote Sensing 2009). The river mainstem in the vicinity of the Project is predominantly 12 m deep with no shallow shoals, characterized by unstable sandy substrates subject to annual maintenance dredging. Also considering the low tolerance of eulachon eggs to higher salinity water, the likelihood of suitable eulachon spawning habitat in the Project alignment is greatly reduced. To reach spawning habitat, eulachon transit through areas of relatively slow current (<0.7 m/s) that are 5 to 12 m deep, and have stable sandy

substrates (LGL and Terra Remote Sensing 2009). In the vicinity of the Project alignment, these transit areas likely occur close to the shoreline rather than mid-channel. Immediately after hatching, larvae are flushed seaward (Hay and McCarter 2000).

Eulachon (central Pacific coast and Fraser River populations) was designated as Endangered by COSEWIC in 2011 (COSEWIC 2011), and is provincially Blue-listed (B.C. CDC 2015). The Fraser River and central Pacific coast populations are currently being considered for listing as Endangered under SARA (DFO 2014a). Although historically very abundant, numbers of eulachon returning to the lower Fraser River began declining steadily in the mid-1940s, then exhibited a steeper decline in the 2000s (Moody 2008, Schweigert et al. 2012). During consultation with the Ministry in the context of the Project, Aboriginal Groups cited loss of habitat along with other factors as the cause of these declines, but noted they have also reported that eulachon have been recovering in recent years.

Trout

Coastal Cutthroat Trout: Coastal cutthroat trout inhabit low elevation lakes and rivers along much of the B.C. coast, including streams in the Fraser River basin. They range as far upstream as Hope (160 km inland), and use sloughs and backwaters of the lower Fraser River mainstem, as well as several of its major tributaries (i.e., Pitt, Stave, Harrison, and Chilliwack Rivers and associated lakes) (McPhail 2007, Costello 2008). Sloughs and backwaters provide rearing, overwintering, and migratory habitat for coastal cutthroat trout.

Coastal cutthroat trout are able to spawn multiple times in successive years, usually from late winter to spring, though sea-run populations have also been known to spawn during autumn (McPhail 2007). Depending on the life history form, adults either remain in natal streams, or migrate to lakes or larger river systems to forage before returning to spawn. Sea-run cutthroat migrate to the ocean between March and June (Slaney and Roberts 2005).

Coastal cutthroat trout is provincially Blue-listed (B.C. CDC 2015).

Rainbow/Steelhead Trout: Steelhead trout (*Oncorhynchus mykiss*) is the sea-run form of rainbow trout. Steelhead are found along the entire coast of B.C. in larger streams and rivers, including the Fraser River, that empty directly into the ocean (Hartman and Gill 1968). In the Fraser River, winter-run steelhead enter fresh water in various stages of maturation between November and April (Withler 1966), and spawn by May (McPhail 2007). Summer-run steelhead enter fresh water between May and September as immature fish (Withler 1966), and do not mature and spawn until the following spring, between late March and early May (McPhail 2007). Typically, winter runs are associated with coastal populations and summer runs with inland

populations (Pauley et al. 1986). Steelhead may spawn over multiple years. Some spent spawners migrate to the ocean to feed and may return to their spawning grounds within the same year, or skip a year before spawning again (Levy and Parkinson 2014).

Upon emergence, fry rear in fresh water for one to three years, then migrate to salt water between late April and mid-June, where they feed and grow rapidly before moving out into the open ocean (Quinn 2005). Steelhead use the Fraser River South Arm as a migratory corridor during smolt outmigration and adult spawning migration to natal streams. Resident forms of rainbow trout may also use rearing and overwintering habitats in the Fraser River South Arm.

Rainbow/steelhead trout are not federally or provincially listed.

Char

Dolly Varden: Dolly Varden (*Salvelinus malma*) are associated with cold water streams in most B.C. coastal drainages. Dolly Varden occur as anadromous, migrating between freshwater streams and the ocean; stream-resident, remaining in rivers and streams for most of their life; and lake-run, remaining in a single freshwater body and spawning in adjacent streams. Anadromous Dolly Varden enter the ocean regularly (McPhail 2007).

Spawning occurs in autumn within headwaters of small streams. Upon emergence, juveniles remain in the stream for two to four years (Armstrong 1970). The lower Fraser River is likely used as a migratory corridor by Dolly Varden, due to its proximity to nearshore estuarine and coastal feeding and overwintering grounds. Dolly Varden smolts migrate to the ocean in spring and may remain for only two to four months before returning to fresh water (Armstrong and Morrow 1980). Alternatively, Dolly Varden may remain in marine waters well into the autumn, returning only for spawning or overwintering in freshwater habitats (Bond and Quinn 2013).

Dolly Varden are not federally or provincially listed.

Bull Trout: Bull trout are associated with cold water streams (Dunham et al. 2003). They exhibit variable life histories, including stream resident, lake-run, large river, and sea-run. Anadromous bull trout populations are suspected in the lower Fraser River (McPhail and Baxter 1996, McPhail 2007). Because anadromous char populations occur where bull trout and Dolly Varden overlap, evidence that these char are bull trout rather than Dolly Varden is often circumstantial.

Bull trout spawn in autumn in shallow stream habitats (McPhail and Baxter 1996). Upon emergence in spring, juvenile bull trout rear in spawning streams for at least two years before migrating to larger rivers, or the ocean, depending on the form (Pratt 1992, McPhail and Baxter 1996). The lower Fraser River is likely used as a migratory corridor by bull trout, due to its proximity to nearshore estuarine and coastal feeding and overwintering grounds.

Bull trout is provincially Blue-listed (B.C. CDC 2015), and was designated in 2012 as a species of Special Concern (COSEWIC 2012). Bull trout populations of the B.C. south coast are currently being considered for listing as species of Special Concern under SARA (DFO 2014b).

4.4.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with fish and fish habitat, and the potential effects of such interactions. Information on the mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.4.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 4.4.5**. A discussion of potential cumulative effects on fish and fish habitat is presented in **Section 4.4.6**.

4.4.3.1 Project Interactions

An overview of potential interactions between Project activities and fish and fish habitat during the construction and operation of Project components is provided in **Appendix A**. A preliminary evaluation of the potential effects of Project interactions on fish and fish habitat, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: Potential interactions of Project-related construction activities with fish and fish habitat include the following:

- Exposure of fish to construction equipment, underwater noise generated by activities such as pile driving and Tunnel decommissioning, and increased suspended sediment and turbidity levels resulting from activities associated with Tunnel decommissioning and other instream or near-shore construction activities.
- Potential disturbance of fish habitat during construction adjacent to water.
- Potential overlap of Project components with small portions of fish habitat along the edges of Deas Slough and Green Slough.
- Potential release of construction area run-off into adjacent waterbodies during highway upgrades.

Operation: Once operational, interactions of the Project with fish and fish habitat are expected to be limited to the following:

- Potential release of stormwater runoff from the new bridge and upgraded highway into the river and sloughs.
- Sedimentation during routine maintenance activities such as vegetation and debris removal, and temporary disruption of natural flows during ditch maintenance.

4.4.3.2 Potential Effects

Potential Effect #1: Physical Injury or Mortality to Fish through Crushing or Entrainment

Crushing or entrainment of fish during Project-related activities can be lethal or sub-lethal, as a result of physical abrasion of the body surface, removal of protective mucous, or physiological stress associated with respiratory obstruction and anoxic conditions. Juvenile and smaller size-class fish are more susceptible to crushing or entrainment than larger fish, due to their limited swimming capability, which may prevent them from avoiding the area of disturbance (Larson and Moehl 1990, McGraw and Armstrong 1990, Reine and Clarke 1998). Because they are associated with bottom substrates, demersal species, such as sturgeon, are more likely to experience adverse effects during dredging (sediment removal) than are pelagic species (Hatin et al. 2007). The potential for crushing or entrainment of fish in the Fraser River South Arm and in upland ditches during Project construction and operation is discussed below.

Fraser River South Arm, Deas Slough and Green Slough

Crushing or entrainment of fish could occur during activities associated with Tunnel decommissioning, including removal of sediment and the protective rock apron and concrete mattress on top of the Tunnel sections.

Crushing or entrainment of salmonid and sturgeon eggs will not occur as these species spawn beyond the RAA boundaries. Eulachon eggs are also unlikely to be crushed or entrained since sediment removal will be conducted in areas where conditions are unsuitable for eulachon spawning (i.e., at a depth of approximately 12 m over a dynamic section of the river with unstable substrates that lack plateaus or stable edges shallower than seven metres, and where the influence of higher salinity water is greater).

Juvenile fish sub-components may be susceptible to crushing or entrainment if present in the Project alignment during sediment removal. Crushing and entrainment during sediment removal does not typically result in the mortality of adult fish because they are highly mobile and able to avoid the area of disturbance.

To the extent that is technically feasible (see **Section 4.4.4**), sediment removal for Tunnel removal is proposed to occur between July 16 and February 28, the least-risk timing window for the protection of juvenile salmon and eulachon (FREMP 2006). Adherence to this timing window will avoid or minimize the potential for crushing and entrainment of these species.

Sturgeon forage and overwinter in the lower Fraser River. Small size classes of juvenile sturgeon may experience physical injury or mortality due to crushing or entrainment if present within the RAA and near the sediment removal site during the least-risk timing windows. The risk of entrainment increases when sediment removal occurs in areas of overwintering aggregations of juvenile sturgeon that are smaller than 19 cm fork length (Boysen and Hoover 2009). Since it is not possible to fully mitigate this effect, it is identified as a potential residual effect and assessed further in **Section 4.4.5**.

Upland Ditches

Construction activities associated with highway improvements that may require works in and around upland ditches will be undertaken in accordance with provincial standards and best practices, including the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012). Project construction activities that involve instream works will be conducted within prescribed regional least-risk fisheries timing windows⁴ (i.e., July 15 to September 30; Delta 2003, B.C. MOE 2006b) or will use alternative, standard mitigation approaches that protect fish and fish habitat (e.g., work in-the-dry, combined with fish salvages), and will adhere to the provisions of the B.C. *Water Sustainability Act* (where applicable).

The majority of upland ditches within the Project alignment are of relatively low values from a CRA fish habitat perspective (**Section 4.4.2.3**). Further information regarding standard mitigation pertaining to instream works is provided **Section 4.4.4**. After implementation of these mitigation measures, no effects to fish from crushing or entrainment in upland ditches are anticipated, and are not considered further in this assessment.

Potential Effect #2: Physical Injury or Mortality to Fish through Exposure to Underwater Noise during Construction

Exposure to loud, pulsed underwater sound, such as that generated during impact pile driving, can result in:

- Non-auditory effects, such as traumatic injury (i.e., severe tissue or organ damage)
- Auditory effects, such as temporary reduction of hearing sensitivity, thereby compromising the ability of fish to communicate, detect predators or prey, or assess their surroundings

⁴ Prescribed regional least-risk fisheries timing windows encompass Delta's timing window for the protection of salmonids (i.e., August 1 to September 30; Delta 2003), as well as B.C. MFLNRO's timing window for the protection of Pacific salmon (i.e., July 15 to September 15; B.C. MOE 2006b).

Mortality to fish can occur from exposure to peak sound pressure levels (SPL_{peak}) that exceed 30 kilopascal (kPa) (~210 dB re 1 μ Pa) (Vagle 2003, Popper and Hastings 2009). Adult fish are typically more tolerant of underwater noise than juvenile fish of the same species (Halvorsen et al. 2011, 2012, Casper et al. 2012).

Continuous sound, generated from activities such as vessel movement, vibratory piling, and sediment removal, is less intense, and generally insufficient to cause injury or mortality to fish (Michel et al. 2007, Popper and Hastings 2009). Continuous sound, however, has the potential to result in behavioural effects (e.g., habitat avoidance).

For projects that involve loud underwater activities, DFO requires underwater sound monitoring, and deployment of mitigation (e.g., bubble curtain) within one metre from the sound source if underwater sound levels exceed 30 kPa (B.C. MPDCA 2003), or if evidence of impacts to fish is observed.

The U.S. Fisheries Hydroacoustic Working Group (FHWG 2008) has set the following threshold criteria for avoiding injury to fish: 206 dB re 1 μ Pa SPL_{peak} per single strike, or 187 dB re 1 μ Pa²s cumulative sound exposure levels (SEL_{cum}) for fish heavier than or equal to two grams; for fish weighing less than two grams, the SEL_{cum} threshold is 183 dB re 1 μ Pa²s (FHWG 2008). Mitigation is required if a strike is likely to exceed SPL_{peak} or if multiple strikes reach SEL_{cum} (FHWG 2008). Further details regarding threshold criteria for injury to fish are described in **Section 4.3 Underwater Noise**.

Fraser River South Arm, Deas Slough and Green Slough

Potential effects to fish resulting from Project-related underwater noise were assessed by comparing the results from JASCO Applied Science's Marine Operations Noise Model against the FHWG (2008) criteria for fish weighing less than two grams, as well as the BC Marine and Pile Driving Association Contractors (2003) criteria adopted by DFO. Modelled scenarios of Project construction activities are described in **Section 4.3 Underwater Noise**.

Impact pile driving is the only Project-related construction activity that has the potential to generate pulsed underwater noise at levels that, if not mitigated, could injure fish. Underwater noise modelling suggests that, without mitigation, impact pile driving could generate noise at levels that exceed FHWG and DFO SPL_{peak} thresholds within a radius of 53 m and 42 m, respectively (see **Section 4.3 Underwater Noise**).

For 100 minutes of continuous impact piling, the FHWG SEL_{cum} threshold extends to a radius of 602 m for fish with body weight greater than or equal to two grams, and 698 m for fish with body weight less than two grams (see **Section 4.3 Underwater Noise**).

Project siting and design are expected to help prevent or minimize underwater noise-related effects to fish. For example, current Project construction plans call for the piles to be driven either on land or along the edge of Deas Slough to avoid or minimize the need for driving piles through deep water. Underwater noise is expected to be more strongly attenuated in shallow water, restricted by the surrounding slough and river banks, and absorbed by silt and clay sediments. As sediment-borne sound is approximately 20 dB lower than water-borne sound (Zampolli et al. 2013), sound propagating through soil is expected to be sufficiently attenuated before it reaches the water.

Mitigation measures to further minimize adverse effects to fish from underwater noise during Project construction are described in **Section 4.4.4**.

Upland Ditches

Project-related construction activities in upland ditches are not expected to generate underwater noise. Therefore, effects to fish in upland ditches as a result of underwater noise exposure during construction are not considered further in this assessment.

Potential Effect #3: Behavioural Changes due to Increase in Underwater Noise Levels during Construction

In general, fish can be sensitive to changes to the acoustic environment, with species-specific effects depending on fish anatomy and the physical characteristics of the underwater noise. Continuous underwater noise has the potential to result in fish behavioural effects, including alarm response, habitat avoidance, interference with sensory orientation and navigation, and communication masking effects (Knudsen et al. 1997, Fay and Popper 2000). Aboriginal Groups have noted that salmon are sensitive to noise and show changes in behaviour in response to noise.

In the lower Fraser River, fish are continually exposed to ambient noise of low- to moderate-frequency generated predominantly by shipping traffic and intermittently by construction activities. Ambient measurements in the lower Fraser River in the vicinity of the Project exceed 120 dB re 1 μ Pa about 20% of the time, primarily due to larger vessels, such as tugs and container ships, transiting the river. Ambient noise levels in Deas Slough are lower than in the lower Fraser River mainstem, because slough traffic consists primarily of smaller, slow-moving pleasure craft using the marinas. Details on ambient underwater noise levels (i.e., existing conditions) in the vicinity of the Project are provided in **Section 4.3 Underwater Noise**.

Fraser River South Arm

Project construction activities anticipated to generate continuous underwater noise include vibratory pile driving and vibrodensification of native loose soils for the installation of foundations on the edge of Deas Slough and sediment and rip rap removal in preparation for and during Tunnel decommissioning. Underwater noise will also be generated by tugs, which may be operating at the Tunnel crossing during Tunnel removal.

There are no specific behavioural threshold criteria in place for fish exposed to continuous underwater noise; however criteria for marine mammals (see **Section 4.3 Underwater Noise**) is appropriate for reference as a potential disturbance level. As with marine mammals, underwater noise does not have the potential to cause behavioural effects in fish when it falls below background ambient noise levels.

Anthropogenic noise is commonly categorized as pulsed or non-pulsed sounds. Pulsed sounds are brief (less than a few seconds) and intermittent, with rapid changes of sound pressure (e.g., impact-hammer strike, from impact pile-driving). In contrast, non-pulsed sounds are characterized by gradual changes in sound pressure over time (e.g., marine vessels transiting or a vibratory pile driver in operation). Without mitigation, impact-pile driving is expected to result in the highest level of pulsed sound while vibratory pile driving and vibrodensification of native soils are expected to be the most notable sources of non-pulsed sound. Sediment removal and vessel operations are expected to result in minimal change in underwater noise conditions as the noise predicted to be generated by these activities are similar to ambient acoustic levels measured in the lower Fraser River where behavioural disturbance threshold is exceeded 20% of the time (see **Section 4.3 Underwater Noise**). The most notable potential source of changes to ambient noise levels, construction-based noise from impact pile-driving, vibratory pile driving and vibrodensification of native soils are proposed to occur either on land or in shallow water. Given this planned approach, the sound generated by these activities is expected to be sufficiently attenuated before it reaches the receptors so that any potential behavioural effects will be avoided (see **Section 4.4.4** below for a description of proposed mitigation measures and monitoring related to pile driving).

Project operation is not anticipated to involve any activity that could generate underwater noise. Therefore, noise-related behavioural effects on fish during Project operation are not considered further in this assessment

Upland Ditches

No Project-related construction or operation activities are anticipated to generate underwater noise in upland ditches. Therefore, behavioural effects to fish as a result of underwater noise in upland ditches are not considered further in this assessment.

Potential Effect #4: Physical Injury or Mortality due to Exposure to Elevated Levels of Total Suspended Solids

Exposure to elevated TSS levels in the water column can affect fish through:

- Mechanical abrasion and hyper-secretion of mucous, clogging of the gill tissue and consequent respiratory distress caused by lack of the passage of water, and mortality
- Physiological stress leading to reduced growth, reduced feeding rates, and increased susceptibility to invasion by disease-causing parasites

Fish eggs, larvae, and later stages of juvenile fish are typically more sensitive to elevated TSS levels than adults of the same species.

The potential for Project activities to affect fish through elevated TSS levels was determined by comparing TSS concentrations expected to be encountered in plumes generated during Project-related sediment removal activities against B.C. water quality guidelines (WQG) (B.C. MOE 2006a), and the Canadian Council of Ministers of the Environment (CCME) *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) (see **Table 4.4-2**).

Fraser River South Arm, Deas Slough, and Green Slough

Project-related construction activities that may result in elevated TSS levels in the lower Fraser River, Deas Slough, and Green Slough include instream and near-shore construction activities associated with decommissioning the Tunnel and Deas Slough Bridge, realignment of Green Slough to its historic location, and installation of support structures for the new bridge and approaches. Of the proposed instream construction activities, removal of Tunnel segments and overlying sediment and protective cover are anticipated to generate the greatest amounts of re-suspended sediment.

Most fish present in the vicinity of the Project at the start of Tunnel removal activities are likely to disperse out of the immediate area due to elevated noise and physical disturbance associated with the operation. However, fish, especially larval and juvenile stages that remain in or near the sediment plume, could be exposed to elevated TSS levels due to their limited ability to disperse away from a plume.

To prevent or minimize potential Project-related effects to fish from exposure to elevated TSS levels within the Fraser River, mitigation measures will be implemented to maintain TSS levels within the B.C. WQG (B.C. MOE 2006a) and CCME *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) (see **Table 4.4-2**). These include undertaking instream activities between July 16 and February 28 (FREMP 2006) to the extent that is technically feasible and viable, and use of a hydraulic (hopper or cutter) suction dredge where possible to reduce the amount of re-suspended sediment. Sediment suspension during activities associated with Tunnel removal will be of a short temporal nature, and the incremental change in sediment volume is predicted to range from one to nine per cent, which is considered low in comparison with background TSS loads in the lower Fraser River (**Section 4.1 River Hydraulics and River Morphology**). Some CRA fish, in particular sturgeon, are known to use the lower Fraser River outside the least risk timing window. However, turbid conditions often exceeding 50 NTU appear to be favoured by sturgeon, because these conditions provide cover and minimize the risk of predation (Hatfield et al. 2004, Gadowski and Parsley 2005). Also, adult salmon that migrate upriver to natal spawning streams during the least risk timing window have evolved in this highly turbid environment.

Mitigation measures to prevent or minimize potential effects to fish from exposure to elevated TSS levels within Green and Deas sloughs will include undertaking instream works in a manner that provides for maintenance of TSS levels within the B.C. WQG (B.C. MOE 2006a) and CCME *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014). As noted previously with respect to Tunnel decommissioning, a key mitigation measure for instream activities will be application of least-risk timing window (July 16 and February 28), to the extent that is technically feasible and viable. Further to the application of seasonal timing to reduce risk to CRA fish, these tidal sloughs extensively dewater during low tides which will facilitate application of additional mitigation measures (e.g., working during low tide when the work site is extensively dewatered, temporary isolation of flow, fish salvage, installation of fill containment berms). Silt curtains can also be deployed within Green and/or Deas sloughs, adjacent to the infill area, if warranted.

Further mitigation measures to minimize physical injury or mortality to fish from exposure to elevated TSS levels during instream Project activities are described in **Section 4.4.4**.

Sediment suspension during activities associated with Tunnel removal will be of a short temporal nature, and the incremental change in sediment volume is predicted to range from one to nine per cent, which is considered low in comparison with background TSS loads in the lower Fraser River (**Section 4.1 River Hydraulics and River Morphology**). Sediment suspension during activities within Green Slough provides for more extensive mitigation, given the tidal

characteristics and separation from the South Arm. As a result, any sediment suspension in Green or Deas sloughs is anticipated to occur within an even shorter timeframe and will result in a more reduced change in background TSS levels than will apply within the South Arm during Tunnel removal.

Some CRA fish, in particular sturgeon, are known to use the lower Fraser River outside the least risk timing window. However, turbid conditions often exceeding 50 NTU appear to be favoured by sturgeon, because these conditions provide cover and minimize the risk of predation (Hatfield et al. 2004, Gadomski and Parsley 2005). Also, adult salmon that migrate upriver to natal spawning streams during the least risk timing window have evolved in this highly turbid environment.

Regardless of the extent of change in TSS levels, it is not possible to fully mitigate sediment suspension effects during either Tunnel removal or partial infilling of Green Slough resulting in identification of a potential residual effect which is assessed further in **Section 4.4.5**.

Upland Ditches

Clearing and grubbing of vegetation along ditches in the LAA for Highway 99 widening and interchange upgrades have the potential to result in localized streamside disturbance, erosion, and sedimentation. In addition, relocation of or modifications to ditches have the potential to result in a temporary increase of TSS levels.

Works proposed in and around upland ditches will be conducted will comply with provincial standards and best practices, adhering to the provisions of the B.C. *Water Sustainability Act* (where applicable) (see **Section 4.4.4**). The majority of upland ditches within the Project alignment are of low value from a CRA fish habitat perspective (**Section 4.4.2.3**). After implementation of these mitigation measures, effects to fish from exposure to elevated TSS levels in upland ditches are not anticipated, and are therefore not considered further in this assessment.

Once operational, highway maintenance activities such as ditch cleaning, clearing, brushing, road maintenance, and repaving of road surfaces have the potential to result in elevated TSS levels within upland ditches.

Maintenance activities will comply with provincial standards and best management practices, adhere to the provisions of the B.C. *Water Sustainability Act* (where applicable), and be undertaken in accordance with the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010). As such, potential adverse effects to fish from exposure to elevated TSS levels in upland ditches during Project operation are not likely to occur and not considered further in this assessment.

Potential Effect #5: Effects of changes in Ambient Water Quality

Changes in habitat quality have the potential to alter the ability of fish to carry out essential life processes such as spawning, rearing, or foraging, increase physiological stress, and result in behavioural changes.

Ambient water quality may be affected during Project-related construction and operation activities that have the potential to induce increased levels of turbidity, re-mobilization of sediment contaminants, and siltation from re-deposition of suspended sediments. Potential effects to fish and fish habitat from changes in ambient water quality are assessed below with reference to baseline conditions as described in **Section 4.2 Surface Water and Sediment Quality**.

Turbid conditions may affect vertical migration of visually-dependent species such as salmon, and induce an alarm reaction, resulting in habitat avoidance. Turbid conditions may also limit light penetration through the water column, restrict prey capture, and reduce the ability of fish to avoid predation.

Conversely, turbid conditions, which may reduce the risk of predation, appear to be favoured by juvenile sturgeon that rear or overwinter in habitats of the river mainstem (Hatfield et al. 2004, Gadomski and Parsley 2005). It has also been suggested that increased turbidity may temporarily increase organic matter in the water column, and cause sturgeon to react positively to the perception of greater food availability (Parsley et al. 2011).

The lower Fraser River is naturally turbid and also subject to annual dredging for maintenance of the navigation channel. Since 1987, ambient water quality has been screened against CCME *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) for parameters including TSS, pH, dissolved oxygen (DO), and metals (e.g., Phippen 2008). On average, objectives have been met 98% of the time and ambient water quality in the South Arm is assessed as good (Phippen 2008).

Concentrations of total aluminum, chromium, and copper exceeding CCME WQG were observed during field sampling conducted for the Project in September 2014 at a mid-channel location upstream of the Tunnel crossing. Total aluminum and chromium concentrations exceeding CCME WQG were also observed at the Deas Slough mouth; although, total chromium concentrations in Deas Slough were lower than those in the South Arm. Petroleum hydrocarbons, oil, and grease were not detected in any water samples.

Arsenic, chromium, and copper in sediment samples collected in September 2014 from the Fraser River mainstem in the vicinity of the Tunnel crossing and Deas Slough consistently exceed *Canadian Sediment Quality Guidelines for the Protection of Aquatic Life* (CCME 1999). Exceedances of Canadian sediment quality guidelines have not been recorded for PCBs.

Fraser River South Arm, Deas Slough, and Green Slough

Project-related construction activities that may result in changes to ambient water quality in the LAA, include sediment removal, removal of the Tunnel and its protective rock apron and concrete mattress. Other activities that involve local disturbance of surficial sediments (e.g., installation of temporary barging facilities, vibrodensification of native soils, pile driving) may also have some potential to affect ambient water quality.

To prevent or minimize potential Project-related changes in ambient water quality, mitigation measures will be implemented to maintain turbidity levels within the B.C. WQG (B.C. MOE 2006a) and CCME *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014) (see **Table 4.4-2**). These include undertaking instream activities between July 16 and February 28 (FREMP 2006) to the extent that is technically feasible and viable, and use of a hydraulic suction dredge where possible to reduce the amount of re-suspended sediment.

Some CRA fish, in particular sturgeon, are known to be present within the lower Fraser River throughout the year including the period outside the aforementioned least-risk fisheries timing window of July 16 to February 28. However, turbid conditions appear to be favoured by sturgeon and migrating adult salmon are adapted to inhabit and transit through this highly turbid environment. Therefore, potential effects to habitat quality resulting from changes in ambient water quality are not considered further in this assessment.

Localized disturbance of sediments will occur in Deas and Green sloughs as a result of pile driving and vibrodensification of native soils. As noted above, concentrations of metals greater than those found in the sandy sediments of the Fraser River South Arm in the vicinity of the Project alignment have been documented in the sediments of Deas Slough historically and during field sampling conducted in September 2014. Proposed mitigation measures to limit the dispersion of these sediments during instream works are described in **Section 4.4.4**.

Accidental spills of toxic or hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete), or potential failure of sediment containment measures could result in changes to ambient water quality during Project-related construction activities. Potential changes to ambient water quality resulting from accidents or malfunctions during Project construction are assessed in **Section 8.0 Accidents and Malfunctions**.

Post construction, the increase in impervious surface area associated with the new bridge over the Fraser River South Arm and Deas Slough may result in the discharge of larger volumes of stormwater runoff into these watercourses. Contaminants in stormwater runoff can degrade ambient water quality and may result in toxicity to aquatic life. Mitigation measures to prevent or reduce adverse effects associated with stormwater runoff are described in **Section 4.4.4**. With respect to stormwater runoff, Aboriginal Groups expressed concern for potential project related effects on fish and associated fisheries as a result of highway runoff.

Upland Ditches

Clearing and grubbing along ditches within the LAA in support of Highway 99 widening and interchange upgrades have the potential to result in streamside disturbance, erosion, and sedimentation of the receiving aquatic environment. In addition, relocation or modifications to upland ditch also have the potential to result in changes to ambient water quality.

Construction activities that require works in and around red and dashed-red upland ditches will be conducted, where appropriate, within prescribed regional least-risk fisheries timing windows (i.e., July 15 to September 30; Delta 2003, B.C. MOE 2006b), in isolation of water flows, and with fish salvages as required. In general, instream works that may be required in upland ditches will be undertaken in accordance with provincial standards and best practices, including the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012), and will comply with the B.C. *Water Sustainability Act*. For more information on standard mitigation pertaining to instream works, refer to **Section 4.4.4**.

After implementation of mitigation, no changes to ambient water quality are expected in upland ditches during instream works. The majority of upland ditches within the Project alignment are of low values from a CRA fish habitat perspective (**Section 4.4.2.3**). Therefore, associated potential adverse effects to fish habitat quality are not considered further in this assessment.

Maintenance activities will comply with provincial standards and best practices, adhere to the provisions of the B.C. *Water Sustainability Act* (where applicable), and be undertaken in accordance with the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).

Widening of Highway 99 and interchange upgrades are expected to result in an increase of impervious surface area and consequently increased volumes of stormwater runoff that may enter upland ditches. Mitigation measures to prevent or reduce adverse effects associated with stormwater runoff are described in **Section 4.4.4**.

Potential Effect #6: Fish Habitat Alteration

Project-related activities that have the potential to alter fish habitat include: upgrades to existing riprap and new rip rap in the vicinity of the new bridge, removal of the Tunnel, and disturbance or realignment of ditches associated with interchange upgrades, highway widening, and construction of bridge approaches.

Fraser River South Arm, Deas Slough and Green Slough

The new bridge will have a clear span over the Fraser River South Arm. Instream construction activities will be limited to upgrading the existing riprap protection around the base of the bridge support towers. Tunnel removal will be undertaken such that the river banks will be left intact. No excavation and river training works will be required (see **Section 4.1 River Hydraulics and River Morphology**). The extent of fish habitat alteration associated with changes in river hydraulics and morphology as a result of slope armouring upgrades is considered negligible and consequently is not carried forward in the assessment.

Tunnel removal, and associated sediment removal and floating of the Tunnel segments will result in localized scour and sedimentation, as river flow is reduced over the trench left behind after the tunnel segments have been removed. The hydraulic/morphodynamic model (see **Section 4.1 River Hydraulics and River Morphology**) assumes that Tunnel removal will begin in mid-summer during the least-risk timing window, after freshet has receded and turbidity is relatively low, and that any effects will be instantaneous. Since Tunnel removal will actually occur over several months, model results are conservative (i.e., actual effects will likely be of lower magnitude than they would be if the Tunnel removal occurred all at one time).

The incremental change in sediment volume during Tunnel removal is predicted to range from one to nine per cent above ambient, which is considered low compared to existing TSS loads in the lower Fraser River. Elevated TSS may result in a short-term, localized increase in turbidity which will persist during the period in which the disturbance is occurring. Effects from re-deposition of suspended sediment are expected to be minimal.

Therefore, potential fish habitat alteration from sediment suspension and re-deposition in the LAA during Tunnel removal are considered negligible, and potential associated changes in habitat quality in the Fraser River South Arm are not considered further in this assessment.

Operation of the proposed clear-span bridge is not expected to affect river hydraulics and morphology on the Fraser River South Arm. On Deas Slough, where some instream foundations are expected to be located along the water edge, effects related to changes in flow conditions are not anticipated due to the backwater nature of this habitat. Potential associated changes in habitat quality from the new bridge are therefore not considered further in the assessment.

In the Fraser River South Arm, Tunnel removal is not anticipated to result in short-term bank erosion or create barriers to fish migration (**Section 4.1 River Hydraulics and River Morphology**). Predicted changes to river hydraulics and morphology are modest and will occur in a dynamic section of the river that has been previously affected by annual and historic dredging (**Section 4.1 River Hydraulics and River Morphology**), and other manmade disturbances to the river bed such as the downstream Metro Vancouver watermain.

Potential effects on habitat quality associated with decommissioning of the existing Tunnel are considered negligible. Sensitive life stages of salmonids migrating through or foraging in this section of the river tend to occupy the upper water column. As previously noted, eulachon spawning habitat is absent near the Tunnel crossing, while sturgeon overwintering habitat will continue to be present after the trench has naturally infilled. As a result, potential Project-related effects associated with fish habitat alteration are not considered further in the assessment (see **Section 4.4.5**).

Upland Ditches

Proposed highway improvements involving construction activities in and around upland ditches have the potential to alter fish habitat. As described in **Section 4.4.3**, instream works are proposed in or around 15 km (35 %) of total ditch length of dashed-red-, and orange-coded ditches within the LAA.

Most of these instream works will involve relocation of manmade, channelized watercourses (upland ditches), poorly connected to the tidal waters of the lower Fraser River (e.g., located upland of flood control infrastructure, included floodgates and pump stations) and with relatively low values from a CRA fish habitat perspective. Without mitigation, works in and around dashed-red- and orange-coded ditches with the potential to alter fish habitat include, but are not limited to, the following:

- Removal of vegetation cover, potentially resulting in increased water temperatures and decreased food/nutrient inputs
- Temporary flow diversion and ditch realignment, potentially resulting in impairment of ditch connectivity for fish
- Temporary impairment of fish habitat functions within upland ditches, until replacement and/or relocated channels become more mature

Potential encroachment on watercourses and fish habitats, as well as potential environmental effects resulting from ground disturbance and instream works, will be minimized as Project construction is proposed to occur primarily within the existing Highway 99 ROW. Project-related construction in and around ditches will be conducted in accordance with provincial standards and best practices, including the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012). For more information on standard mitigation pertaining to instream works, refer to **Section 4.4.4**.

Potential effects associated with fish habitat alteration in upland ditches during Project construction are expected to be negligible.

Project activities during operation with the potential to result in fish habitat alteration in upland ditches include highway maintenance activities, such as ditch cleaning, removal of in-channel vegetation, brushing, and clearing.

Instream works will be conducted in accordance with provincial standards and best practices, including the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010) (see **Section 4.4.4**).

Given the low existing values, no potential fish habitat alteration in upland ditches during Project operation is anticipated and resultant changes in habitat quality of these manmade watercourses are not considered further in this assessment.

Potential Effect #7: Changes in Fish Habitat Quantity

Changes in habitat quantity involve the direct loss of fish habitat associated with overlap of Project components with fish habitat. Loss of habitat that supports CRA fish can be expected to meet the definition of serious harm under the *Fisheries Act*. Potentially affected aquatic habitats include highly productive (red-coded) tidal brackish marsh, and intertidal and shallow subtidal channel areas of Deas and Green sloughs. Fish habitat loss has the potential to affect fisheries productivity, because it may result in a measureable reduction in the slough's productive capacity as year-round rearing habitat for CRA fish, including juvenile Pacific salmon.

The new bridge is proposed as a clear span structure over the Fraser River South Arm and without any instream supports; however, there will be a small overlap between bridge/approach support piers and the edges of Deas Slough and Green Slough. The nature and extent of this overlap was determined by overlaying the proposed alignment on the terrestrial ecosystem maps for the assessment area. As shown in **Table 4.4-5**, this exercise indicated that Project alignment overlap with fish habitat is expected to be limited to portions of Deas Slough and Green Slough.

Mitigation measures to minimize the potential loss of fish habitat during Project construction are discussed in **Section 4.4.4**.

Table 4.4-5 Estimated Fish Habitat Losses Associated with Construction of the New Bridge and Approaches

| Structure | Estimated Habitat Loss (m ²) | |
|---------------------------|--|---------------|
| | Instream Area | Riparian Area |
| Deas Slough Piers Total | 2,027 | 2,080 |
| Green Slough Piers Total | 5,707 | 1,654 |
| Total Habitat Loss | 7,734 | 3,734 |

Activities during the Project’s operation phase are not anticipated to result in the permanent loss of fish habitat. As a result, changes in fish habitat quantity during Project operation are not considered further in this assessment.

4.4.4 Mitigation Measures

A hierarchical approach based on the four types of mitigation as outlined below was used in identifying strategies to avoid or minimize potential Project-related effects:

- **Avoidance:** Measures to avoid potential effects on the VC have been/will be incorporated into project considerations such as site and route selection, project scheduling, project design, and construction and operation procedures and practices.
- **Minimization:** Where potential effects on the VC cannot be avoided through project considerations, standard mitigation measures, best management practices (BMPs), and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels.
- **Restoration or Habitat Enhancement:** Where potential Project-related effects cannot be avoided or minimized through standard mitigation measures, best practices, or implementation of EMPs, affected components will be restored on-site to pre-Project conditions.
- **Compensation/offset:** Where on-site restoration is not feasible, appropriate means to counteract, or make up for potential Project-related effects on the VC will be identified.

4.4.4.1 Avoidance

The design for the new bridge includes a clear span across the Fraser River South Arm, thereby avoiding instream footprint effects in the river mainstem.

4.4.4.2 Minimization

Selection of measures to minimize unavoidable effects of the Project has been informed by a review of standard industry and BMPs; consideration of mitigation measures and follow-up programs undertaken for past developments by the Ministry; input from regulators, public and Aboriginal Groups; and evaluation of the technical and economic feasibility of proposed measures. Design considerations, standard industry practices and BMPs proposed to avoid or minimize effects on fish and fish habitat described in the following key documents have also informed the development of Project-specific mitigation measures as discussed in this section:

- *Measures to Avoid Causing Harm to Fish and Fish Habitat* (DFO 2013a).
- *Fisheries Productivity Investment Policy: A Proponent's Guide to Offsetting* (DFO 2013b).
- *Environmental Management Strategy for Dredging in the Fraser River Estuary* (FREMP 2006).
- *Dredge Management Guidelines* (FREMP 2005).
- *2012 Standard Specifications for Highway Construction* (B.C. MOTI 2012).
- *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).
- *Standards and Best Practices for Instream Works* (B.C. MWLAP 2004).
- *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (B.C. MOE 2014).
- *Best Management Practices for Pile Driving and Related Operations* (B.C. MPDCA 2003).
- *Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck et al. 1993).
- *Riparian Restoration Guidelines* (B.C. MOE 2008).
- *Tree Replacement Criteria* (B.C. MELP 1996).

Project Design

Highway 99 improvements are proposed to occur primarily within the existing Highway 99 ROW. Potential encroachment on fish habitat, as well as potential effects resulting from instream works, ground disturbance, clearing, and grubbing of riparian vegetation will be minimized and restricted within the ROW.

Design and construction of the new bridge crossing will conform to standards outlined in the Canadian Highway Bridge Design Code (CHBDC) CAN/CSA S6-06, and the Ministry's Supplement to CHBDC S6-06 *Bridge Standards and Procedures Manual* (B.C. MOTI 2007).

The new bridge design will incorporate stormwater management considerations to mitigate potential effects to fish and fish habitat due to storm runoff-related changes in ambient water quality in the Fraser River South Arm during. This will involve the management and treatment of stormwater runoff from the bridge deck, with stormwater flows diverted away from the river and into stormwater detention ponds.

To prevent or minimize potential effects associated with stormwater runoff during highway operation, roadside ditches will be designed to maintain ambient water quality and pre-development flow regimes. Mitigation measures will include the incorporation of vegetated shoulders and drainage swales, stormwater storage facilities to control runoff rates, headwall structures in culverts, wide bottom ditches, and stormwater management ponds for flood protection.

Best Management Practices and Environmental Management

Environmental protection measures that will be implemented during Project construction and operation to prevent or minimize potential effects on fish and fish habitat will be outlined in a Construction Environmental Management Plan (CEMP) and subsequently in an Operational Environmental Management Plan (OEMP), as described in **Section 12.0 Management Plans**. The CEMP and OEMP will include Fish and Fish Habitat Management Plans that describe mitigation measures to avoid or minimize potential Project-related adverse effects to fish and fish habitat, including physical injury or direct mortality, exposure to underwater noise or elevated TSS levels, and potential changes in fish habitat quality. The plan will comply with best practices, including:

- *Standard Specifications for Highway Construction* (B.C. MOTI 2012).
- *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).

As described below, the plan will identify regional least-risk timing windows during which Project construction and operation activities with the potential to cause adverse effects to fish and fish habitat can be undertaken. Alternatively, instream work can proceed after implementation of mitigation approaches that protect fish and fish habitat. The plan will also describe the approach and measures to mitigate potential effects from elevated underwater sound and TSS levels.

Timing Windows

To the extent that is technically feasible and viable, sediment removal for Tunnel removal and realignment of Green Slough for bridge support structure construction will be undertaken between July 16 to February 28, the least-risk timing window for the protection of juvenile salmon and eulachon (FREMP 2006). Other CRA fish species can be expected to receive some level of protection from adherence to this instream construction window.

Project construction activities (e.g., site preparation and installation of equipment lay-down areas, highway widening, and interchange upgrades) and Project operation activities (e.g., routine highway and ditch maintenance) involving instream work on upland ditches with CRA fish habitat values will be undertaken during prescribed regional least-risk fisheries timing windows (i.e., July 15 to September 30; Delta 2003, B.C. MOE 2006b), or alternative mitigation approaches will be implemented to protect fish. For example, alternative mitigation may include isolation of flow and pump-arounds, to facilitate work in-the-dry supported by fish (and aquatic life) salvages.

Least-risk timing windows, by their nature, have been developed as standard mitigation measures by regulators (e.g., B.C. FLNR and DFO) to limit activities that involve changes in and around water to periods of least risk. Adherence to the prescribed least-risk timing windows is therefore anticipated to be very effective at minimizing potential effects to fish and fish habitat. Should instream work outside a least-risk timing window be required, the application of alternative mitigation measures as described above is also expected to be effective in protecting fish as well as other aquatic life. The success of adhering to timing windows and/or the application of alternative mitigation measures will be continuously verified through environmental monitoring efforts (see below).

Mitigation of Underwater Noise Effects

Construction activities that have the potential to generate underwater noise will adhere to BMPs and other standard industry practices which set appropriate sound thresholds for the protection of fish. Specifically, *BMPs for Pile Driving and Related Operations* will be adhered to so that underwater noise does not exceed sound levels (i.e., SPL_{peak} 210 dB re 1 μ Pa) that may cause harm to fish (B.C. MPDCA 2003).

Impact pile driving, vibratory pile driving and vibrodensification of native soils during Project construction are anticipated to be the most notable sources of underwater noise (**Section 4.4.3.2**). The potential effects of underwater noise on fish will be avoided or minimized by limiting the occurrence of these activities to land or shallow water along the edge of Deas Slough. For activities that have the potential to generate underwater sound levels in exceedance of thresholds causing physical injury to fish, underwater noise monitoring will be conducted. If considered necessary, additional mitigation measures will be deployed.

As described above, the most effective mitigation measure for avoiding potential effects from underwater noise will be limiting activities with the most notable sources of ambient noise levels to land or shallow water environments. The effectiveness of this mitigation will be confirmed through construction monitoring. If, during a noise-generating activity, a threshold is either exceeded or negative effects to fish in the immediate vicinity of the activity are noted, the activity will cease until additional mitigation measures are implemented.

Mitigation of Effects from Turbidity or Elevated Levels of Total Suspended Solids

Construction activities with the potential to adversely affect fish and fish habitat through increased turbidity and elevated TSS levels will adhere to BMPs and standard industry practices that specify water quality criteria to be met for the protection of fish and fish habitat. To prevent or minimize elevated turbidity and TSS levels associated with Project-related construction activities, mitigation measures will be implemented to maintain levels within the CCME (2002) and B.C. (B.C. MOE 2006a) WQG (see **Table 4.4-2**). Measures that will be implemented to mitigate effects from turbidity or elevated TSS levels in the Fraser River South Arm, and Deas and Green sloughs, as well as provisions for water quality monitoring are described in **Section 4.2 Sediment and Water Quality**. In and around upland ditches, standard industry practices and BMPs that will be adhered to during Project construction activities will include, but will not be limited to:

- Demarcation of vegetation clearing limits on drawings and in the field.
- Delineation (flagging or fencing) in the field of environmentally sensitive no work areas.
- Temporary water diversion, ditch isolation, and fish salvage/relocation to suitable aquatic habitats outside the Project's immediate zone of influence.
- Ditch realignment in accordance with applicable standards and guidelines (e.g., B.C. MWLAP 2004, B.C. MOTI 2012).
- Restoration and revegetation or hydroseeding of cleared areas promptly after use.
- Implementation of a riparian planting design to enhance pre-Project condition, according to applicable riparian restoration guidelines (e.g., B.C. MELP 1996, B.C. MOE 2008).

Erosion and Sediment Control plans within the CEMP and OEMP will describe measures to be followed to avoid or minimize potential physical injury or direct mortality of fish from elevated TSS levels, or changes in fish habitat quality resulting from degradation of ambient water quality due to induced turbidity, and re-mobilization of sediment contaminants. The plans will comply with the *Fisheries Act*, the B.C. *Water Sustainability Act* and associated Water Regulation, provincial standards and best practices, including:

- *Standard Specifications for Highway Construction* (B.C. MOTI 2012).
- *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).

Erosion and sediment control measures to be implemented during Project construction and operation (bridge and highway maintenance) activities, including works in and around upland ditches will include, but will not be limited to:

- Minimizing the extent and duration of ground disturbance.
- Installing functional erosion and sediment control measures at potentially affected watercourses prior to the onset of Project construction and operation activities.
- Maintaining (repairing or replacing) functional erosion and sediment control measures throughout Project construction and operation (highway maintenance phases).
- Operating construction equipment in-the-dry from the top top-of-bank of watercourses
- Restoration, revegetation or hydroseeding of cleared areas promptly after disturbance, according to applicable riparian restoration guidelines (e.g., B.C. MELP 1996, B.C. MOE 2008).

Erosion prevention and sediment control measures to be implemented in Deas and Green sloughs to control the dispersion of re-suspended sediments generated during ground improvements, pier construction activities, and removal of existing infrastructure may include:

- Developing temporary drainage systems to receive, filter, and direct stormwater and runoff during construction
- Installation of sediment control measures (e.g., turbidity curtains)
- Developing sediment settlement ponds, if required
- Re-stabilization of vegetated areas that are cleared or disturbed during construction
- Careful storage of waste material and soil to prevent possible entry into the aquatic environment

Specific mitigation to be implemented during Tunnel decommissioning to maintain TSS levels within the CCME and B.C. WQG may include such measures as using a hydraulic (hopper or cutter) suction dredge where possible during fill removal to reduce the amount of re-suspended sediment. Removed material is expected to be transported off-site using spoil barge(s) equipped with a sediment containment system (e.g., filter cloth, concrete lock blocks, straw bales).

Environmental Monitoring

The environmental monitoring approach and procedures to be followed during Project construction to evaluate the effectiveness of mitigation measures intended to avoid or minimize potential Project-related adverse effects to fish and fish habitat will be described in the CEMP. The plan will comply with the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012).

A description of water quality monitoring during Project construction in the Fraser River South Arm and the sloughs, is provided in **Section 4.2 Sediment and Water Quality**.

A description of underwater noise monitoring during Project construction in the Fraser River South Arm and the sloughs, is included in **Section 4.3 Underwater Noise**.

4.4.4.3 Habitat Enhancement

Proposed Project design provides the following opportunities to enhance fish habitat within and adjacent to the Project alignment:

- Restoration of historic Green Slough under the new south approach span into a small embayment on Deas Slough, and creation of 1,700 m² of instream (intertidal and shallow subtidal) habitat and 1,275 m² of riparian habitat.
- Restoration of 125 m² of shallow subtidal fish habitat in Deas Slough, following removal of the existing Deas Slough Bridge instream support piers.

Additional habitat to offset the difference between habitat lost and habitat enhanced will be described in a Fish Habitat Offsetting Plan, as described below.

Habitat enhancement features are generally anticipated to become productive within the first year and become fully productive and viable within 3 to 5 years following restoration. Effectiveness of Project-related habitat enhancement features will be closely monitored and managed through a follow-up monitoring program.

4.4.4.4 Habitat Offsetting

Unavoidable footprint effects of the Project on Deas Slough and Green Slough will be offset through the development of comparable habitat. A Fish Habitat Offsetting Plan will be developed in consultation with regulatory authorities. The offsetting plan will identify on- or near-site offsetting opportunities and outline offsetting implementation methods. Offsetting options described in this plan will be designed to maintain or improve the productivity of CRA fisheries. Offsetting options currently under consideration include:

- Other on- or near-site offsetting opportunities expected to offset any outstanding fish habitat losses, including tidal habitats and adjacent riparian areas of comparable or higher value than the impacted habitat (e.g., construction of intertidal fish habitats on Deas Island within the Highway 99 ROW to provide long-term substantive benefits to CRA fish).

As with habitat enhancement sites, habitat offsetting features are expected to provide some immediate benefits (e.g., construction of new tidal habitat features), and become fully productive and viable within 3 to 5 years. To address the potential risk associated with offsetting habitat(s) not becoming fully functional, effectiveness of these features will be confirmed through a follow-up monitoring program.

Through implementation of a Fish Habitat Offsetting Plan, changes in fish habitat quantity resulting from permanent fish habitat loss will be avoided and are therefore not considered further in this assessment.

4.4.5 Residual Effects and their Significance

After implementation of measures described above, the following potential adverse effects to fish and fish habitat during construction are not expected to be fully mitigated, and are considered further in this assessment:

- Physical injury or mortality to fish from crushing or entrainment
- Physical injury or mortality due to exposure to elevated levels of total suspended solids

Potential residual effects to fish and fish habitat are characterized with respect to the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of each anticipated residual effect. Definitions for ratings applied to residual effects criteria, developed with specific reference to fish and fish habitat are presented in **Table 4.4-6**. Summaries of criteria ratings for the potential residual effects are provided in **Table 4.4-7** (Physical injury or direct mortality to fish from crushing or entrainment) and **Table 4.4-9** (Injury or Mortality due to exposure to elevated levels of total suspended solids). Context, i.e., sensitivity and resilience of fish and fish habitat, based on existing conditions, to changes was also taken into account in characterizing potential Project-related residual effects.

Table 4.4-6 Criteria Used to Characterize Residual Effects on Fish and Fish Habitat

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|--|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project. |
| | | Positive | Beneficial effect as a result of the Project. |
| | | Neutral | Neutral effect as a result of the Project. |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible | No measurable change in fish populations, fish habitat quality or quantity, or contaminant levels. |
| | | Low | A measurable change within the range of natural variability, but not affecting fish population viability. |
| | | Moderate | A measurable change outside the range of natural variability, but not posing a risk to fish population viability. |
| | | High | A measurable change outside the range of natural variability and may affect long-term fish population viability. |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project alignment. |
| | | Local | Effect is restricted to the LAA. |
| | | Regional | Effect is restricted to the RAA. |
| Duration | Length of time over which the residual effect is expected to persist | Transient term | Effect occurs once during Project construction or operation. |
| | | Short term | Effect occurs throughout Project construction or operation. |
| | | Moderate term | Effect persists until the first freshet following Project construction or operation before returning to existing conditions. |
| | | Long term | Effect persists beyond the first freshet following Project construction or operation before returning to existing conditions and is unlikely to return to existing conditions. |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor affects the VC) | Rare | Effect occurs once during Project construction or operation. |
| | | Uncommon | Effect occurs intermittently during Project construction or operation. |
| | | Frequent | Effect occurs frequently during Project construction or operation. |
| | | Continuous | Effect occurs continuously during Project construction or operation. |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Baseline conditions will be naturally restored after disturbance has ceased. |
| | | Irreversible | Baseline conditions will not be naturally restored after disturbance has ceased. |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance. |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 25%. |
| | | Moderate | Likelihood of residual effect is between 25% and 75%. |
| | | High | Likelihood of residual effect is greater than 75%. |

Residual Effect #1: Physical Injury or Mortality to Fish from Crushing or Entrainment

Activities associated with Tunnel removal have the potential to result in physical injury or direct mortality of fish, particularly demersal fish species, such as sturgeon. While low, there remains a risk of crushing or entrainment of smaller size classes of juvenile sturgeon in the event that Project-related sediment removal occurs within deep holding areas where sturgeon aggregate. Low numbers (up to five individuals) of juvenile sturgeon are known to aggregate in deep (>10 m) mainstem pools within the Fraser River South Arm. Such features have been identified in Annacis Channel (approximately nine kilometres upstream of the Tunnel) and upstream of the New Westminster trifurcation. Although the river deepens appreciably (>20 m) immediately downstream of the Tunnel along the south bank, holding areas for juvenile sturgeon have not been identified at that location.

The risk may be higher if Project-related sediment removal occurs during the winter months when water temperature drops below 7°C, and juvenile sturgeon become more sedentary within overwintering habitats (Neufeld et al. 2010, Ghilarducci and Reeve 2012). However, residual effects to fish from physical injury are expected to be of low magnitude, to occur only during sediment removal, and to be limited to the immediate vicinity of the sediment removal operations. An overview of the criteria ratings for this residual effect is presented in **Table 4.4-7**.

Context for Characterization Ratings for Residual Effect #1: Project-related sediment removal is proposed to occur in a dynamic section of the river, where maintenance dredging of sections of the navigation channel is conducted on an annual basis. Near-bed water flows are also high at this location, uncharacteristic of low to moderate flow velocities that appear to be more typical of holding and overwintering areas preferred by sturgeon.

Although most fish tend to disperse away from the noise and physical disturbance associated with sediment removal, it is possible that juvenile sturgeon may be entrained if they are unable to swim away from the disturbance. Increased turbidity may also temporarily increase organic matter in the water column and cause sturgeon to perceive greater food availability and swim towards the disturbance. In the lower Fraser River, juvenile white sturgeon as small as 19 cm have been caught upstream of the Annacis Channel and the presence of smaller size classes of sturgeon cannot be precluded from the Fraser River South Arm including the Project alignment (Glova et al. 2008, 2009). As a result, entrainment and loss of a few individual fish may occur during Project-related sediment removal; however, this is not expected to adversely affect overall population integrity.

Fish that do disperse are likely to return to the affected area soon after the disturbance has ceased. Substantial areas of alternative feeding and holding habitat to accommodate any dispersed fish also exist outside of the proposed Project alignment.

Table 4.4-7 Criteria Ratings for Residual Effect #1: Physical Injury or Mortality to Fish Resulting From Crushing or Entrainment

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Individual demersal fish that may be present where in-river Project construction activities are occurring may experience physical injury or direct mortality through crushing or entrainment. |
| Magnitude | Low | Change will be within the range of natural variability and is not expected to adversely affect fish population viability. A measureable change is not expected to apply, as only low numbers of individual demersal fish may be directly affected by these construction activities. |
| Extent | Site | Spatial extent will be restricted to the area of disturbance. |
| Duration | Transient term | Effect will occur only during Tunnel removal. |
| Frequency | Rare | Effect will occur only in association with Tunnel removal. |
| Reversibility | Reversible | Affected fish populations are expected to return to baseline conditions. |
| Likelihood | Low | Similar habitat for sturgeon and other demersal species is abundant outside the RAA. Only smaller fish size classes are expected to be at any risk and small numbers are expected to be present during in-river Project construction activities. |

Residual Effect #2: Physical Injury or Mortality to Fish Due to Exposure to Elevated Levels of Total Suspended Solids

Activities associated with Tunnel removal in the Fraser River South Arm and Green Slough realignment have the potential to result in physical injury or direct mortality of fish due to exposure to elevated levels of total suspended solids. Although mitigation measures will be applied to minimize the exposure of fish to elevated TSS levels during these activities, such measures will not completely remove the potential for residual effects on some fish species and life history stages. As the primary mitigation measure, adherence to the least-risk work window of July 16 through February 28 will provide for the substantial avoidance of sensitive life history stages, most notably upstream-migrating adult eulachon and downstream-migrating juvenile Pacific salmon, and eulachon larvae. There are, however, fish present within the river on a year-round basis, and the aforementioned timing window does not provide for avoidance of upstream-migrating adult Pacific salmon or trout and char that are present within a broader timeframe. Although fish populations are well-adapted to the turbid waters of the Fraser River and are often exposed to other sources of elevated TSS levels (both natural and human-sourced), it is recognized that both physical injury and direct mortality can apply in some cases.

Demersal fish species, including sturgeon, are less likely to be adversely affected by elevated TSS levels, given their ecology and physiology. The impact of sediment generation on non-demersal fish during these activities will depend on the ambient suspended sediment concentrations at the time of the works. It is assumed that Tunnel removal will commence in mid-summer and will likely occur after freshet flows have receded, and extend into the winter low-flow period. Suspended sediment volume is predicted to temporarily increase between one per cent and nine per cent over ambient levels during the course of the disturbance. This increase is considered low, given the natural variability of suspended sediment seasonally and annually in the river main channel. Any elevated TSS levels generated during realignment of Green Slough is less likely to be transported and fewer fine sediments would remain in suspension. An overview of the criteria ratings for effects associated with construction-related increase in TSS levels is presented in **Table 4.4-8**.

Context for Characterization Ratings for Residual Effect #2: It is noted that most fish tend to disperse away from impaired water quality, especially when there are opportunities to do so. By avoiding sensitive life history stages (juvenile Pacific salmon and larval eulachon), potential effects of elevated TSS levels will generally be limited to fish that are more active and strong swimmers that can swim away from zones of temporarily impaired water quality. Although it is still possible that physical injury or direct mortality may apply to small numbers of fish, this is not expected to adversely affect overall population integrity. Fish that do disperse are likely to return to the affected area soon after the disturbance has ceased. In addition, substantial areas of alternative migratory, holding, and feeding habitat is present within the wide channel of the Fraser River South Arm to temporarily accommodate any dispersed fish. Similarly, within Green and Deas sloughs there are extensive alternate habitat areas for any dispersed fish that may be present.

Table 4.4-8 Criteria Ratings for Residual Effect #2: Physical Injury or Mortality to Fish Due to Exposure to Elevated Levels of Total Suspended Solids

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|--|
| Direction | Adverse | Individual fish that may be present at, or in close proximity to, in-river or in-slough Project construction activities may experience physical injury or direct mortality due to exposure to elevated levels of total suspended solids. |
| Magnitude | Low | Change will be within the range of natural variability and is not expected to adversely affect fish population viability. A measureable change is not expected to apply, as only low numbers of individual fish may be directly affected by these construction activities. |
| Extent | Site | Spatial extent will be restricted to, or in close proximity to, the area of disturbance. |
| Duration | Transient term | Effect will occur only during Tunnel removal (Fraser River South Arm) and partial infilling activities (Green Slough). |
| Frequency | Rare | Effect will occur only in association with Tunnel removal (Fraser River South Arm) and partial infilling activities (Green Slough). |
| Reversibility | Reversible | Affected fish populations are expected to return to baseline conditions. |
| Likelihood | Low | Similar habitat for potentially affected species is abundant outside the RAA. Only a small subset of CRA fish species and age/size classes are expected to be at risk and only small numbers are expected to be present during in-river and in-slough Project construction activities. |

4.4.5.1 Determination of Significance of Residual Adverse Effects

Significance Definition

A significant adverse residual effect to fish and fish habitat is one that may cause a decline in fish abundance or change in fish distribution to a level at which long-term population integrity is compromised. For a residual adverse effect to be considered significant, re-establishment of the population through natural recruitment (e.g., reproduction or immigration from unaffected areas) would not be expected to occur within a fish species' generation time, after the disturbance has ceased. Fish sub-components that are most susceptible to population effects as a result of the Project are those with longer generation times, such as sturgeon. Fish sub-components with shorter generation times are more likely to re-establish population levels following an adverse effect.

Significance Determination

The significance determination of residual effects to fish and fish habitat is presented in **Table 4.4-9**.

Likelihood characterization was based on professional judgement, with effects defined as those having low, moderate, or high probability of resulting in an adverse residual effect on fish and fish habitat. Low, moderate, or high confidence reflects the level of uncertainty associated with determinations of significance and likelihood.

The residual effect of physical injury or direct mortality of individual fish during Project construction (i.e., from crushing/entrainment or exposure to elevated levels of total suspended solids) is not expected to affect the population integrity of any fish sub-components. Adherence to prescribed least-risk timing windows and implementation of standard industry practices and mitigation measures will limit the extent and magnitude of Project-related effects, and reduce the likelihood of individual fish injury or mortality. As such, the potential residual effects of physical injury or direct mortality are both assessed as not significant. Confidence in the assessment is high due to the localized nature of the effects and the corresponding absence of an anticipated effect on population integrity.

Table 4.4-9 Summary of Determination of Significance of Residual Effects for Fish and Fish Habitat

| Residual Effect | Significance (significant/not significant) | Likelihood (low/moderate/high) | Level of Confidence (low/moderate/high) |
|--|--|--------------------------------|---|
| Residual Effect: Physical injury or mortality due to crushing or entrainment | Not significant | Low | High |
| Residual Effect: Physical injury or mortality due to exposure to elevated levels of total suspended solids | Not significant | Low | High |

4.4.6 Cumulative Effects Assessment

This section describes the assessment of potential cumulative effects associated with residual effects to fish and fish habitat. The combination of the residual Project effects in concert with the effects of other certain and reasonably foreseeable projects and activities comprise the future cumulative effects.

Spatial Boundaries

The spatial boundary of the cumulative effects assessment for fish and fish habitat is defined as the section of the Fraser River South Arm extending from the river mouth to 1,000 m upstream of the Project alignment, and Project alignment plus 500 m on either side of the Project alignment in upland area. The extent of the cumulative effects assessment area coincides with that of the RAA (Table 4.4-3).

Other Certain and Reasonably Foreseeable Projects and Activities

Annual maintenance dredging along sections of the navigation channel within the Fraser River South Arm is the only certain and reasonably foreseeable activity that could interact temporally and spatially with the Project. Maintenance dredging is undertaken annually to maintain adequate depth to accommodate vessel draft (FREMP 2006). Vancouver Fraser Port Authority performs annual maintenance dredging operations in the Fraser River South Arm, which are managed in a way that minimizes adverse effects to fish and fish habitat. Dredging operations adhere to BMPs, including use of suction dredging, avoidance of productive fish habitat areas, and adherence to least-risk timing windows (i.e., July 16 to February 28) for the protection of juvenile salmon and eulachon (FREMP 2006).

Cumulative Interactions and Potential Cumulative Effects

It is assumed that future maintenance dredging operations within the navigation channel of the Fraser River South Arm will continue to be undertaken by Vancouver Fraser Port Authority in a manner that minimizes adverse effects to fish and fish habitat. The potential for an interaction with the effects of the Project resulting in residual effects would depend on the timing and location of the maintenance dredging relative to the Project alignment. It is considered very unlikely that maintenance dredging within the RAA would be scheduled to coincide, spatially or temporally, with the Project's in-river construction activities, including Tunnel removal or partial infilling of Green Slough. Therefore, no cumulative effects to fish and fish habitat are anticipated as a result of an interaction between the Project and future annual maintenance dredging.

4.4.7 Follow-up Strategy

Monitoring will be conducted during and after construction to ensure the mitigation measures identified in **Section 4.4.4** are implemented and expected outcomes in terms of avoiding or minimizing effects on fish and fish habitat are achieved. Broadly, monitoring will include the following:

- Fish habitat monitoring in the vicinity of the Project alignment during construction (including Tunnel removal and decommissioning of any temporary construction-related facilities and post-construction to record any physical habitat changes as a consequence of the Project. During the post-construction period, monitoring will be conducted until the trench has infilled and the riverbed has returned to a stable state. This monitoring will involve ongoing assessment and evaluation of fish habitats located in close proximity to the Project, including fish habitat reference sites within the Fraser River South Arm, Deas Slough and Green Slough.
- Water quality monitoring during Project construction to ensure turbidity levels are maintained below thresholds for the protection of aquatic life.
- Hydrophone monitoring (when applicable) during Project construction activities that have the potential to generate underwater noise to ensure sound levels are maintained below relevant thresholds.

Further follow-up may be undertaken, subject to the results of these monitoring measures and discussion with regulatory agencies.

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APPENDIX A

Overview of Potential Project Interactions with Fish and Fish Habitat

Table 1 Overview of Potential Project Interactions with Fish and Fish Habitat

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|---|--|
| Fish and Fish Habitat | | | |
| Pre-Construction / Site Preparation | | | |
| Pre-Construction / Site Preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Acquiring property for the Project • Relocating utilities | <p>Nature of interaction: No interaction anticipated</p> <p>Rationale: All activities to be land-based</p> |
| | No effect | <ul style="list-style-type: none"> • Conducting additional site investigations (i.e. geotechnical drilling program) | <p>Nature of interaction: Riverbed disturbance associated with additional site investigations (e.g., in the vicinity of the Tunnel)</p> <p>Rationale: Riverbed disturbance expected to be localized with low-volume of re-suspended sediment</p> |
| | Potential Effect | <ul style="list-style-type: none"> • Clearing and grubbing vegetation within the existing Highway 99 ROW • Installing temporary roads, laydown areas, and site offices • Installing temporary bridges and barging facilities • Installing temporary drainage structures and diversions • Preloading for embankment and highway construction • Restoration of Green Slough to its historic alignment | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Potential decrease in ambient water quality in upland watercourses due to sedimentation during clearing and grubbing, and in the Fraser River and sloughs due to sedimentation during installation of temporary barging facilities • Acoustic effects to fish from noise during ground improvements for new bridge piers (i.e., vibrodensification of native soils) • Accidental spills of deleterious substances (e.g., concrete fines, concrete wash water) (see Section 8.0 Accidents and Malfunctions) |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing retaining walls • Installing drainage structures/settling ponds • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment | <p>Nature of interaction: No interaction anticipated Rationale: Proposed activities to include use of precast concrete structures and to be land-based</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Realignment of Green Slough • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Physical injury or direct mortality to fish from elevated TSS levels • Physical injury or direct mortality to fish due to auditory injuries from pulsed noise (i.e., impact pile driving) • Changes in fish habitat quality due to acoustic effects to fish from continuous noise (vibratory pile driving, in-river operation of construction vessels, machinery, and equipment), and changes to ambient water quality from sedimentation in the Fraser River and sloughs • Changes to fish habitat quantity due to permanent placement of in-stream piers in Deas and Green sloughs, and partial infilling of Green Slough |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|--|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Potential changes to ambient water quality due to sedimentation in upland watercourses • Accidental spills of deleterious substances (e.g., concrete debris, asphalt, hydraulic fluids) into upland watercourses (see Section 8.0 Accidents and Malfunctions) |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|--|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> • N/A | <ul style="list-style-type: none"> • N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite recycling and operating support vessels for that activity | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Physical injury or direct mortality from crushing or entrainment, and elevated TSS levels • Changes in fish habitat quality due to acoustic effects to fish from noise (jetting, mechanical demolition, tug and equipment operation), changes in ambient water quality as a result of induced turbidity, and alteration of fish habitat as a result of riverbed lowering, local scouring |
| Decommissioning of Deas Slough Bridge | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Potential changes to ambient water quality from localized sedimentation during removal of instream concrete piers • Accidental spills of deleterious substances (e.g., concrete debris, asphalt debris, hydraulic fluids) into the river and slough (see Section 8.0 Accidents and Malfunctions) |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|---|--|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | • N/A | N/A |
| | No effect | • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges. • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.). | Potential Project-related effects include: <ul style="list-style-type: none"> • Changes in ambient water quality resulting from increased stormwater runoff into upland watercoursees due to increase in impervious surface • Alteration of fish habitat due to watercourse maintenance activities, vegetation and debris removal, temporary disruption of natural channel flows • Accidental spills of deleterious substances (e.g., asphalt, hydraulic fluids) into upland watercoursees (see Section 8.0 Accidents and Malfunctions) |
| New bridge | No interaction | • N/A | N/A |
| | No effect | • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Operating the new bridge. • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.). | Potential Project-related effects include: <ul style="list-style-type: none"> • Potential changes in ambient water quality resulting from increased stormwater runoff into the river due to increase in impervious surface • Accidental spills of deleterious substances (e.g., asphalt, hydraulic fluids) into manmade watercourses (see Section 8.0 Accidents and Malfunctions) |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.5 At-risk Amphibian Assessment Highlights:

- The Project is located primarily within the existing, previously disturbed Highway 99 right-of-way, and suitable habitat within the Project alignment is limited.
- At-risk amphibians were not detected within the Project alignment during field studies undertaken in 2014 and 2015. The potential for at-risk amphibians to occur within the Project alignment is low.
- Applying mitigation, including least-risk timing windows, and adherence to standard practices for undertaking in-stream works and highway maintenance activities, will ensure that Project-related effects on at-risk amphibians are addressed.
- No Project-related residual or cumulative effects on at-risk amphibians are expected.

4.5 At-risk Amphibian Assessment

This section presents the results of the assessment of potential effects of the Project on at-risk amphibians, and includes a description of existing conditions, potential Project-related effects and proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects.

4.5.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on at-risk amphibians in terms of Project setting and defines the spatial and temporal assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

No jurisdictional, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects, accessibility constraints, or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore, administrative or technical boundaries do not exist for this VC and are not discussed further.

4.5.1.1 Assessment Context

Amphibians are an important component of aquatic and terrestrial ecosystems and the Lower Mainland region supports a diversity of amphibian species. Areas along the Project alignment, such as Burns Bog in Delta and the Richmond Nature Reserve in Richmond, provide habitat for amphibians. However, previous introduction of two invasive amphibian species and a variety of other stressors, including introduced pathogens and urban, industrial, and agricultural development, have likely contributed to the decline of native amphibian species in this area from historic levels (BC MOE 2014). No long-term trend monitoring is being conducted in the regional assessment area (RAA) and the variety of current projects and activities in the RAA that affect amphibians are not required to monitor and report on their effects. As such, the current ecological trend for amphibians in relation to the effects of other projects is not well understood.

This assessment is focused on the potential effects to at-risk amphibians, these being the ones with potential sensitivity to Project-related effects. In addition to having the potential to interact with and be affected by the Project, at-risk amphibians are of interest to the public, Aboriginal Groups, and/or the government agencies. There are also legally binding requirements that protect certain species and, in some cases, their habitat. Additional information supporting the selection of at-risk amphibians as a VC is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.5.1.2 Methodology

The assessment of at-risk amphibians follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Building on this approach, the assessment of at-risk amphibians was designed to focus on two specific at-risk amphibian species that have the potential to occur within the Project alignment given the habitat available:

- Northern red-legged frog (*Rana aurora*; Special Concern under SARA Schedule 1, provincially Blue-listed).
- Western toad (*Anaxyrus boreas*; Special Concern under SARA Schedule 1, provincially Blue-listed).

Northern red-legged frog (red-legged frog) have been documented in Richmond, Delta, and Surrey (B.C. CDC 2015), including on the east, north, and west sides of Burns Bog (Delta 2003a). During studies conducted for the Project in 2014, red-legged frog DNA was not found within the Project alignment although it was detected in a roadside ditch approximately 200 m north of the Project, northeast of Highway 91 in Richmond. The species has been selected as representative of the at-risk amphibian VC.

Western toad use aquatic and terrestrial habitat, and return to the same breeding sites each year (Wind and Dupuis 2002). Although suitable habitat is available near the Project alignment (i.e., Burns Bog and Richmond Nature Reserve), western toad has not been documented within the Project alignment. Historic records exist from the Delta Nature Reserve, about 10 km from the Project alignment (Klassen et al. 1971), and from Tilbury Island, approximately four kilometres from the Project alignment (Hemmera 2006). Riparian habitat, in areas likely to be affected by the Project, is primarily grassy roadside verge and shrub-lined ditches abutting agricultural fields, and is of insufficient quality for western toad juvenile rearing. On this basis, western toad is considered unlikely to occur within the Project alignment (Dennis Knopp, pers. comm.) and is not considered further in this assessment.

The Project has the potential to interact with and affect red-legged frog through the loss or disturbance of its breeding or living habitat, or through direct mortality associated with Project construction. Interactions between Project activities and red-legged frog are discussed further in **Section 4.5.3.1**.

The presence of at-risk amphibians, change in area of available habitat, and change in water quality in aquatic habitat were used as indicators to assess trends of at-risk amphibians within the assessment area and evaluate potential Project-related effects. **Table 4.5-1** presents the indicators chosen for the assessment of Project-related effects on red-legged frog, and the rationale for their selection.

Table 4.5-1 Indicators for the At-risk Amphibians

| Indicator | Rationale for Selection |
|---|---|
| Presence of at risk amphibians | Assesses Project-related construction and operations phases' potential mortality to at-risk amphibians. |
| Change in area of available at-risk amphibian habitat | Quantifies Project-related changes in at-risk amphibian habitat availability. |
| Change in water quality in at-risk amphibian habitat | Describes indirect Project-related changes to quality of at-risk amphibian breeding and living habitat. |

4.5.1.3 Assessment Boundaries

The assessment boundaries for at-risk amphibians are defined below.

Spatial Boundaries

The local assessment area (LAA) and RAA for at-risk amphibians are defined in **Table 4.5-2** and shown on **Figure 4.5-1**. The boundaries of the assessment area take into account the scale and spatial extent of potential environmental effects deemed appropriate for red-legged frogs.

Table 4.5-2 Spatial Boundary Definitions for At-risk Amphibians

| Spatial Boundary | Description of Assessment Area |
|--------------------------------|---|
| Local Assessment Area (LAA) | Project alignment. |
| Regional Assessment Area (RAA) | Project alignment plus two km on either side. |

The LAA includes the anticipated Project footprint, where direct effects may occur including the area in which the Project could interact with and potentially have an effect on at-risk amphibians. Consideration was also given to the behaviours and characteristics of at-risk amphibians in the area and their available habitat. The RAA was established to provide a regional context for the assessment of Project-related effects. While the spatial extent of seasonal movements of red-legged frog is not well known (COSEWIC 2004, Maxcy 2004), the maximum distance of their seasonal migration of two kilometres has been chosen as the RAA.

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on at-risk amphibians were established based on the potential for each phase of the Project to interact with and have an effect on at-risk amphibians. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect at-risk amphibians present within the Project alignment; therefore, the following temporal boundaries will be assessed:

- Existing conditions
- Project construction (including Tunnel decommissioning)
- Project operation (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of the Proposed Project**. Specific temporal considerations for the assessment of at-risk amphibians are discussed in the context of Project interactions and potential effects in **Section 4.5.3**.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on at-risk amphibians have been identified; therefore, no administrative boundaries are defined.

Technical Boundaries

No technical boundaries have been identified that could impose limitations on the assessment of potential Project-related effects on at-risk amphibians.

4.5.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of at-risk amphibians within the assessment areas. An overview of the regulatory context for management of at-risk amphibians as relevant to the Project is also provided.

4.5.2.1 Baseline Data Collection

In 2014, the Ministry initiated studies on at-risk amphibians to support Project planning and assessment (**Table 4.5-3**). Building on available information, these studies were designed to address known data gaps.

Table 4.5-3 Desktop and Field Studies Related to At-risk Amphibians

| Study Name | Purpose of Study |
|--------------------------------------|--|
| Desktop literature review | <ul style="list-style-type: none"> • Determine which at-risk amphibians may be present in the LAA. • Identify key data gaps and areas of uncertainty within the LAA. |
| At-risk amphibian habitat assessment | <ul style="list-style-type: none"> • Assess at-risk amphibian habitat in aquatic features (e.g., streams, wetlands, sloughs, and ditches) within the LAA. |
| Environmental DNA (eDNA) sampling | <ul style="list-style-type: none"> • Determine at-risk amphibian presence in the LAA. |

Desktop Literature Review

To determine the potential for presence of at-risk amphibians in the LAA and RAA, an ecosystem-based search of the B.C. Conservation Data Center’s (CDC) online Species and Ecosystems Explorer database (B.C. CDC 2015) was conducted. The results included attributes for at-risk status (i.e., Red- or Blue-listing and inclusion on Schedule 1 of the SARA). The list was then refined by comparing each species’ known geographic range and habitat requirements to the habitat available in the LAA. Information on the potential for presence of at-risk amphibians and their habitat in the Project alignment were compiled from the following sources:

- Species and Ecosystem Explorer (B.C. CDC 2015).
- Species at Risk Public Registry (Government of Canada 2013).
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC; Government of Canada 2014).
- iMapBC (DataBC 2014).
- Delta Watersheds: Fish and Amphibian Distributions Map (Delta 2003a).

- Delta Fish and Amphibians Study: 2000-2003 Sample Site Locations Map (Delta 2002).
- COSEWIC Assessment and Status Report on Western Toad (Wind and Dupuis 2002).
- Accounts and Measures for Identified Wildlife – Red-legged Frog (Maxcy 2004).
- South Fraser Perimeter Road Environmental Assessment Application (Hemmera 2006).

Habitat Assessment and Environmental DNA (eDNA) Sampling

The red-legged frog field studies used: (i) habitat assessments based on known occurrences, (ii) habitat information from the sources above, and (iii) environmental deoxyribonucleic acid (eDNA) analysis of red-legged frog DNA present within the Project alignment aquatic features. All aquatic features (e.g., streams, wetlands, sloughs, and roadside ditches) in the LAA were examined using aerial photographs to identify probable red-legged frog living and breeding habitat for the first stage of the at-risk aquatic amphibians assessment. Field-based assessments of habitat suitability were then conducted in the LAA and eDNA sampling was completed in aquatic features determined to be potentially suitable to support red-legged frog breeding based on:

- Presence of standing fresh water deeper than 0.5 m.
- Permanent or ephemeral status of water feature.
- Presence of emergent vegetation suitable for egg mass attachment.
- Connectivity to other water features having suitable habitat for red-legged frog.
- Proximity to known occurrences of red-legged frog (based on CDC 2015 and the other sources noted above).

Fourteen sites (a site is defined as a discrete lentic aquatic feature) in the LAA had suitable red-legged frog breeding or living habitat at the time of the field assessments, and most were sampled using eDNA methods (**Figure 4.5-1** and **Table 4.5-4**). Environmental DNA is any trace fragment of DNA that is released by an organism into the environment. This method requires collection of water samples from potentially inhabited habitat, with subsequent ex-situ polymerase chain reaction (PCR) analysis of the sample for the presence of red-legged frog and western toad DNA. Reliable detection of aquatic vertebrate species using eDNA, from a variety of freshwater systems, has been confirmed as an effective survey method for amphibians (Ficetola et al. 2008, Goldberg et al. 2011, Thomsen et al. 2012).

At each aquatic feature, one location, and at one site two locations, triplicate water samples were collected using eDNA-specific methods during the red-legged frog breeding season in May 2014 and May 2015. Samples were collected in clean polypropylene bottles and labelled using an indelible marker with the site name, collection time and date, and name of collector. The biologists did not enter the water during sampling in order to prevent contamination from boots and other gear. Biologists wore clean, sterile nitrile gloves to triple rinse the sample bottles with site water, and each bottle was filled with water from the surface of the feature. Immediately after sample collection, a water quality meter was used to collect water chemistry data to facilitate the calculation of detection probabilities. Using a GIS-capable tablet, biologists marked site UTM coordinates and collected water quality data. Water chemistry parameters collected in the field included:

- water temperature (°C)
- pH
- conductivity (mS/cm)
- dissolved oxygen (mg/L)

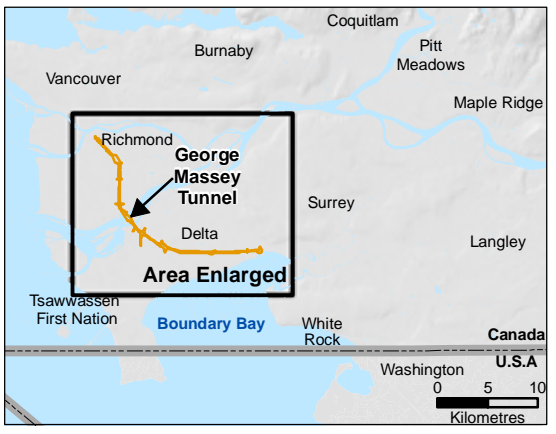
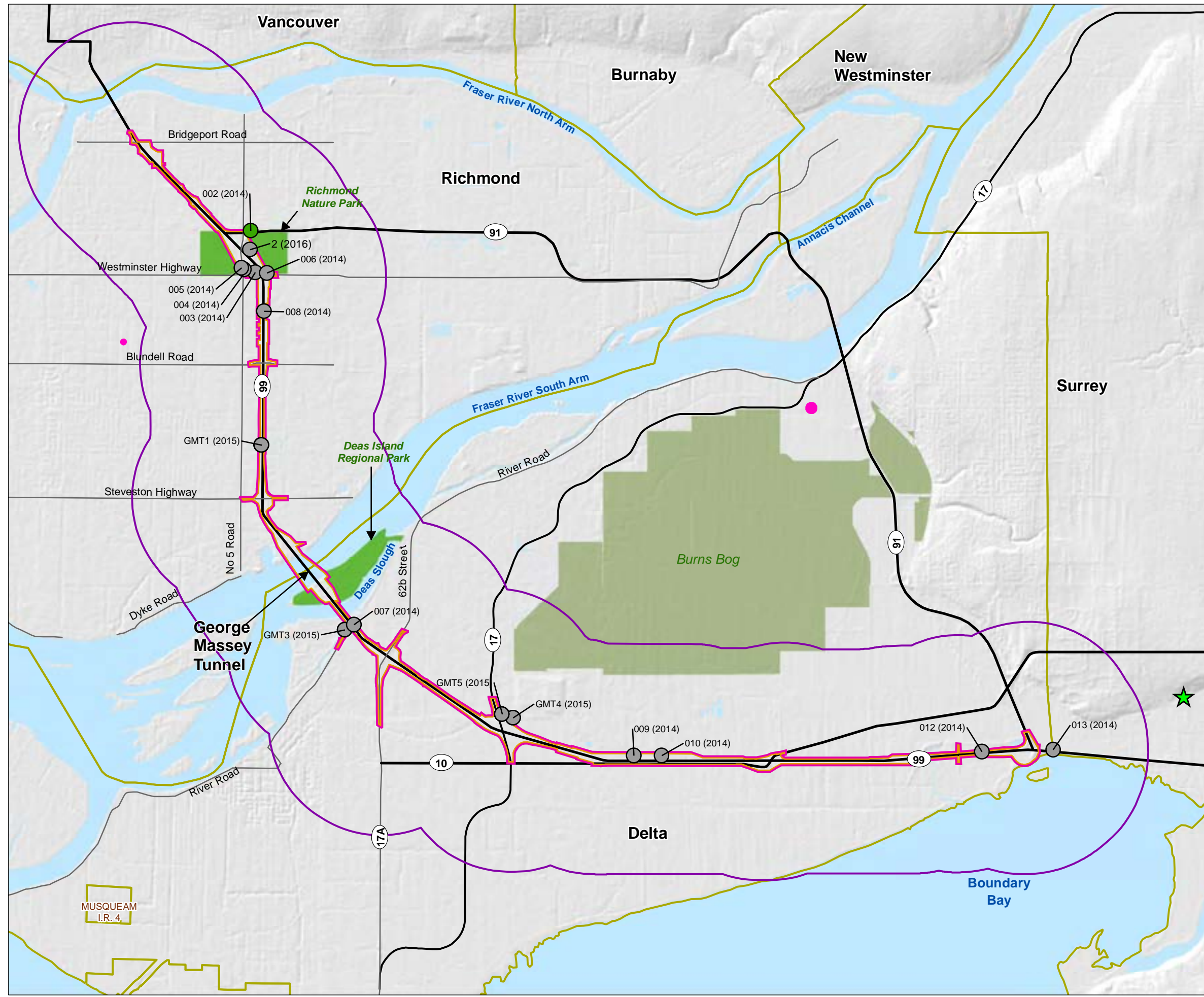
The biologists placed the sample bottles in an insulated cooler with ice packs during fieldwork to prevent DNA degradation prior to off-site filtration and preservation.

Detailed information on the habitat characteristics of the sites is provided in **Appendix A**.

Table 4.5-4 Sample Sites within the LAA with Potentially Suitable Habitat for Red-Legged Frog

| Site # | Description |
|--|---|
| Sites in LAA | |
| GMT1 (2015) | Roadside ditch immediately west of Highway 99 near Mylora Sidaway golf course. |
| 2 (2016) | Ditch beside a disused road west of the Highway 99 to Highway 91 east-bound off-ramp in Richmond. A 300 m-long continuous ditch with mixed conifer hardwood forest on one margin. Permanently wet with emergent wetland vegetation present. |
| 003 (2014) | Roadside ditch with cattails on the west side of Highway 99, just north of Westminster Highway. |
| GMT3 (2015) | Cattail wetland adjacent to Green Slough. |
| 004 (2014) | Roadside ditch with cattails on the east side of No. 5 Road, just north of Westminster Highway. |
| GMT4 (2015) | Roadside ditch with cattails west of 72 nd Street near the Vancouver Landfill entrance. |
| 005 (2014) | Roadside ditch with cattails on the west side of No. 5 Road, just north of Westminster Highway. |
| GMT5 (2015) | Cattail wetland on the north side of Burns Drive east of the South Fraser Perimeter Road near the Vancouver Landfill. |
| 006 (2014) | Roadside ditch with cattails on the east side of Highway 99, just north of Westminster Highway, adjacent to the Richmond Nature Reserve. |
| 007 (2014) | Cattail wetland adjacent to Green Slough. |
| 008 (2014) | Roadside ditch south of Westminster Highway, east of Highway 99. |
| 009 (2014) | Roadside ditch in the flooded cottonwood/red alder – salmonberry forest on the north side of Highway 99 near Highway 17. |
| 010 (2014) | A second sample from the roadside ditch in the flooded cottonwood/red alder – salmonberry forest on the north side of Highway 99 near Highway 17. |
| 012 (2014) | Roadside ditch, on the north side of Highway 99, east of the Highway 91 interchange near Boundary Bay. |
| Sites immediately adjacent to the LAA (and sampled) | |
| 002 (2014) | Roadside ditch with cattails on the west side of Highway 99, just north of Highway 91 in Richmond. |
| 013 (2014) | Ditch south of Colebrook Road. |

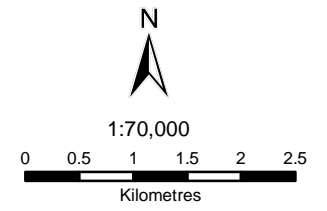
Path: O:\217-299\285\077\03\mxd\Wildlife\EA\Fig4-5-1_285_077_03_EA_AIRiskAmphibians_160114_FINAL.mxd



- Legend**
- ★ Red-legged frog sighting
 - Red-Legged Frog eDNA Sample Location (eDNA present)
 - Red-Legged Frog eDNA Sample Location (No eDNA present)
 - CDC records of red-legged frog observations ¹
 - At-Risk Amphibians Local Assessment Area
 - At-Risk Amphibians Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

¹Variation in polygon size represents differences in mapping accuracy associated with source data for each B.C. CDC element occurrence record

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AT-RISK AMPHIBIANS
OVERVIEW

| | |
|--------------|------------|
| Figure 4.5-1 | 15/05/2016 |
|--------------|------------|

4.5.2.2 Regulatory Context

Regulation and management of at-risk amphibians in B.C. occur primarily through the following federal and provincial legislation.

Federal

At the federal level, legal protection for at-risk amphibian species is provided under the *Species at Risk Act* (SARA), S.C. 2002, c. 29, which enables management of species at risk to prevent extinction or extirpation from Canada. Under the SARA Section 32(1), it is an offence to kill, harm, harass, capture, or take an individual of a wildlife (including amphibian) species that is listed as Extirpated, Endangered, or Threatened under Schedule 1. The species' residence and critical habitat are also afforded legal protection under Sections 33, 56 and 58(1) of the SARA.

Provincial

The B.C. *Wildlife Act*, R.S.B.C. 1996, c. 488 is the primary provincial legislation protecting wildlife but excluding plants, plant communities, and insects. The Province of B.C., through the B.C. CDC, also assigns species and ecological communities at risk in B.C. to one of three lists (Red, Blue, Yellow) based on provincial Conservation Status Rank. Further explanation regarding the assignment of Conservation Status Rank by the CDC to species and ecosystems at risk is provided in **Section 4.7 Vegetation**.

4.5.2.3 Existing Conditions

Red-legged Frog Habitat

Red-legged frogs require different habitats for breeding and living. They breed in a wide variety of wetlands, including both temporary and permanent ditches, ponds, lakes, and slow-moving streams with emergent vegetation (Maxcy 2004). Living habitat is generally in smaller water bodies in or adjacent to damp forests.

The terrestrial ecosystem mapping (TEM; **Section 4.7 Vegetation**) identified three wetland community types in the LAA, which were evaluated during field studies in 2014 for habitat suitability of red-legged frog. Two of these wetland communities were evaluated during field studies in 2014 to determine their habitat suitability for red-legged frog. These habitats were:

- The cattail marsh adjacent to Green Slough (0.7 ha, TEM polygon 428 [see Section 4.7 Appendix A for TEM mapping figures]).
- The flooded forest on the north side of Highway 99 near the Vancouver Landfill (7.1 ha, TEM polygon 157 [see Section 4.7 Appendix A]).

The remaining identified wetland community, the Lyngbye's sedge salt marsh wetland situated on Deas Island, was not considered to be suitable habitat for at-risk amphibians because of the prevailing saline environment and was therefore not sampled.

Other cattail marsh wetlands were not field-sampled because they either did not appear to support suitable red-legged frog breeding habitat during the sampling period (i.e., TEM polygon 380, a recently constructed highway water detention pond [see **Section 4.7 Appendix A**]), or were on the south side of Highway 99, where the potential for red-legged frog to occur is very low (i.e., TEM polygon 155 [see **Section 4.7 Appendix A**]). The remainder of the aquatic features (i.e., ditches) in the LAA have low potential to support red-legged frog breeding because of poor water quality. Amphibians are sensitive to oxygen availability in aquatic habitats (Govers et al. 2010), and breeding success is partly dependant on levels of dissolved oxygen (Sacerdote and King 2009). Water quality data collected within roadside ditches, as part of the fish and fish habitat baseline study and during the eDNA baseline study, indicate that the majority of the roadside ditches within the Project alignment have levels of dissolved oxygen that fall below the B.C. ambient water quality criteria for dissolved oxygen (B.C. MOE 1997), in both spring and summer sampling periods. As such, the levels of dissolved oxygen in the majority of LAA watercourses are likely prohibitive to at-risk amphibian breeding. Furthermore, habitat in these roadside ditches is unlikely to support at-risk amphibian breeding due to lack of slow flowing, shallow water with emergent vegetation for egg-laying (Storm 1960, Licht 1969, Briggs 1987, Richter and Azous 1995). These ditches also support invasive amphibian species (green frog [*Lithobates clamitans*] and bullfrog [*L. catesbeianus*]), which prey upon native amphibian eggs and out-compete native tadpoles (Kiesecker and Blaustein 1997, COSEWIC 2012).

Pathogens, including Chytridiomycosis (caused by *Batrachochytrium dendrobatidis* (Bd)) and illness caused by rana viruses (family *Iridoviridae*) are infectious amphibian diseases that have been confirmed to cause mortality in amphibians (COSEWIC 2012). Direct evidence of disease-induced amphibian declines has been linked to Chytridiomycosis globally and in B.C. (SPES 2012). Widespread presence of these pathogens is suspected in the LAA and RAA due to the ubiquitous presence of highly mobile non-native amphibians that carry these pathogens (green frog and American bullfrog).

Based on water quality, the roadside ditches in the LAA are unlikely to support at-risk amphibian breeding habitat. They may provide living habitat for red-legged frog, as supported by observations outside the LAA of an adult red-legged frog in a roadside ditch near King George Highway and detection of eDNA from red-legged frog in a roadside ditch in Richmond. This ditch habitat, however, is also considered low quality living habitat.

Red-legged Frog Presence

When applied with strict protocols and validated methods, eDNA provides a highly effective and accepted method to identify presence of target taxa, including red-legged frog, western toad, chytrid and Bd with a high degree of efficacy (Hobbs 2015, Herder et al 2014). Accepted methods were applied during sample collection, to ensure rigour and reliability from the eDNA assessment (Hobbs et al 2015).

From the result of the eDNA sampling, no red-legged frog¹ presence was confirmed in the LAA (Table 4.5-5); specifically, there was no evidence of recent (approximately 7 to 25 days) presence of red-legged frog within the LAA (Strickler et al. 2015) at the time of sampling (Strickler et al. 2015). Since samples were collected during the breeding season in 2014 and 2015, when DNA concentration is expected to be the highest and the likelihood of positive detection is increased (Goldberg et al. 2011), the negative results provide evidence that red-legged frog is not likely to be using wetlands and ditches within the LAA for breeding. These areas could, however, be used as living habitat. Red-legged frog was detected at Site # 002 (2014) (Figure 4.5-1), immediately adjacent to the LAA.

Table 4.5-5 Red-legged Frog Observations in the LAA and RAA

| Site ID | Habitat Type | Red-legged frog detected (Yes/No) | Habitat Present | |
|---------------------|--------------|-----------------------------------|-----------------|----------|
| | | | Breeding | Living |
| Sites in LAA | | | | |
| GMT1 (2015) | Ditch | No | No | Unlikely |
| 003 (2014) | Ditch | No | No | Unlikely |
| GMT3 (2015) | Marsh | No | No | Unlikely |
| 004 (2014) | Ditch | No | No | Unlikely |
| GMT4 (2015) | Ditch | No | No | Unlikely |
| 005 (2014) | Ditch | No | No | Unlikely |
| GMT5 (2015) | Ditch | No | No | Unlikely |
| 006 (2014) | Ditch | No | No | Unlikely |
| 007 (2014) | Marsh | No | No | Possible |
| 008 (2014) | Ditch | No | No | Unlikely |
| 009 (2014) | Marsh | No | No | Possible |

¹ Although the focus of this assessment is red-legged frog, the eDNA study also evaluated the presence of western toad. No western toad presence was identified during this study

| Site ID | Habitat Type | Red-legged frog detected (Yes/No) | Habitat Present | |
|--|--------------|-----------------------------------|-----------------|-----------|
| | | | Breeding | Living |
| 010 (2014) | Marsh | No | No | Possible |
| 012 (2014) | Ditch | No | No | Unlikely |
| 2-2015 (2016) | Ditch | Not sampled | Possible | Possible |
| Sites immediately adjacent to the LAA | | | | |
| 002 (2014) | Ditch | Yes | Unlikely | Confirmed |
| 013 (2014) | Ditch | No | No | Unlikely |

4.5.2.4 Quality and Reliability

The quality and reliability of the data collected and analysed for this analysis is high because it used standard government-approved (e.g., RISC) methods for habitat assessments and peer-reviewed methods for other studies (e.g., eDNA). These methods have been developed for the specific purpose of identifying or establishing trends in amphibians, and in the case of eDNA, are particularly effective for uncommonly occurring at-risk species.

4.5.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with at-risk amphibians, and potential effects of such interactions on red-legged frog. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.5.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 4.5.5**. A discussion of potential cumulative effects on at-risk amphibians is presented in **Section 4.5.6**.

4.5.3.1 Project Interactions

An overview of potential interactions between Project activities and at-risk amphibians during the construction and operation of Project components is provided in **Appendix B**. A preliminary evaluation of the potential effects of Project interactions on at-risk amphibians, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Potential effects on at-risk amphibians resulting from Project construction and operation (i.e., maintenance) activities may include direct mortality, disturbance or permanent loss of breeding/living habitat, and introduction of alien invasive species (AIS; e.g. green frog, pathogens). Project-related activities could occur year round, including during the at-risk amphibian breeding season which is a sensitive life period, generally extending from February to October (Calef 1973).

During pre-Application consultation, Aboriginal Groups expressed concern that atmospheric noise from construction activities and traffic could adversely affect wildlife and interfere with frog calls. Changes to noise, light, and visual stimuli resulting in effects on at-risk amphibians are unlikely to occur as a result of the Project and are therefore not considered further in this assessment. As at-risk amphibian breeding habitat was not identified within the LAA, disturbance to breeding activity (calling) as a result of construction is not expected.

Direct highway mortality has been acknowledged as an effect on red-legged frogs (COSEWIC 2004); however, the existing width of, and traffic volumes on, Highway 99 present a formidable barrier to red-legged frog migrations and will continue to do so after the widened highway becomes operational. Direct highway mortality is therefore not considered further.

As previously discussed, no likely at-risk amphibian breeding habitat was identified within the LAA; therefore, consideration of interactions and Project-related effects to at-risk amphibians is limited to the effects related to living habitat.

Fragmentation of at-risk amphibian habitat, and habitat avoidance as a result of sensory disturbance, was not considered a potential interaction given that Highway 99 activities that lead to such potential effects will be the same in the future as they are under existing conditions. The future alignment of Highway 99 with the Project will not change from the existing Highway 99 alignment, resulting in no fragmentation effects as a result of the Project.

Construction: Potential effects on at-risk amphibians as a result of Project-related site preparation and construction activities are as follows:

- Mortality from vegetation grubbing and clearing, and instream construction activities.
- Change in area of available living habitat from disturbance and infilling of upland ditches, as well as instream construction activities in and around roadside ditches.
- Indirect change to living habitat from changes in ambient water quality (e.g., dissolved oxygen) due to an increase in sediment input resulting from road construction activities (e.g., vegetation clearing, temporary drainage de-watering and relocation).
- Indirect change to living habitat from introduction to AIS, including pathogens, green frog, and bull frog, during construction (e.g., transfer of pathogens on equipment or machinery and introduction through relocation of AIS during salvage).

Operation: Potential effects on at-risk amphibians during Project operation may result from routine maintenance activities of the highway and upland ditches. These activities have the potential to cause changes in amphibian living habitat due to vegetation and debris removal, induced turbidity, or temporary disruption of natural channel flows.

Given that the Project is within an existing transportation corridor, and land cover in the LAA is of a disturbed nature (see **Section 4.7 Vegetation**), at-risk amphibian living habitat within these areas is influenced by a combination of direct physical activities and indirect factors such as road runoff. The Ministry has standard operating practices (e.g., B.C. MOTI 2003, B.C. MOTI 2010) to minimize the effects of highway operations and maintenance on adjacent land uses. In addition, aquatic features that do not currently support pathogens, and are therefore sensitive to pathogen transfer effects will be identified during pre-construction eDNA assessment. With these practices in place, Project-related disturbance to at-risk amphibian living habitat during operations and maintenance is anticipated to be negligible. Therefore, the effect is not considered further in this assessment.

4.5.3.2 Potential Effects

Mortality of At-risk Amphibians

Construction Phase

Site preparation activities, including vegetation clearing and grubbing, have the potential to result in direct mortality of at-risk amphibians that may be present in riparian and upland habitats within the Project alignment through crushing by heavy machinery. Because no at-risk amphibians were found within the Project alignment, interactions with vehicles are likely to have a very low probability of occurrence.

Operation Phase

The Project is not anticipated to increase the potential risk of mortality of at-risk amphibians during the operations phase. Existing conditions suggest that there is a low likelihood of at-risk amphibians using living habitat within the Project alignment and the existing risk of mortality is likely to be high given current traffic volume conditions along Highway 99. Traffic volumes in the LAA will increase; however, no measureable change from the existing risk of amphibian mortality is projected. As such, direct amphibian mortality as a result of highway operation will not be considered further in this assessment.

Potential Loss of At-risk Amphibian Living Habitat

Construction Phase

Temporary loss of at-risk amphibian living habitat may occur during instream works including clearing and grubbing of riparian vegetation, temporary de-watering of upland ditches, and installation of temporary drainage structures.

It is anticipated that there will be some overlap between Project components, specifically the support piers for the new bridge and the cattail marsh adjacent to Green Slough (TEM polygon 428 [see **Section 4.7 Appendix A**]), resulting in a potential loss of at-risk amphibian living habitat in this area.

The flooded forest wetland (TEM polygon 157 [see **Section 4.7 Appendix A**]) does not overlap with Project components and, therefore, this site will not be impacted by the Project.

Change in Water Quality in At-risk Amphibian Living Habitat

Construction Phase

Clearing and grubbing of riparian vegetation along ditches, ditch relocation for Highway 99 widening, and interchange upgrades have the potential to result in increased sedimentation and degrade ambient water quality. In addition, inadvertent transfer of AIS and pathogens may occur.

Dissolved oxygen in roadside ditches in the LAA (Sites 003 (2014), 006 (2014), and 008 (2014); **Figure 4.5-1**) and in the flooded forest (sites 9 and 10; **Figure 4.5-1**) are outside the standard *Water Quality Guidelines for the Protection of Aquatic Life* specified by the Canadian Council of Ministers of the Environment (CCME 2014), and are not of a sufficient level to support aquatic life (see **Section 4.2 Sediment and Water Quality**). However, dissolved oxygen levels in the cattail marsh adjacent to Green Slough (TEM polygon 428) meet the *Water Quality Guidelines for the Protection of Aquatic Life* (CCME 2014), and therefore could support living habitat for red-legged frog. Although red-legged frog were not detected during baseline eDNA studies despite repeated sampling (2014 and 2015), mitigation measures to prevent or reduce adverse effects to at-risk amphibians associated with degraded ambient water quality in the cattail marsh are described in **Section 4.5.4**.

Accidental spills of toxic/hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete), as well as potential failure of sediment containment measures, could result in changes to ambient water quality during Project construction activities. Potential changes to ambient water quality resulting from accidents or malfunctions during Project construction are assessed in **Section 8.0 Accidents and Malfunctions**.

Operation Phase

Highway maintenance activities, including ditch cleaning and riparian vegetation maintenance, may induce turbidity within upland ditches and degrade ambient water quality.

Widening of Highway 99 and interchange upgrades are expected to result in an increase of impervious surface area and consequently the rate of stormwater runoff entering the upland ditches will increase. Mitigation measures to prevent or reduce adverse effects associated with stormwater runoff are described in **Section 4.5.4**. It is noted that highway drainage is a small component of the water in the ditches in Richmond where most of the water drains areas outside the highway right-of-way.

4.5.4 Mitigation Measures

Mitigation for the Project has been and will continue to be informed by standard industry practices and best management practices (BMP) including specific amphibian BMP recently developed by the B.C. provincial government, consideration of mitigation measures, and the results of follow up programs undertaken for past Ministry developments; input from regulators, public, and Aboriginal Groups; and evaluation of technical and economic feasibility. Standard industry practices and BMPs proposed to avoid or reduce adverse effects on at-risk amphibians were based on the following key documents:

- *2012 Standard Specifications for Highway Construction* (B.C. MOTI 2012).
- *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).
- *Standards and Best Practices for Instream Works* (B.C. MWLAP 2004).
- *Develop with Care 2014: Guideline for Amphibian and Reptile Conservation during Urban and Rural Land Development in British Columbia* (B.C. MOE 2014).
- *DRAFT Best Management Practices for Amphibian and Reptile Salvages in British Columbia* (Wind et al. 2013).
- *Riparian Restoration Guidelines* (B.C. MOE 2008).
- *Tree Replacement Criteria* (B.C. MELP 1996).
- *National Guide to Erosion and Sediment Control on Roadway Projects* (TAC 2005).

A hierarchical approach based on the four types of mitigation as outlined below, was used in identifying strategies to avoid or minimize potential Project-related effects:

- **Avoidance:** Measures to avoid potential effects on the VC have been/will be incorporated into Project considerations such as site and route selection, project scheduling, project design, and construction and operation procedures and practices.
- **Minimization:** Where potential effects on the VC cannot be avoided through project considerations, standard mitigation measures, BMPs, and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels.

- Restoration or Habitat Enhancement: Where potential Project-related effects cannot be avoided or minimized through standard mitigation measures, best practices, or implementation of EMPs, affected components will be restored on site to pre-Project conditions.
- Compensation/offset: Where on-site restoration is not feasible, appropriate means to counteract, or make up for potential Project-related effects on the VC will be identified.

Proposed mitigation measures to avoid or minimize adverse Project-related effects on at-risk amphibians are summarized in **Table 4.5-6**.

4.5.4.1 Avoidance

The Project has been designed to be located largely within the existing Highway 99 Right-of-Way (ROW), in areas that have been previously disturbed and contain minimal natural vegetation, thereby avoiding potential overlap with at-risk amphibians. As such potential encroachment on at-risk amphibian living habitat, as well as potential temporary loss of at-risk amphibian habitat resulting from instream works, ground disturbance, clearing, and grubbing of riparian vegetation during Project construction will be minimized and restricted to within this ROW.

As described in **Section 4.4 Fish and Fish Habitat**, upland ditches will be designed to maintain ambient water quality and pre-development flow regimes to avoid or minimize potential Project-related changes to ambient water quality as a result of highway stormwater runoff during Project operation.

4.5.4.2 Minimization

Project Design

Engineering considerations indicate that an overlap between the proposed bridge support piers and the cattail marsh adjacent to Green Slough (TEM polygon 428) cannot be avoided; however, through Project design, this unavoidable overlap will be minimized and will not affect the functionality of the ecosystem. This will minimize the extent of potential at-risk amphibian living habitat.

Effects of Project construction on the recently-established cattail marsh in the Highway 17 interchange (TEM polygon 380) will be minimized during design to reduce the ground disturbance.

Best Management Practices and Environmental Management

Environmental protection measures that will be implemented during Project construction and operation to prevent or minimize potential effects on at-risk amphibians will be outlined in a Construction Environmental Management Plan (CEMP), and subsequently in an Operational Environmental Management Plan (OEMP), as described in **Section 12.0 Management Plans**. The CEMP will include a Fish and Fish Habitat Management Plan, Erosion and Sediment Control Plan, and Terrestrial Vegetation and Wildlife Management Plan. These component plans will describe standard best practices and Project-specific mitigation measures and will effectively prevent or minimize potential adverse effects on at-risk amphibians that might otherwise result from the Project during construction. Key elements of these plans are discussed below.

Mitigation Measure #1: Fish and Fish Habitat Management Plan

Mitigation proposed to avoid or minimize potential Project-related adverse effects on fish and fish habitat will also benefit at-risk amphibians. Relevant provisions from the Fish and Fish Habitat Management Plan (e.g., mitigation for upland ditches) will be implemented and are anticipated to mitigate effects to at-risk amphibian habitat related to changes in ambient water quality.

As described in **Section 4.4 Fish and Fish Habitat Assessment**, Project construction and operation activities that involve instream works will be conducted in accordance with provincial standards and best practices, including the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012) and the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010), respectively. Also with consideration of low likelihood of at-risk amphibians to be present in upland ditches within the Project alignment, the potential for at-risk amphibian mortality during Project-related instream works is greatly reduced.

Upon completion of instream works associated with Project construction activities, channel flows will be re-established, and riparian vegetation will be restored through hydro-seeding and re-planting to pre-disturbance conditions or better. Therefore, riparian habitat quality in ditches relative to existing conditions will be maintained or improved.

Mitigation Measure #2: Erosion and Sediment Control

Erosion and sediment control measures to be included in the Erosion and Sediment Control Plan are presented in **Section 4.4 Fish and Fish Habitat**. They generally include installing and maintaining erosion and sediment control measures at potentially affected watercourses prior to the onset of Project construction and operation, operating machinery and equipment in-the-dry from the top-of-bank of watercourses, and restoring cleared areas promptly after use.

Mitigation Measure #3: Terrestrial Vegetation and Wildlife Management

A Terrestrial Vegetation and Wildlife Management Plan will be developed as part of the CEMP to avoid or mitigate potential effects to vegetation and wildlife (including at-risk amphibians) during Project construction. The plan will describe procedures for amphibian salvage and translocation, as well as mitigation approaches to minimize ground disturbance.

Project-related instream works will be conducted within prescribed regional least-risk fisheries timing windows (i.e., July 15 to September 30; Delta 2003*b*, B.C. MOE 2006) or with alternative mitigation approaches (e.g., work in-the-dry, combined with amphibian salvages) to avoid effects to water quality during sensitive amphibian breeding life stages. All maintenance activities will adhere to the provisions of the B.C. *Water Act* (where applicable) and be undertaken in accordance with provincial standards and best practices, including the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).

Amphibian Salvage and Translocation

As part of pre-construction activities, amphibian salvage and translocation will be conducted to avoid or minimize potential Project-related mortality to native amphibians from instream works during Project construction. Salvage and translocation will comply with the B.C. *Wildlife Act* and pertinent permits, and will be undertaken in accordance with the DRAFT *Best Management Practices for Amphibian and Reptile Salvages in BC* (Wind et al. 2013). Salvage areas and suitable translocation habitat will be identified, and sites where salvage is conducted and amphibians are transported, will be pre-tested for pathogens to avoid the transport and introduction of AIS (i.e. green frog) to new aquatic features.

Mitigation to Minimize Ground Disturbance

Project footprint disturbance will be minimized by flagging construction boundaries in the field and marking clearing perimeters to minimize the potential for accidental encroachment on forested areas and wetlands that may be suitable living habitat for at-risk amphibians.

Disturbance to the cattail marsh adjacent to Green Slough, which has potential to support at-risk amphibian living habitat, will be minimized by:

- Limiting heavy machinery access points from River Road South to prevent substrate compaction.
- Placing site infrastructure as close as possible to the existing road verges during detailed design to minimize the need for clearing in the wetland.
- Storing machinery and construction materials outside of the wetland.

4.5.4.3 Habitat enhancement

As discussed under mitigation of Project-related effects on vegetation, the following measures are proposed to improve the functionality of the highly disturbed cattail marsh adjacent to Green Slough (TEM polygon 428), which overlaps with the Project:

- Removal of invasive species and garbage from the marsh and revegetation using native species as appropriate to improve habitat quality in the area surrounding the new bridge support piers.
- Installation of an appropriate stormwater management system for the upgraded highway and the new bridge to avoid potential introduction of contaminants into the ecosystem through road runoff.

The above measures are expected to improve the quality and viability of the ecosystem within TEM polygon 428, and counteract potential effects of the loss of amphibian habitat due to the proposed installation of new bridge piers.

4.5.4.4 Habitat Offsetting

Mitigation Measure #4: Offsetting of Effects to Cattail Marsh near River Road South

As described in **Section 4.7 Vegetation**, unavoidable Project footprint effects on the cattail marsh near Green Slough (River Road South) will be offset through the creation of a cattail marsh within a biofiltration pond near the existing south portal of the Tunnel. This habitat will be subject to monitoring during and after construction to ensure that it is functioning as intended. The establishment of the cattail marsh, which has the potential to provide suitable living habitat for at-risk amphibians, is expected to offset the partial loss of marsh area within TEM polygon 428.

Table 4.5-6 Summary of Mitigation Measures to Address Potential Adverse Project Effects on At-risk Amphibians

| Potential Effect | Mitigation Measure |
|--|--|
| Construction Phase | |
| Direct mortality of at-risk amphibians from instream works | <ul style="list-style-type: none"> • <i>Mitigation measure #3</i>: Salvage and translocate at-risk amphibians to nearby suitable habitat. |
| Loss of at-risk amphibian living habitat | <ul style="list-style-type: none"> • Project siting and design • <i>Mitigation measure #1</i>: <ul style="list-style-type: none"> ▫ Undertake instream works in accordance with standards and best practices, including the Ministry's <i>Standard Specifications for Highway Construction</i> (B.C. MOTI 2012). ▫ Restore riparian vegetation to pre-disturbance conditions or better. • <i>Mitigation measure #3</i>: Minimize ground disturbance to avoid sensitive habitats, including the cattail marsh adjacent to Green Slough. • <i>Mitigation measure #4</i>: Habitat offsetting of the cattail marsh near Green Slough with creation of new approach near south portal. |
| Changes to water quality in at-risk amphibian living habitat | <ul style="list-style-type: none"> • <i>Mitigation measure #1</i>: Undertake instream works in accordance with standards and best practices, including <i>Standard Specifications for Highway Construction</i> (B.C. MOTI 2012). • <i>Mitigation measure #2</i>: Install and maintain functional erosion and sediment controls. • <i>Mitigation measure #3</i>: prior to construction, test for presence of pathogens at aquatic features with potential exposure to machinery or equipment. |
| Operation Phase | |
| Loss of at-risk amphibian living habitat | <ul style="list-style-type: none"> • <i>Mitigation measure #1</i>: Undertake instream works in accordance with the Ministry's <i>Environmental Best Practices for Highway Maintenance Activities</i> (B.C. MOTI 2010). |
| Changes to water quality in at-risk amphibian living habitat | <ul style="list-style-type: none"> • Project siting and design: Design ditches to maintain ambient water quality and pre-development flow regimes. • <i>Mitigation measure #1</i>: Undertake instream works in accordance with standards and best practices, including the Ministry's <i>Environmental Best Practices for Highway Maintenance Activities</i> (B.C. MOTI 2010). |

4.5.5 Residual Effects and their Significance

4.5.5.1 Characterization of Residual Effects

Residual effects are those adverse effects that remain following implementation of mitigation measures. All potential Project-related effects on at-risk amphibians are expected to be addressed through mitigation measures, resulting in no residual effects. Implementation of mitigation measures described in **Section 4.5.4** is anticipated to address potential effects related to physical injury or mortality, change in habitat availability and quality, or introduction of AIS of at-risk amphibians. Avoidance mitigation is expected to be immediately effective in protecting at-risk amphibians from habitat loss and direct mortality. Minimization mitigation is expected to be immediately effective or effective immediately following the proposed restoration and enhancement of disturbed areas. These are standard mitigation measures that the Ministry has used on other project within the lower mainland with proven success.

4.5.5.2 Confidence and Risk

The confidence with this characterization of residual effects and its predictions is high.

A number of factors were considered in reaching this conclusion including:

- (i) The quality and reliability of the data that supported the assessment. Standard sampling methods, reliable methods published in government or peer-reviewed documents were used.
- (ii) The availability of data for the area surrounding the LAA (including in the RAA) is reasonable, in large part from MoTI studies on the nearby South Fraser Perimeter Road and the Environmental Assessment Office-sponsored amphibian work in Burns Bog (Fraker et al. 1999).
- (iii) The experience in identifying and managing effects on at-risk amphibians from the nearby MoTI South Fraser Perimeter Road gives high confidence in the likelihood of effects and the means by which they should be managed.
- (iv) The use of standard BMPs or MoTI-prescribed policies for avoiding or minimizing Project-related effects on at-risk amphibians, including pre-construction assessment of pathogens, minimizing construction-related disturbance to aquatic features in the Project area, avoiding construction-related disturbance to identified Environmentally Sensitive Areas (ESA) and invasive species (and pathogen) management to minimize transfer between sites.

No further risk assessment is considered necessary as the mitigation measures proposed address effects and uncertainty.

4.5.6 Cumulative Effects and their Significance

As discussed in **Section 4.5.5**, the Project is not likely to have any residual effect on at-risk amphibians. Therefore, a cumulative effects assessment was not necessary.

4.5.7 Follow-up Strategy

The potential for at-risk amphibians to occur within the Project alignment is low. During construction, implementation of the CEMP is expected to effectively prevent or minimize potential adverse effects on at-risk amphibians that might otherwise result from the Project during construction.

As described above, the creation of a cattail marsh within a biofiltration pond near the existing south portal of the Tunnel proposed to offset effects on the existing cattail marsh near Green Slough has the potential to provide suitable habitat for at-risk amphibians. As part of the vegetation follow-up program, this habitat will be subject to monitoring during and after construction to ensure that it is functioning as intended.

4.5.8 References

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APPENDIX A

At-risk Amphibian Habitat Assessment Data

Table 1 At-risk Amphibian Habitat Data from eDNA Sample Sites within the LAA

| Sample Site | Habitat Characteristics | | | | | Water Quality Data | | | | eDNA Results |
|-------------|----------------------------------|-----------------------|---------------------------------|--|---|--------------------|------|----------------------|-------------------------|------------------------------|
| | Presence of standing fresh water | Permanent fresh water | Presence of emergent vegetation | Connectivity to other water features with suitable habitat | Within 1 km of CDC red-legged frog record | Temperature (C) | pH | Conductivity (µS/cm) | Dissolved oxygen (mg/L) | Red-legged frog DNA presence |
| 002 (2014) | Yes | Yes | Yes | No | No | 11.7 | 7.27 | 876.0 | 1.61 | Yes |
| 003 (2014) | Yes | Yes | No | Yes | No | 13.9 | 8.06 | 266.5 | 2.86 | No |
| 004 (2014) | Yes | Yes | No | Yes | No | 12.1 | 7.85 | 254.9 | 3.36 | No |
| 005 (2014) | Yes | Yes | Yes | Yes | No | 12.7 | 7.51 | 272.1 | 1.58 | No |
| 006 (2014) | Yes | Yes | Yes | Yes | No | 11.4 | 6.50 | 145.9 | 1.20 | No |
| 007 (2014) | Yes | Yes | Yes | Yes | No | 11.9 | 6.56 | 567.0 | 6.54 | No |
| 008 (2014) | Yes | Yes | Yes | Yes | Yes | 11.9 | 7.19 | 322.3 | 1.01 | No |
| 009 (2014) | No | Yes | Yes | Yes | No | 14.9 | 6.69 | 234.6 | 1.49 | No |
| 010 (2014) | Yes | Yes | Yes | Yes | No | 15.7 | 7.00 | 126.8 | 0.43 | No |
| 012 (2014) | Yes | Yes | No | No | No | 14.6 | 6.95 | 345.5 | 2.33 | No |
| 013 (2014) | Yes | Yes | Yes | Yes | No | 16.5 | 8.62 | 409.5 | 1.66 | No |
| GMT1 (2015) | Yes | Yes | No | No | No | 21.5 | 5.89 | 273.1 | 2.65 | No |
| GMT3 (2015) | Yes | Yes | Yes | Yes | No | 19.0 | 6.76 | 285.1 | 3.31 | No |
| GMT4 (2015) | Yes | Yes | Yes | Yes | No | 23.2 | 7.29 | 382.4 | 7.53 | No |
| GMT5 (2015) | Yes | Yes | Yes | Yes | No | 23.5 | 6.99 | 197.3 | 3.74 | No |
| 2 (2016) | Yes | Yes | Yes | Yes | Yes | 13.7 | 5.52 | 112.1 | 5.2 | Pending |

APPENDIX B

Overview of Potential Project Interactions with At-risk Amphibians

Table 1 Overview of Potential Project Interactions with At-risk Amphibians.

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|---|--|
| Pre-Construction / Site Preparation | | | |
| Pre-construction / site preparation | No Interaction | <ul style="list-style-type: none"> • Surveying. • Conducting additional site investigations (i.e., a geotechnical drilling program). • Relocating utilities. • Preloading for embankment and highway construction. • Acquiring property for the Project. | <p>Nature of interaction: No interactions are anticipated.</p> <p>Rationale: Activities are not proposed near identified at-risk amphibian living habitat and do not represent a risk to amphibian mortality.</p> |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Clearing and grubbing of vegetation, mainly in the existing Hwy 99 ROW. • Restoration of Green Slough to its historic alignment. • Installing temporary drainage structures and diversions. • Installing temporary roads, laydown areas, and site offices. | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Loss (temporary or permanent) of potential at-risk amphibian living habitat from Project-related works in and around upland ditches. • Changes in ambient water quality from induced turbidity during works in and around upland ditches. • Potential direct mortality of at-risk amphibians during instream works. |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|--|--|
| Construction Phase | | | |
| New bridge construction, including approaches and ramp connections | No Interaction | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: No interactions are anticipated.</p> <p>Rationale: Activities are not proposed within or near at-risk amphibian living habitat and do not represent a risk to amphibian mortality.</p> |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation. | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Loss (permanent) of at-risk amphibian living habitat from ground improvements and installation of piers for the new bridge south approach. • Changes in ambient water quality from induced turbidity during works on the edge of Deas Slough and Green Slough. |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|---------------------|--|---|
| Highway 99 improvements, including interchange upgrades | No Interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A. • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street. • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving. | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Direct mortality of at-risk amphibians from Project-related works in and around upland ditches associated with interchange upgrades, compaction of soil. • Changes in ambient water quality from induced turbidity during works in and around upland ditches. |
| Tunnel decommissioning | No Interaction | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel. • Removing of four Tunnel segments and associated scour protection. • Backfilling of onshore portions of Tunnel approaches. • Transporting Tunnel elements for offsite disposal and operating support vessels for that activity. | <p>Nature of interaction: No interactions are anticipated.</p> <p>Rationale: Activities are not proposed within or near at-risk amphibian living habitat, and are not anticipated to result in at-risk amphibian mortality, or cause changes to at-risk amphibian living habitat quality or quantity.</p> |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | N/A |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---------------------------------------|---------------------|---|---|
| Decommissioning of Deas Slough Bridge | No Interaction | <ul style="list-style-type: none"> Removal of Deas Slough Bridge including substructures. | <p>Nature of interaction: No interactions are anticipated.</p> <p>Rationale: Activities are not proposed within or near at-risk amphibian living habitat, and are not anticipated to result in at-risk amphibian mortality, or cause changes to at-risk amphibian living habitat quality or quantity.</p> |
| | No Effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> N/A | N/A |
| Operation Phase | | | |
| Highway 99 and interchanges | No Interaction | <ul style="list-style-type: none"> N/A | N/A |
| | No Effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges. Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.). | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> Changes in ambient water quality from induced turbidity during maintenance works in and around upland ditches, and from stormwater runoff during highway operation. Accidental spills of deleterious substances into upland ditches is assessed in Section 8.0 Accidents and Malfunctions. |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-------------------------|---------------------|--|---|
| New bridge | No Interaction | <ul style="list-style-type: none"> • Operating the new bridge. • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: No interactions are anticipated.</p> <p>Rationale: Activities are not proposed within or near at-risk amphibian living habitat, and are not anticipated to result in at-risk amphibian mortality, or cause changes to at-risk amphibian living habitat quality or quantity.</p> |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | N/A |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.6 Marine Mammals Assessment Highlights:

- Marine mammals, specifically harbour seals and sea lions, are known to use marine areas within the Project alignment. Other species of conservation interest, including southern resident killer whales, do not occur in the Fraser River.
- Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals.
- Underwater noise in the Fraser River South Arm from existing sources currently exceed thresholds for disturbance to marine mammals approximately 20% of the time.
- The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.
- Standard industry and best management practices will be applied to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
- No Project-related residual or cumulative effects on marine mammals are expected.

4.6 Marine Mammals Assessment

This section presents the results of the assessment of potential Project effects on marine mammals and includes the rationale for selecting marine mammals as a valued component (VC), identification of Project-related effects, proposed approaches to mitigation, and evaluation of residual Project-related and cumulative effects.

4.6.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on marine mammals in terms of Project setting, and defines the spatial, temporal, administrative and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

No jurisdictional, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects, accessibility constraints, or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore, administrative or technical boundaries are not considered relevant.

4.6.1.1 Assessment Context

The Project is located in close proximity to the Strait of Georgia which supports a number of marine mammals, including toothed whales, baleen whales, seals, sea lions, and sea otters. In the Strait of Georgia, marine mammals are the focus of a substantial wildlife viewing and ecotourism industry and are of cultural importance to Aboriginal Groups and the public.

Within the lower Fraser River and the Project alignment, only seals, particularly harbour seals and sea lions, are likely to occur, and their presence is seasonal.

Aboriginal Groups have reported that areas within the wider Fraser River estuary were utilized by Hul'q'umi'num'-speaking peoples for harvesting marine mammals such as seals, porpoise, sea otters, sea lions, and whales). The most common marine mammals harvested within the Fraser River estuary included harbour seal, sea lion, and porpoise. It is understood that although there is currently no desire to harvest marine mammals; they remain culturally important to Aboriginal Groups. Details on how Project components and activities have the potential to interact with and adversely affect the availability of resources associated with the exercise of Aboriginal Interests by changing species abundance or habitat, or by causing sensory disturbance, changes in behavior, or harm (physical injury or mortality) to marine mammals is provided in Section 10 Aboriginal Consultation.

Table 4.6-1 details the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) designation for marine mammal species that may occur within the Project alignment. Other species of conservation concern, including southern resident killer whales, do not occur in the Fraser River or within the Project alignment.

Table 4.6-1 Marine Mammal Species with Potential to Occur within the Project alignment

| Common Name (COSEWIC Designation) | Scientific Name | Likelihood of Occurrence within the Project alignment |
|---|-------------------------------|---|
| Pinnipeds – Seals and Sea Lions | | |
| California sea lion (not at risk) | <i>Zalophus californianus</i> | Low (recorded in the Project alignment infrequently) |
| (Northern) Steller sea lion (Special Concern) | <i>Eumetopias jubatus</i> | Moderate (recorded in the Project alignment somewhat regularly) |
| Harbour seal (not at risk) | <i>Phoca vitulina</i> | High (recorded in the Project alignment in relatively high numbers) |

4.6.1.2 Methodology

The marine mammals assessment follows the general methodology described in **Section 3.0 Assessment Methodology**.

In early 2014, the Ministry initiated desktop studies and underwater noise modelling to support Project planning and the assessment of potential Project-related effects. The studies were designed to build on existing information and address known data gaps.

Table 4.6-2 provides a summary of the studies conducted to support the marine mammals assessment. Further detail relating to the underwater noise modelling methodology and results can be found in **Section 4.3 Underwater Noise**.

Table 4.6-2 Marine Mammal Studies to Support the Assessment

| Study Name | Purpose of Study |
|-------------------------------------|---|
| Literature review/ Desktop study | <ul style="list-style-type: none"> • Determine which marine mammals may be present in the local assessment area (LAA). • Identify key data gaps and areas of uncertainty within the LAA. • Sources of data included the <i>Species at Risk</i> Public Registry, COSEWIC Wildlife Species Database, and the BC Cetacean Sighting Network database, DFO Recovery Strategies and academic literature. |
| Modelling Study | <ul style="list-style-type: none"> • Acoustic models were used to predict the underwater noise footprint of proposed Tunnel decommissioning and bridge construction activities. These models were used to inform the marine mammals assessment. |

Selection of Representative Species

Seals and sea lions occur in or near the Project alignment seasonally, with peak abundance in the lower Fraser River and estuary typically coinciding with seasonal physical and biological factors such as availability of prey. Due to similar life histories, habitat requirements, prey preferences, hearing sensitivities, and ecological roles between seals and sea lions, harbour seal was selected as the representative species for the marine mammals VC for the purposes of this assessment. Harbour seals are also common, conspicuous, and well-studied with an established baseline of population information. They are culturally important to Aboriginal Groups and the public. They have the potential to experience similar Project-related effects as sea lions. During consultations, the importance of southern resident killer whale (SRKW) to Aboriginal Groups was acknowledged; however, SRKW have been excluded from the assessment for the following reasons:

- SRKW are not present in the Fraser River; therefore, there is limited potential for direct interaction with Project activities.
- Preliminary results of conservative underwater noise modelling indicate underwater noise generated during construction will not travel beyond the Fraser River.
- Preliminary results of fish and fish habitat studies suggested potential effects of the Project on availability of Chinook salmon are negligible.

Indicator

Change in the acoustic environment from underwater noise was used as an indicator to evaluate potential Project-related effects on marine mammals. Sound pressure level and sound exposure level are two metrics that are commonly used to assess the potential for injury or behavioural disturbance to marine mammals due to Project-related underwater noise. This assessment evaluates the effects of Project-related underwater and in-air noise on harbour seals.

4.6.1.3 Assessment Boundaries

This section describes the spatial and temporal boundaries for the assessment of marine mammals. No administrative or technical boundaries apply to this assessment.

Spatial Boundaries

The LAA and regional assessment area (RAA) for marine mammals are defined in **Table 4.6-3** and shown in **Figure 4.6-1**.

Table 4.6-3 Spatial Boundary Definitions for Marine Mammals

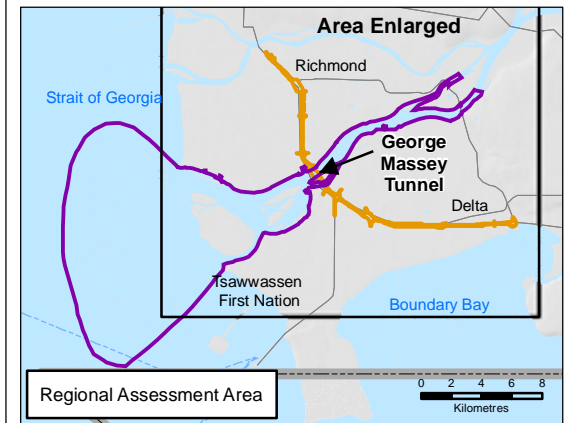
| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|---|
| Local Assessment Area (LAA) | All areas where Project-related effects to marine mammals could potentially occur, including the zone of audibility for harbour seals from modelled underwater noise from construction activities. |
| Regional Assessment Area (RAA) | Encompasses a portion of the Fraser River from the river mouth upstream to Annacis Island and a portion of Roberts Bank, and provides a regional context for the ecological effects of the Project. |

The LAA boundaries were determined by considering the nature and characteristics of harbour seals as the representative VC species, as well as their potential for exposure to Project-related underwater noise, and the maximum extent of potential adverse effects. The RAA was established to provide a regional context for the assessment of Project-related effects.

Project activities during the construction phase are expected to temporarily increase underwater sound levels in the lower Fraser River above existing ambient sound levels within a certain zone upstream and downstream of the Project alignment. Within this zone, noise from Project-related activities may be audible to seals, and has the potential to cause hearing damage, or disturbance resulting in behavioural changes.

Due to the acoustic environment (e.g., riverbed sediment type, channel morphology) within the LAA, the underwater distance from the Project from which seals might hear underwater noise generated by construction activities is estimated at no more than 7.5 km. Beyond that distance, seals will not be able to differentiate Project-related underwater noise from existing ambient sound.

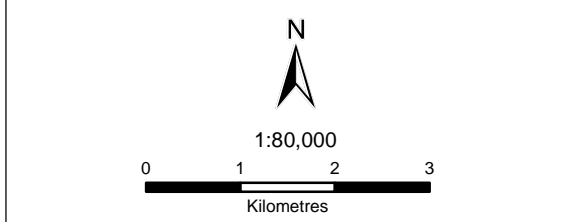
Path: O:\217-299\299\077\03\mxd\Marine_Mammals\EA\Fig4-6-1_295_077_03_EA_MM-StudyAreas_160714_FINAL.mxd



- Legend**
- Marine Mammals Local Assessment Area
 - Marine Mammals Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**MARINE MAMMALS
LOCAL AND REGIONAL ASSESSMENT AREAS**

| | |
|--------------|------------|
| Figure 4.6-1 | 14/07/2016 |
|--------------|------------|

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on marine mammals were established based on the potential for each phase of the Project to interact with, and have an effect on, marine mammals. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with, and affect, marine mammals; therefore, the following temporal boundaries will be assessed:

- Existing conditions.
- Project construction (including Tunnel decommissioning).
- Project operation (including maintenance).

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of Proposed Project**. Specific temporal considerations for the assessment of marine mammals are discussed in the context of Project interactions and potential effects in **Section 4.6.3**.

4.6.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data and describes the existing conditions of the representative species, harbour seal, in the LAA and RAA, and the factors influencing those conditions. A summary of Steller and California sea lion abundance and habitat requirements in and near the Project alignment is also provided to strengthen rationale for selection of harbour seal as a representative species for the marine mammal VC.

4.6.2.1 Regulatory Context

Regulation and management of marine mammals occurs primarily through the Marine Mammal Regulations SOR/93-56 of the *Fisheries Act*, R.S.C. 1985, c. F-14, and the *Species at Risk Act (SARA)*, S.C. 2002, c. 29.

Fisheries Act

Section 7 of the Marine Mammal Regulations prohibits the disturbance of marine mammals, unless fishing for marine mammals under the authority of the regulations. Marine animals, including marine mammals, are defined as fish under the *Fisheries Act*. The *Fisheries Act* provides for the protection of marine mammal habitat from physical alteration and introduction of deleterious substances.

Species at Risk Act

The purpose of SARA is “to prevent wildlife species from being extirpated or becoming extinct, to provide for the recovery of wildlife species that are extirpated, endangered or threatened as a result of human activity and to manage species of special concern to prevent them from becoming endangered or threatened.” Section 32 of SARA further states that “no person shall kill, harm, harass, capture or take an individual of a wildlife species that is listed as an extirpated species, an endangered species or a threatened species.”

Steller sea lion (*Eumetopias jubatus*) is the only marine mammal species listed under SARA Schedule 1 (Special Concern) that may occur in the Project alignment. The term “Special Concern” refers to species that could become threatened or endangered because of a combination of biological characteristics and identified threats (DFO 2010*b*).

Historically, Steller sea lions were the target of subsistence and commercial hunts, and were subject to predator control programs and commercial harvests. As a result, the population decreased substantially by the 1970s to approximately 25 to 33 per cent of early 1900s levels (DFO 2008). In 1971, protection for this species was provided under the *Fisheries Act*. Despite an average increase of 3.2% per year since 1971 in the B.C. population (Pitcher et al. 2007), COSEWIC upgraded the listing for this species from Not at Risk to Special Concern in 2003 for the following reasons:

- There are only three major breeding locations in B.C.
- The species is sensitive to human disturbance while on land.
- There is a threat of acute oil spills, which could hinder recovery of at-risk populations.
- There have been unexplained declines in other populations to the north and west of B.C. (COSEWIC 2003, DFO 2003, 2008).

Other potential threats to Steller sea lions include human disturbance, entanglement in fishing gear, and persecution by humans (SCBC 2009).

Provincial and Other Regulatory Designations

Steller sea lion is provincially Blue-listed (i.e., of Special Concern in B.C.; B.C. CDC 2014). Under the International Union for Conservation of Nature, the eastern Steller sea lion population (which includes the B.C. population) is listed as of Least Concern, and the western population as Near Threatened (Gelatt and Lowry 2012).

4.6.2.2 Existing Conditions

Steller Sea Lion

Steller sea lions use marine habitats to forage and terrestrial locations as haul-out sites (Jeffries et al. 2000, DFO 2010a). Steller sea lions haul out on rocky outcrops, logbooms, floats, and docks when not foraging, to avoid predators, thermoregulate, engage in social activity, rest, and reproduce. Breeding of Steller sea lions occurs from May to August (LGL Limited et al. 2009), in four rookeries: northern tip of Vancouver Island, southern tip of Haida Gwaii, as well as central and northern mainland coasts (DFO 2008, BCMCA Project Team 2011). In late summer and autumn, sea lions disperse to wintering haul-out sites. Winter haul-out sites have been identified on the southern B.C. coast, including the Strait of Georgia (Jeffries et al. 2000, DFO 2003, Olesiuk 2009). The documented haul-out site closest to the Project alignment is near Sand Heads (along the Steveston jetty) at the mouth of the Fraser River, approximately 18 km downstream of the Project (Jeffries et al. 2000, DFO 2010b). While Steller sea lions can be found year-round in marine waters (COSEWIC 2003, DFO 2010b), they occasionally venture into freshwater, as far as 35 km upriver (Olesiuk, unpublished data as cited in DFO 2010b). They also congregate in estuaries during autumn to feed on pre-spawning salmon and at the mouth of the Fraser River in spring when eulachon are running (Bigg 1985, Bigg et al. 1990, Olesiuk, unpublished data as cited in DFO 2010b). While eastern Steller sea lion may occur near the Project alignment, they are not likely to be present in large numbers. During consultation on the Project, Aboriginal Groups noted that Stellar sea lions were historically hunted in the Project area.

California Sea Lion

California sea lions congregate on rookeries off the coast of California and Mexico to mate and pup between May and August. At the end of the breeding season, they leave the rookeries and disperse. Females and juveniles remain in California and Mexico, while adult and sub-adult males travel north as far as central Vancouver Island, arriving in B.C. in September to October and departing from April to May. Approximately 3,000 California sea lions winter in B.C., where individuals feed mainly on mid-water schooling fish such as herring, hake, pollock, and dogfish (Olesiuk and Bigg 1984). Numbers have increased substantially over the past 30 years, likely due to recovery of the breeding population in California and the recovery of local herring stocks (Olesiuk and Bigg 1988). California sea lions occur in waters adjacent to the Project alignment less frequently than Steller sea lions. They have been documented hauling out near Sand Heads (along the Steveston jetty) at the Fraser River mouth (Jeffries et al. 2000, DFO 2010b).

Harbour Seal

The harbour seal is the most abundant marine mammal species in B.C. With a population estimated at about 105,000 individuals in 2008, their numbers may be approaching historic highs (Olesiuk 1999, DFO 2010a). Historically, harbour seals were hunted for pelts to the point of population depletion. Since 1970, however, there have been no commercial harvests or predator control efforts (DFO 2008, 2010a). The current population size appears to be similar to pre-exploitation levels of the 1880s, and recent increases can be attributed to population recovery since cessation of over-hunting. The highest harbour seal population density occurs in the Strait of Georgia (13.1 seals per km of shoreline), representing 37% (39,000 individuals) of the provincial population (DFO 2010a).

Harbour seals inhabit estuarine and coastal waters, and haul out on rocks, reefs, and beaches. Unlike sea lions, harbour seals do not congregate on a few large rookeries, but breed in smaller groups along shorelines throughout most of their range. In southern B.C., female harbour seals give birth to a single pup each year, from early July to late August, while hauled out on shore (Olesiuk et al. 1990, Olesiuk 1999, DFO 2010a). Harbour seal pups are relatively mature and mobile at birth and are reared in the water as well as on land (Riedman 1990). The mother and pup remain together until weaning occurs at three to six weeks after birth (Bishop 1967, Bigg 1969). Moulting (shedding of hair) occurs from late June to October during which time harbour seals are typically hauled out on shore.

During late autumn and winter, harbour seals can be at sea continuously for several weeks to feed and regain weight lost during the mating and moulting seasons. They are thought to be an inshore species, occurring within 20 km of land (Spalding 1964); however, some individuals have been observed up to 100 km from shore (DFO 2010a). Juvenile harbour seals can travel up to 525 km to forage or disperse when population densities get too high. Adults usually remain closer to their haul-outs (i.e., within about 35 km) (Frost 1997). The smaller home range used by adults suggests strong site fidelity (Pitcher and Calkins 1979, Pitcher and McAllister 1981, Lowry et al. 2001).

Harbour seals are generally non-migratory, but move locally with time of day, tides, weather, season, food availability, and to find mates (Scheffer and Slipp 1944, Bigg 1969, 1981, Frost et al. 1996, 1997, Olesiuk et al. 1995, Swain et al. 1996). They are typically seen in small groups, resting on exposed reefs, boulders, and sandbars, but can also sleep for short periods underwater on the ocean floor if no suitable haul-out is available (Baird 2001).

Harbour seals (*Phoca vitulina*) are common year-round in the Strait of Georgia (Keple 2002), relatively common in the lower Fraser River, especially in channels and sloughs (Fisher 1952), and found in proximity to the Project (Tim McCormick, personal communication, 2014). They forage at the mouth of rivers and streams and enter navigable rivers and lakes in pursuit of prey such as spawning salmon (e.g., Baird 2001). The Fraser River is one of the most important rivers in terms of seal abundance (Fisher 1952) and harbour seals have been known to travel 50 km up the Fraser River (DFO 2010a). The nearest documented haul-out site to the Project alignment is at Garry Point, on the southeastern edge of Sturgeon Bank (EAO and VFPA 2012). Fishers on the Fraser River have stated that it used to be unusual to see harbour seals far up the Fraser River, but now they are regularly observed feeding on migrating runs of eulachon and salmon (DFO 2010a, Hume 2010). Vessel operators along the river have reported seals at the river mouth and hundreds hauled-out on log booms (Hume 2010). A DFO assessment in 2000 determined that approximately 1,600 harbour seals are present in the Fraser River (Pablo 2008, DFO 2010a).

Acoustic Environment

Marine mammals use sound as a primary means of underwater communication and sensing. A considerable number of studies have been undertaken in the last decade to describe the effects of anthropogenic noise on marine organisms (Richardson et al. 1995, U.S. NRC 2003, 2005, Wright 2008).

Underwater noise due to the Project could affect marine mammal hearing, communication, or behaviour. Effects to hearing can include temporary or permanent hearing loss, or auditory masking. Behavioural effects can include increased breathing rates, more time spent under or at the water surface, changes in swimming direction or speed, or displacement or avoidance of habitat. Underwater noise could potentially result in behavioural effects, displacement, or habitat avoidance. The types and ranges of effects are highly dependent on the characteristics of the sound source, the environment in which the sound occurs, and the animal(s) receiving the sounds (Richardson et al. 1995, Southall et al. 2007).

The LAA is currently subject to underwater and in-air noise from a variety of anthropogenic sources — mainly commercial and recreational vessel traffic and industrial activity — that contribute to the ambient noise levels. Existing conditions of underwater noise currently exceed thresholds for behavioural disturbance to marine mammals approximately 20 percent of the time. Details on the existing conditions of ambient underwater sound and underwater noise levels associated with the Project are provided in **Section 4.3 Underwater Noise**.

4.6.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with marine mammals, and the potential effects of such interactions. Information on the mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.6.4**.

4.6.3.1 Project Interactions

This section presents a preliminary evaluation of the potential effects of Project interactions on marine mammals for the purpose of focusing the assessment on those interactions of greatest importance. An overview of potential interactions between Project activities and marine mammals during Project construction is provided in **Appendix A**.

Construction: Potential interaction with, and effects on, marine mammals during Project construction may include the following:

- Physical injury during Project construction activities along the edge of Deas Slough, including pile driving, that can generate underwater noise at levels sufficient to injure the hearing of marine mammals, and injury or mortality due to collisions with construction-related vessels or equipment on land or in water.
- Behavioural changes resulting from construction activities along the edge of Deas Slough and Tunnel removal, including vibrodensification, vibratory pile driving, and operation of support vessels, that can generate underwater and in-air noise at levels sufficient to disturb, but not injure, marine mammals.
- Behavioural changes resulting from construction and operation activities that could generate atmospheric (in-air) noise at levels sufficient to disturb marine mammals hauled out on land.
- Potential effects from changes to sediment and water quality.

Operation: Project operation activities are not anticipated to generate underwater or in-air noise that can physically injure or disturb marine mammal behaviour, resulting in no adverse effects on marine mammals.

4.6.3.2 Potential Effects

Potential effects associated with the identified Project-marine mammal interactions were identified through discussions with regulators, Aboriginal Groups, stakeholders, review of the Project's Application Information Requirements, experience from past projects and activities, and professional judgement of the Project team. Potential effects from construction activities are anticipated to be similar for all marine mammals occurring in the Fraser River in the LAA.

Underwater and in-air noise generated during construction was carried forward into the assessment. Potential changes associated with other Project interactions, including potential changes to sediment and water quality and potential collisions with vessels and other construction equipment either on land or in water, were determined to have a negligible effect on marine mammals and were not considered further.

As harbour seals are not common in the Fraser River and it is not their prime habitat (marine), any short-term effects to their habitat or prey from changes in sediment and water quality will not affect their ability to feed and successfully reproduce. The change in harbour seal habitat quality between existing conditions and the Project was considered negligible.

Collisions between construction-related vessels and construction equipment and harbour seals may be fatal to a harbour seal, or an individual may recover. However, only one record of a pinniped (sea lion) strike has been reported in B.C. (2009), involving a whale watching vessel at Race Rocks Marine Reserve (DFO Marine Mammal Incident Database 1973 to October 2012). Vessel strikes were not identified as a potential threat in the DFO Management Plan for harbour seals and will not be assessed further. Due to their small size and agility, and propensity to flee terrestrial disturbance while on haulouts, the chance of a Project-related vessel or construction equipment striking a seal and resulting in injury or mortality during construction is very low and determined to be negligible and no adverse effects to marine mammals are anticipated.

Mitigation measures, including Project design measures to avoid or reduce adverse effects, are described in **Section 4.6.4**. Potential residual effects of the Project on marine mammals in terms of established criteria are discussed in **Section 4.6.5**. A determination of the significance of each residual effect, the likelihood of the residual effect, and the level of confidence in each residual effect prediction, if applicable, are also presented in **Section 4.6.5**. The potential for cumulative effects is assessed in **Section 4.6.6**.

Potential Effects of Underwater Noise

Underwater Noise Background

Sound can be classified as either pulsed or non-pulsed (i.e., continuous). Pulsed sound is brief (less than a few seconds) and intermittent, with rapid changes of sound pressure (e.g., a seismic airgun shot or an impact-hammer strike). Non-pulsed sound is characterized by gradual changes in sound pressure over time (e.g., marine vessels transiting and a vibratory pile driver in operation).

Several acoustic metrics (detailed in **Section 4.3 Underwater Noise**) are typically used to characterize pressure levels of underwater sound. Metrics used to assess potential injury and behavioural disturbance to marine mammals as a result of underwater noise generated during Project-related construction activities include:

- Root mean square (rms) sound pressure levels (SPL): the average pressure in a given time window of noise.
- Peak SPL: the maximum level attained by an acoustic pressure signal. This metric is commonly quoted for pulsed sound, and can be a criterion for assessing whether a sound could cause injury.
- Sound exposure level (SEL): the total acoustic energy received at a given location during an acoustic event, and thus the sound energy to which an organism at that location would be exposed. The SEL is also commonly used to quantify the loudness of noise.

Underwater Noise Effect Criteria

In Canada, there are currently no regulations or policies regarding underwater noise and marine mammals. Two widely acknowledged yet different sets of injury and disturbance criteria, however, are commonly used to assess sound exposure of marine mammals (see **Table 4.6-4**; refer also to **Section 4.3 Underwater Noise**):

- Regulatory criteria applied in the U.S. by the National Marine Fisheries Service (NMFS)¹ (Funk et al. 2008).
- Criteria recommended by Southall et al. (2007).

These criteria incorporate available known marine mammal reactions and various physical injury and behavioural effects due to pulsed and non-pulsed underwater noise sources.

The NMFS injury criteria are based on the rms SPL of a single pulse, averaged over the pulse duration to which a marine mammal may be safely exposed before injury occurs. The NMFS has not established injury criteria for exposure to non-pulsed sounds.

Southall et al. (2007) employ a dual criteria based on peak SPL and cumulative M-weighted SEL thresholds; the cumulative injury criteria (SEL) are specified as originating from single- or multiple-exposure events over a 24-hour period. A received sound exposure is assumed to cause injury if it exceeds either the peak SPL or the SEL criterion, or both. Southall et al. (2007) do not recommend specific SPL thresholds for marine mammal disturbance criteria.

¹ The NMFS auditory injury threshold criteria are under review but remain in use until newly proposed draft criteria are revised and formally accepted by the agency.

Table 4.6-4 National Marine Fisheries Service (NMFS) and Southall et al. (2007) Auditory Injury and Disturbance Thresholds for Seals in Water

| NMFS rms SPL Thresholds (dB re 1 µPa) | | | | Southall et al. (2007) M-weighted 24-Hour SEL Thresholds (dB re 1 µPa ² s) | Southall et al. (2007) peak SPL Thresholds (dB re 1 µPa) |
|---------------------------------------|-------------|--------------|-------------|--|--|
| Continuous Sound | | Pulsed Sound | | Pulsed Sound | |
| Injury | Disturbance | Injury | Disturbance | Injury | Injury |
| - | 120 | 190 | 160 | 186 | 218 |

Notes: SEL: sound exposure level
rms SPL: root mean square sound pressure level

Potential Effects of Underwater Noise during Construction

Proposed construction activities associated with the Project will generate underwater noise that can potentially injure or disturb marine mammals in the Fraser River. Physical injury and behavioural disturbance effects were assessed based on the distance sound propagates away from the sound source, modelled for six conservative Project construction scenarios that are likely to produce the greatest amount of underwater sound. These scenarios are as follows:

1. Localized impact pile driving along Deas Slough.
2. Localized vibratory pile driving along Deas Slough.
3. Localized vibrodensification along Deas Slough.
4. Cutter suction dredging with tug operating at the Tunnel.
5. Tugs operating at the Tunnel during Tunnel segment lifting.
6. Combined operation of tugs (Tunnel segment lifting) and sediment removal in the Fraser River.

Details on the underwater noise modelling methods, scenarios, source levels, and predicted underwater noise produced during Project construction activities are provided in **Section 4.3 Underwater Noise**. Modelling results are summarized below and in **Table 4.6-5**. It should be noted that modelled scenarios are highly conservative as they assumed construction activities in water up to 5 m in depth, and actual construction work is anticipated to occur on land or in shallow water.

Physical Injury

Project construction activities that will produce underwater noise include impact pile driving, vibratory pile driving, vibrodensification, sediment removal, lifting of the Tunnel segments, and support vessel movements. Of the six scenarios modelled (**Table 4.6-5**), in-water impact hammer pile driving in Deas Slough is the only activity that could potentially generate sound levels sufficient to physically injure the hearing of harbour seals within 53 m of the pile driving noise source. Hearing damage to harbour seals from vibratory pile driving in Deas Slough was predicted to occur within nine metres from the sound source. A worst-case scenario of 100 minutes of impact pile driving (M-weighted 24-hr SEL threshold) resulted in a zone of injury having a maximum radius of 618 m from the source (**Table 4.6-5**). Underwater noise generated during this construction scenario is not predicted to reach the mainstem of the Fraser River and will remain in Deas Slough.

These distances are conservative because they assume that 1) a seal is stationary for the duration of the sound exposure, and 2) that construction activities will occur in water. Avoidance behaviour by seals would reduce their overall sound exposure and thus the effective extent of the injury zone for impact pile driving. Furthermore, the modelled scenario considered pile driving at a depth of five metres below the water surface and localized pile installation may occur between the high and low tide water marks in dry conditions. Underwater noise is expected to be more strongly attenuated in shallow water, restricted by the surrounding slough and river banks, and absorbed by silt and clay sediments. Sediment-borne sound from impact pile driving is approximately 20 dB lower than water-borne sound (Zampolli et al. 2013). Propagation of sound through soil is expected to attenuate water-borne sound levels generated by pile driving. Thus, the six scenarios considered in this study represent the most conservative cases in terms of underwater noise emissions and potential physical injury radii.

Behavioural Disturbance

The Project-related construction activities of vibratory pile driving, vibrodensification, sediment removal, and operation of support vessels are not expected to generate sound at levels that could affect the hearing of harbour seals. However, underwater noise produced during these activities could result in behavioural disturbance.

For marine mammals, the area of potential disturbance is taken to be the zone within which sound levels exceed 120 dB rms SPL. The modelled extent of the 120 dB rms SPL zone for continuous sound sources, such as operation of tugs or vibrodensification, within which behavioural effects could occur ranges from between 441 m to 3,447 m from the source location (**Table 4.6-5**).

Although vibratory pile driving has the highest source level of all continuous sources, noise from this activity is concentrated at low frequencies (<200 Hertz), and would therefore rapidly dissipate in the shallow sediments of Deas Slough, meaning the extent of the behavioural effect zone (120 dB re 1 μ Pa SPL) would be relatively small (593 m) for this activity. The extent of the behavioural effect 120 dB re 1 μ Pa SPL zone would be smallest (441 m) for tug and barge activities during crane lifting of the Tunnel segments (scenario 5; **Table 4.6-5**).

Project-related sediment removal in preparation for Tunnel removal is assumed to occur during the prescribed least-risk timing window for the protection of juvenile salmon and eulachon (i.e., July 16 to February 28; FREMP 2006). Use of the Fraser River by seals and sea lions is known to be dependent on the seasonal migration of eulachon and salmon as a predictable and plentiful food source. This work window coincides with the time juvenile salmon and eulachon are absent from the lower Fraser River, and consequently, seals and sea lions that prey on them are also scarce or likely absent. Moreover, Project-related construction activities that have the potential to result in marine mammal behavioural disturbance will generate underwater noise that is similar to ambient acoustic levels measured in the lower Fraser River 20% of the time (see **Section 4.3 Underwater Noise**).

Seals and sea lions are known to habituate readily to human activity, including underwater noise. Previous monitoring of disturbance of seals and sea lions, at Race Rocks Ecological Reserve (Strait of Juan de Fuca, B.C.), from underwater noise generated by blasting of explosives during nearby military training indicated that behavioural changes, including displacement from a haul-out, were short term with little or no consequence on long-term use (Demarchi 2010). Shortly after each observable disturbance, animals typically returned to the haul-out, suggesting their resilience to this type of disturbance. With repeated disturbance over a period of a year, individuals continue to use Race Rocks as habitat with no measureable effect on seal or sea lion populations (Demarchi 2010).

Potential Effects of In-Air Noise during Construction

In-air noise during Project construction will not propagate into waters in the LAA at levels that could result in injury or behavioural effects to marine mammals. However, atmospheric noise could be audible to seals hauled out on land. Behavioural responses of seals to physical and acoustic disturbance range from increased alertness and sometimes threat displays to moving towards and flushing into the water. Some species have been observed to be more habituated to human disturbance (e.g., sea lions), while other species are more sensitive to disturbance (e.g., harbour seals). Studies of the distance of the disturbance source, whether land or water-based, from hauled-out harbour seals have found that the closer the disturbance,

the more likely seals are to flush into the water. The actual distance at which most flushing to the water occurs has varied from study site to study site, but has been given as approximately <100 m from disturbance, including vessels and pedestrian traffic (Allen et al. 1984, Jackson and Wilson 1990, Calambokidis et al. 1991, Brown and Prior 1998, Suryan and Harvey 1998, Jansen et al. 2010). However, the distance at which seals become alert and begin to move towards the water can be as much as 500 to 800 m at some sites (Henry & Hammill 2001, Wilson et al. 2011), and some seals begin to move into the water at 200 to 300 m for all vessels (Suryan and Harvey 1998), 300 to 500 m for cruise ships (Calambokidis et al 1991), 300 m for tour boats (Young 1998), 140 m for kayaks (Henry and Hamill 2001), and 137 m and 371 m for kayaks and stopped power boats respectively (Johnson and Acevedo-Gutiérrez 2007). Habituation to noise has also been observed in seals and sea lions hauled out on docks in direct proximity to regularly scheduled float plane operations in Victoria, B.C. (S. Meier, personal communication). In locations with regular vessel traffic, harbour seals have been observed to habituate and to allow close approach by touring boats that repeatedly visit haul-out locations (Bonner 1982, Johnson et al. 1989).

Potential behavioural effects to hauled-out harbour seals on land are not expected because of habituation. Any temporary behavioural changes will be short-term, and are not anticipated to result in population-level effects. Given this, potential changes in in-air noise levels from the Project are not anticipated to result in adverse effects to marine mammals.

Table 4.6-5 Predicted Distances within which Physical Injury and Behavioural Disturbance to Harbour Seals May Occur from Modelled Construction-related Underwater Noise Scenarios

| Construction Scenario ² | National Marine Fisheries Service Thresholds rms SPL (dB re μ Pa) | | | Southall et al. (2007) M-weighted 24- Hour SEL Threshold (186 dB re 1 μ Pa ² s) | Southall et al. (2007) peak SPL Threshold (218 dB re 1 μ Pa) |
|---|--|--|--|---|---|
| | 120 rms Behavioural Disturbance Radius Continuous Sound (m) | 160 rms Disturbance Radius Pulsed Sound (m) | 190 rms Injury Radius Pulsed Sound (m) | Injury Radius Pulsed Noise (m) | |
| 1. Impact pile driving in Deas Slough | 3,043 | 1,233 | 53 | 618 | 27 |
| 2. Vibratory pile driving in Deas Slough | 593 | 58 | 9 | n/a | n/a |
| 3. Vibrodensification in Deas Slough | 951 | <10 | n/a | n/a | n/a |
| 4. Cutter suction dredging with tug operating at Tunnel crossing | 2,726 | 11 | n/a | n/a | n/a |
| 5. Tugs operating at Tunnel crossing during Tunnel segment lifting | 441 | n/a | n/a | n/a | n/a |
| 6. Combined operation of tugs (Tunnel segment lifting) and sediment removal in the Fraser River | 3,447 | 10 | n/a | n/a | n/a |

Note: n/a = not applicable (levels were not reached).

² Construction scenarios represent the most conservative scenario in terms of potential levels of underwater noise generated

4.6.4 Mitigation Measures

As described in **Section 12.0 Management Plans**, a Construction Environmental Management Plan (CEMP) and an Operational Environmental Management Plan (OEMP) will be developed for works to be undertaken during Project construction and operation. Pertinent to marine mammals, the CEMP will include component plans, organized by environmental topic, including a Marine Mammal Management Plan. The Marine Mammal Management Plan will describe standard best practices and mitigation measures, as well as monitoring efforts, to prevent or minimize potential adverse effects to marine mammals that might otherwise result from the Project during construction. In consultation with Fisheries and Oceans Canada (DFO), mitigation measures will be developed to avoid or reduce the potential adverse effects of the Project on marine mammals (as represented by harbour seals).

4.6.4.1 Mitigation Measure #1: Marine Mammal Management

A Marine Mammal Management Plan of the CEMP will be developed in consultation with DFO to mitigate potential effects of the Project to marine mammals during Project-related underwater construction activities and will describe the measures to be followed to minimize underwater noise. Specifically, construction activities that have the potential to generate underwater sound at levels that can physically injure marine mammals, such as impact pile driving, will adhere to standard industry and best management practices such that sound thresholds for the protection of marine mammals (**Section 4.6.3.2**) are not exceeded. For example, piles could be driven through construction pads to reduce sediment-borne sound levels generated during pile driving before they reach the aquatic medium.

The Marine Mammal Management Plan will focus on best practices and mitigation measures that will be implemented to minimize underwater noise generated during marine-based construction activities, and to mitigate the potential for physical injury to marine mammals. Mitigation and monitoring measures that will be described in the plan will include, but will not be limited to:

- Limited use of engines and propellers on stationary vessels, whenever possible.
- Maintaining consistent navigation courses and speeds.
- Conducting land-based pile driving whenever possible.
- Conducting activities with the potential to generate underwater noise as efficiently as possible.
- Avoiding unnecessary idling of marine-based equipment.

- Procedures to prevent direct or indirect discharge of deleterious substances (including soil, sediment, sediment laden or turbid water, or fuel, and oils) into the marine environment.
- Implementation of marine mammal monitoring during activities anticipated to generate underwater noise, including an underwater noise monitoring program.

4.6.4.2 Mitigation Measure #2: Underwater Noise Monitoring

As part of the Marine Mammals Management Plan, underwater noise monitoring will be conducted during Project construction activities that have the potential to generate underwater sound levels that may exceed auditory thresholds that can cause physical injury to fish and marine mammals. In consultation with DFO, underwater noise monitoring is expected to be conducted during Project construction in the Fraser River South Arm and Deas and Green Sloughs to confirm underwater noise levels and ensure that injury thresholds are not exceeded, as described in **Section 4.3.4.2 Underwater Noise, Underwater Noise Monitoring**.

4.6.5 Residual Effects and their Significance

Residual effects are those that are expected to persist after implementation of mitigation measures. Implementation of mitigation measures described in **Section 4.6.4** is anticipated to prevent physical injury and minimize the potential for behavioural disturbance of marine mammals (as represented by harbour seals). Potential effects of the Project to marine mammals will be temporally limited to the construction phase and spatially limited to those activities occurring within or along the Fraser River South Arm, Deas Slough and Green Slough. Mitigation is expected to be immediately effective in protecting harbour seals from underwater noise levels that could result in injury or mortality. These mitigation measures have been used worldwide for decades to effectively mitigate potential effects of marine industrial noise on marine mammals. As a result of the implementation of mitigation measures, Project-related construction activities are not anticipated to result in population-level effects to marine mammals, including species at risk, and no residual effects on marine mammals are anticipated.

4.6.6 Cumulative Effects and their Significance

Cumulative effects result from interactions between Project-related residual effects and incremental effects of other certain and reasonably foreseeable projects and activities. The Project is not likely to result in any residual adverse effects on marine mammals. Consequently, cumulative effects are not discussed further in this assessment.

4.6.7 Follow-up Strategy

As described above, underwater noise monitoring will be conducted during Project construction in the Fraser River South Arm and Deas and Green Sloughs to confirm underwater noise levels and ensure that injury thresholds are not exceeded, as described in **Section 4.3.4.2 Underwater Noise, Underwater Noise Monitoring**.

No follow-up strategy is proposed for marine mammals.

4.6.8 References

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APPENDIX A

Overview of Potential Project Interactions with Marine Mammals

Table 1 Overview of Potential Project Interactions with Marine Mammals

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|--|--|
| Pre-Construction / Site Preparation | | | |
| Pre-construction / site preparation | No Interaction | <ul style="list-style-type: none"> • Surveying • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Installing temporary drainage structures and diversions • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction • Acquiring property for the Project | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Activities to be land-based.</p> |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Restoration of Green Slough to its historic alignment • Installing temporary bridges and barging facilities | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Behavioural disturbance (i.e., some individuals hauled out may re-enter the water) from increased atmospheric noise. Potential effect is expected to be negligible, affecting individuals hauled out on land. The nearest haul-out site is at the Fraser River mouth, approximately 18 km downstream of the Project alignment. • Behavioural disturbance, hearing loss, or auditory masking from increased underwater noise. |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|--|--|
| Construction | | | |
| New bridge including approaches and ramp connections | No Interaction | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Activities to be land-based.</p> |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-------------------------|---------------------|--|---|
| | Potential Effect | <ul style="list-style-type: none"> • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Behavioural disturbance (i.e., some individuals hauled out may re-enter the water) from increased atmospheric noise. Potential effect is expected to be negligible, affecting individuals hauled out on land. The nearest haul-out site is at the Fraser River mouth, approximately 18 km downstream of the Project alignment. • Auditory physical injury (impact pile driving) or behavioural disturbance (vibratory pile driving and in-river operation of construction vessels) from increased underwater noise. Noise from machinery and equipment during hoisting pre-assembled deck segments from barges in the river or land-based transport system and partial infilling of Green Slough is expected to be minimal. |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|---------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No Interaction | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Activities to be land-based.</p> |
| | No Effect | N/A | N/A |
| | Potential Effect | N/A | N/A |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-------------------------|---------------------|--|---|
| Tunnel decommissioning | No Interaction | N/A | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Behavioural disturbance (i.e., some individuals hauled out may re-enter the water) from increased atmospheric noise. Potential effect is expected to be negligible, affecting individuals hauled out on land. The nearest haul-out site is at the Fraser River mouth, approximately 18 km downstream of the Project alignment. • Physical injury or direct mortality to marine mammals from increased risk of vessel strikes by in-river construction support vessels. However, vessel strikes against harbour seals are rare due to their agility. • Temporary changes to the ability to feed on migrating fish stocks, that may in turn be affected from changes in ambient water quality from induced turbidity, re-mobilization of sediment contaminants, and re-deposition of suspended sediment. • Behavioural disturbance from increased underwater noise during operation of in-river dredging equipment and construction support vessels (i.e., tugs). |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---------------------------------------|---------------------|--|--|
| Decommissioning of Deas Slough Bridge | No Interaction | N/A | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> Removal of Deas Slough Bridge including substructures. | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> Behavioural disturbance (i.e., some individuals hauled out may re-enter the water) from increased atmospheric noise. Potential effect is expected to be negligible, affecting individuals hauled out on land. The nearest haul-out site is at the Fraser River mouth, approximately 18 km downstream of the Project alignment Behavioural disturbance from increased underwater noise during operation of in-river equipment and support vessels |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-----------------------------|---------------------|---|---|
| Operation Phase | | | |
| Highway 99 and interchanges | No Interaction | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | Nature of interaction: No interaction anticipated Rationale: Activities to be land-based |
| | No Effect | N/A | N/A |
| | Potential Effect | N/A | N/A |
| New Bridge | No Interaction | <ul style="list-style-type: none"> Operating the new Bridge. Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | Nature of interaction: No interaction anticipated. Rationale: Activities to be land-based. |
| | No Effect | N/A | N/A |
| | Potential Effect | N/A | N/A |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.7 Vegetation Assessment Overview

- The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.
- Project components and activities will be primarily located within the existing Highway 99 ROW, where the vegetation consists mainly of grassy, mowed verges.
- Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh, that occur in the vicinity of the Project.
- Creating comparable habitat within the Project alignment will offset unavoidable potential Project-related effect, which is limited to a small reduction in area of the cattail marsh that overlaps with Project components.
- No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.
- Applying best practices such as flagging of at-risk ecosystems to avoid encroachment during construction, removal of invasive species within areas required for the Project, and replanting of disturbed areas with native species will ensure that Project-related effects on vegetation are effectively addressed.
- No Project-related residual or cumulative effects on vegetation are expected.

4.7 Vegetation

This section presents the results of the assessment of potential effects of the Project on vegetation, and includes a description of existing conditions, potential Project-related effects and proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects. The assessment of potential Project-related effects on vegetation presented in this section is confined to non-agricultural vegetated ecosystems. Potential effects of the Project on agricultural lands are described in **Section 5.4 Agricultural Use**.

In this assessment, vegetation refers to terrestrial and wetland plant species and ecosystems, particularly those considered federally or provincially to be at-risk (i.e. native species, subspecies, or ecological communities identified as being vulnerable to population declines). Potential Project interaction with aquatic vegetation species is discussed in **Section 4.4 Fish and Fish Habitat**.

4.7.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on vegetation in terms of Project setting and defines the spatial, temporal, administrative, and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

No jurisdictional, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects, accessibility constraints, or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore, administrative or technical boundaries are not considered relevant.

4.7.1.1 Assessment Context

The Project is located largely within the right-of-way (ROW) of an active transportation corridor and vegetation within the Project alignment is generally indicative of intense management associated with urban and agricultural development. There are, however, small portions of the Project alignment that support native vegetation, which may include species or ecosystems that are considered to be at risk by provincial or federal regulators, or are of interest to Aboriginal Groups. Additional information supporting the selection of vegetation as a VC is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.7.1.2 Methodology

The assessment of vegetation follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Building on this approach, the assessment of vegetation was designed to focus on specific vegetation species and ecosystems considered most appropriate in the context of existing conditions in the Project area. In this context, the assessment of vegetation focuses on two sub-components as presented in **Table 4.7-1**.

Table 4.7-1 Sub-components of Vegetation

| Sub-Component | Rationale for Selection |
|-----------------------|--|
| At-risk ecosystems | Considered to be at risk (Red- or Blue-listed) by provincial regulators and potentially present within the Project alignment. |
| At-risk plant species | Considered to be at risk by provincial regulators (Red- or Blue-listed) or federal regulators (Endangered, Threatened, or Special Concern) and potentially present within the Project alignment. |

The presence and extent of at-risk ecosystems, described in terms of spatial extent and location, and species populations were used as indicators to assess trends of vegetation within the assessment area and evaluate potential Project-related effects. **Table 4.7-2** presents the indicators chosen for the assessment of Project-related effects on the two vegetation sub-components, and the rationale for their selection.

Table 4.7-2 Indicators for Assessment of Vegetation Sub-components

| Vegetation Sub-component | Indicators | Rationale for Selection |
|--------------------------|---|---|
| At-risk plant species | Presence and extent of individual species | Quantifies existing abundance and possible reduction in abundance due to Project-related clearing and habitat alteration. |
| At-risk ecosystems | Presence and extent of population(s) | Quantifies existing abundance and possible reduction in abundance due to Project-related clearing and habitat alteration. |

4.7.1.3 Assessment Boundaries

The assessment boundaries for vegetation are defined below.

Spatial Boundaries

The local assessment area (LAA) for vegetation is defined in **Table 4.7-3**, and shown in **Figure 4.7-1** and **Appendix A, Figures 1a to 1p**). The boundaries of the assessment area take into account the scale and spatial extent of potential environmental effects that are appropriate for the two sub-components.

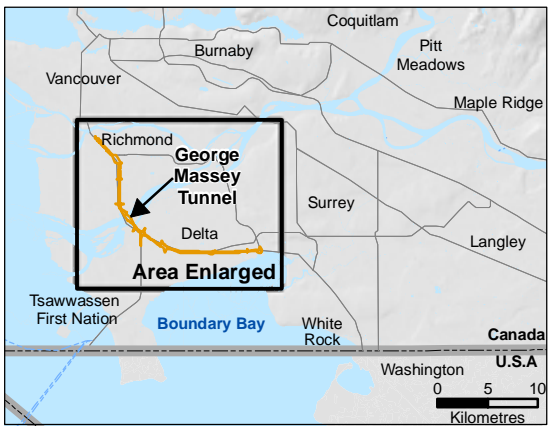
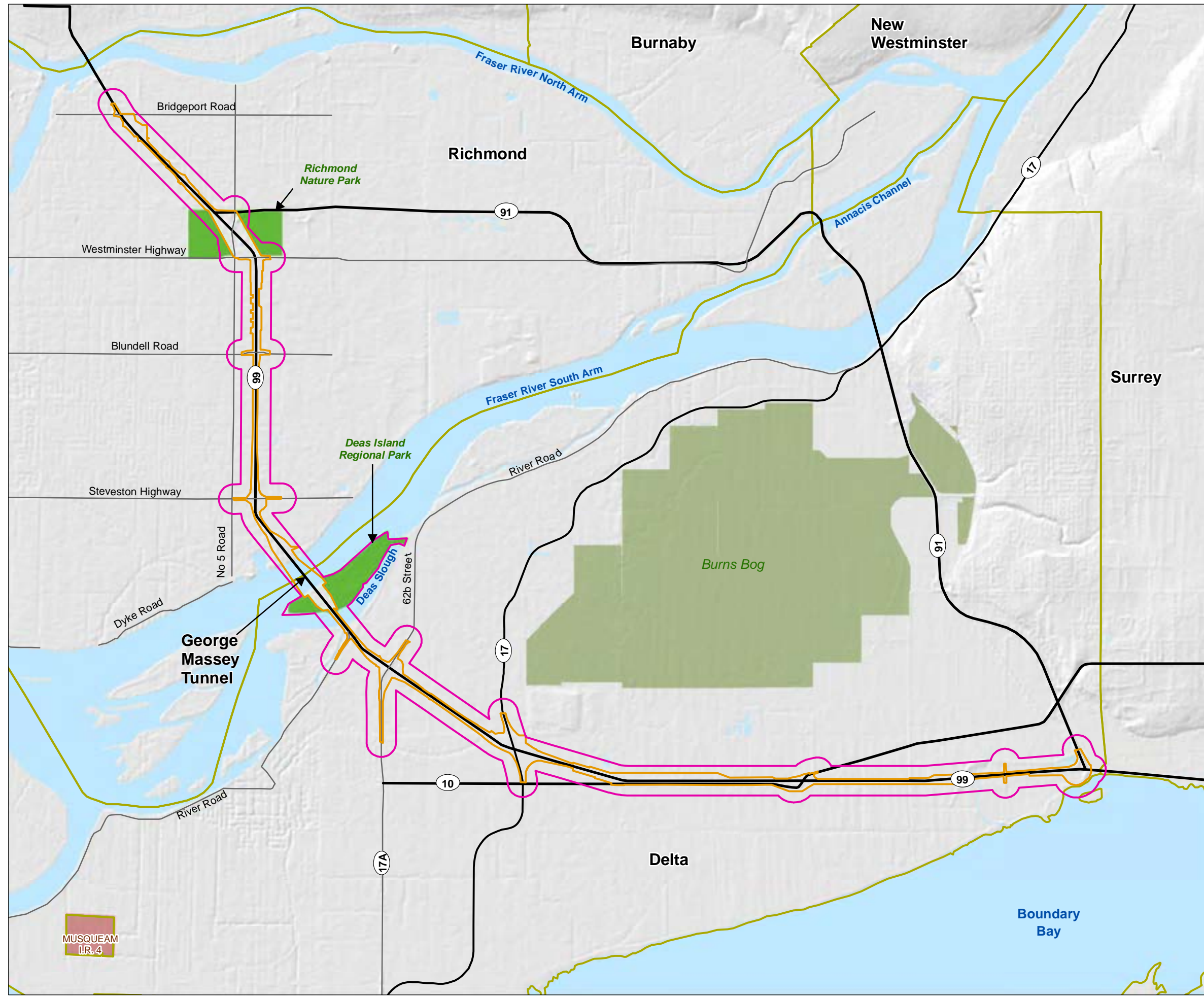
Table 4.7-3 Spatial Boundaries for Vegetation Assessment

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|---|
| Local Assessment Area (LAA) | The area within a 500-m wide corridor, extending 250 m from either side of the Highway 99 centreline, over the length of the Project alignment, including interchanges. In the area of Deas Island, the LAA is extended to include the entire island, some of which extends beyond 250 m on either side of the Highway 99 centreline. |
| Regional Assessment Area (RAA) | Project-related effects on vegetation are expected to be limited to within the LAA; therefore the RAA is defined the same as the LAA. |

The LAA for vegetation (**Table 4.7-3**) was established to encompass the area within which the Project is expected to interact with, and potentially have an effect on vegetation. In determining the LAA boundaries, consideration was given to the nature and characteristics of the vegetation sub-components, their potential exposure to habitat loss due to Project-related activities, and the maximum extent of potential effects. The Project is part of an existing transportation corridor and is located within a highly disturbed urban setting. The extent of plants and ecosystems likely to be affected by Project-related activities is constrained by the nature of adjacent land uses; therefore, a 500-m wide corridor that incorporates the Project alignment is considered sufficient to understand potential Project-related effects and to design appropriate mitigation measures where needed. Deas Island was included into the assessment in April 2016 as an extension to the vegetation study area.

Since Project-related effects on vegetation are expected to be limited to within the LAA, the RAA has been defined same as the LAA (i.e. extending over the length of the Project alignment, including interchanges).

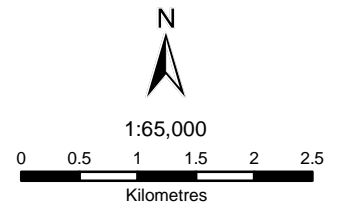
Path: C:\1217-299\285077\03\mxd\Vegetation\EA\Fig4-7-1_285_077_03_EA_Veg-AA_160503_FINAL.mxd



- Legend**
- Vegetation Local and Regional Assessment Areas
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| VEGETATION LOCAL AND REGIONAL ASSESSMENT AREA | |
| Figure 4.7-1 | 13/05/2016 |
| | |

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on vegetation were established based on the potential for each phase of the Project to interact with and have an effect on vegetation. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect vegetation present within the Project alignment; therefore, the following temporal boundaries were defined for vegetation assessment:

- Existing conditions
- Project construction (including Tunnel decommissioning)
- Project operation (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of the Proposed Project**. Specific temporal considerations for the assessment of vegetation and its sub-components are discussed in the context of Project interactions and potential effects in **Section 4.7.3**.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on vegetation have been identified; therefore, no administrative boundaries are defined.

Technical Boundaries

No technical boundaries have been identified that could impose limitations on the assessment of potential Project-related effects on vegetation.

4.7.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of vegetation within the assessment areas. An overview of the regulatory context for management of vegetation as relevant to the Project is also provided.

4.7.2.1 Baseline Data Collection

In 2014, the Ministry initiated vegetation studies to support Project planning and effects assessment. Building on available information, these studies were designed to address known data gaps. Desktop and field studies conducted with respect to vegetation are summarized in **Table 4.7-4**. A comprehensive description of methods is provided in **Appendix B**, and highlights are provided below.

Table 4.7-4 Desktop and Field Studies Related to Vegetation

| Study Name | Purpose of Study |
|--|--|
| Terrestrial ecosystem mapping | To provide a baseline map of vegetation types, including agricultural lands, within the LAA and identify potential locations of at-risk plants or ecosystems for guiding rare plant surveys. |
| Assessment of at-risk plant species and ecosystems | Field surveys of selected terrestrial ecosystem mapping (TEM) polygons to verify presence of at-risk ecosystems and determine presence of at-risk plant species. |

Baseline data collected for the Project consisted of obtaining high resolution orthophotos from the Ministry and digitizing terrestrial ecosystem mapping (TEM) polygons (ecosystems) based on observable land cover. The orthophotos were of sufficient quality to accurately delineate ecosystems to a high level of confidence.

Vegetated and non-vegetated land cover types were first defined and delineated on the orthophotos using methods described in the *Standard for Mapping Terrestrial Ecosystems in British Columbia* (RIC 1998). Because much of the assessment area is disturbed, modifications to the standard approach were applied so that some cover types (e.g., roads, bare soil) could be adequately described. Factors that were considered in delineating ecosystems and other land cover types included parent material (e.g., soil), slope, aspect, and nature of vegetation cover. In addition to the desktop TEM work, a list of rare plant species that have some likelihood of occurring in the LAA was compiled based on knowledge of species habitat requirements. Further details on the TEM objectives, methods, and results are provided in **Appendix B**.

The provincial TEM standard data collection methods, as well as the provincial standard *Field Manual for Describing Ecosystems in the Field* (B.C. MOF 2010), were followed in collecting data during the field program. All ecosystems delineated as being at-risk during desktop studies were surveyed to confirm presence and habitat quality. Sampling of vegetation was conducted within 20 m-radius plots and data collected on a standard Ground Inspection Form (GIF). Within each plot, data were collected on stand structure and plant species composition. Per cent cover per species was recorded, and plant species were identified at minimum to the genus level. Total per cent cover for trees, shrubs, and herbs respectively was also recorded. TEM data for each plot were recorded on standard ground inspection forms.

In the absence of provincial standards in B.C., at-risk plant species followed methods outlined in the *Guidelines for Rare Vascular Plant Surveys* (ANPC 2012). At-risk ecosystems were mapped following the provincial *Standard for Mapping Ecosystems at Risk* (B.C. MOE 2006).

Federal, provincial, and municipal mapping and databases as well as existing reports were also consulted prior to the field surveys to understand the potential for at-risk plant species and ecosystems and included the following:

- *Species at Risk Act (SARA)* Registry
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC)
- B.C. Conservation Data Centre (B.C. CDC)
- Province of B.C. online geospatial system (Hectares B.C.)
- Electronic Atlas of Flora of B.C. (e-Flora B.C.)
- Province of B.C. online mapping system (iMapBC)
- City of Surrey online mapping system (COSMOS)
- Corporation of Delta online mapping system (DeltaMap)
- City of Richmond Interactive Map (RIM)
- South Fraser Perimeter Road (SFPR) Environmental Assessment Application

The rare plant species and at-risk ecosystems surveys were focused on the Highway 99 component of the Project alignment. Roadside ditches were visually scanned as encountered. The rare plant surveys were conducted by a qualified professional using accepted protocols for field surveys

4.7.2.2 Regulatory Context

Federal

Legal protection for at-risk plant species is provided at the federal level under the *Species at Risk Act (SARA)*, S.C. 2002, c. 29, which aims to protect species at risk from becoming extinct or lost from the wild. The Act covers all Canadian wildlife species, including vascular plants, mosses and lichens, along with their critical habitats¹, that have been identified as being at risk of extinction.

The *SARA* Schedule 1 lists all plant and animal species that the Government of Canada considers to be at risk, or trending towards becoming at risk. This list is periodically updated based on recommendations provided by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an expert group that assesses and designates which wildlife species are in danger of disappearing from Canada (see **Table 4.7-5** for definitions of species status designations).

¹ Habitat that is necessary for the survival or recovery of a listed wildlife species and that is identified in the recovery strategy or in an action plan for the species.

Cabinet makes the final decision on whether a species will be listed under SARA Schedule 1, based on COSEWIC recommendations. Such a decision is made after the federal government has held consultations with affected stakeholders and other groups, and has considered the economic and social implications. An endangered or threatened listing under SARA mandates the formation of a species recovery team and strategy, which may in turn lead to designation of critical habitat to be protected by law.

Provincial

Although B.C. has no stand-alone endangered species legislation, the provincial *Forest and Range Practices Act (FRPA)*, SBC 2002, c. 69 enables species at risk to be designated as identified wildlife by the Deputy Minister of Environment, if the species requires special management to address the impacts of forest and range activities. Under the *FRPA*, wildlife includes endangered, threatened, or vulnerable plant species. In addition, conservation and recovery planning of at-risk species and ecosystems in B.C. are guided through the B.C. Ministry of Environment (MOE) and the B.C. Task Force on Species at Risk, and informed by the B.C. CDC.

The task of identifying at-risk species, subspecies, populations, and ecosystems (referred to collectively as elements), rests with the CDC, which is aligned with national and international organizations that cooperate to gather and exchange information on threatened elements of biodiversity. The CDC systematically collects and disseminates information on elements at risk in B.C. and assigns a provincial conservation status rank according to set criteria. Elements are placed on either a Red or Blue list for the purposes of helping to set conservation priorities and to inform more formal designations, such as by COSEWIC. The CDC designations are similar to those under SARA (**Table 4.7-5**). A Red- or Blue-list designation does not confer protection to the element or its habitat, but does highlight species and ecological communities that have particular threats, declining population trends, or restricted distributions.

Table 4.7-5 Designations for Species at Risk

| Species Status | Federal Definition ¹ | Provincial Equivalent ² |
|-----------------|--|------------------------------------|
| Extinct | No longer exist in the wild anywhere. | Red-listed |
| Extirpated | No longer exist in the wild in Canada, but occur elsewhere. | Red-listed |
| Endangered | Face imminent extirpation or extinction. | Red-listed |
| Threatened | Likely to become endangered if the factors that limit their numbers and/or range are not reversed. | Red-listed |
| Special Concern | Sensitive to or at risk from human activities or natural events but are not Extirpated, Endangered, or Threatened. | Blue-listed |
| data deficient | Insufficient information to assign a status ranking. | n/a |

Notes: ¹ COSEWIC 2014 ² B.C. CDC

4.7.2.3 Existing Conditions

General Vegetation Conditions

The LAA is within the Coastal Douglas-fir Moist Maritime (CDFmm) and Coastal Western Hemlock Eastern Very Dry Maritime (CWHxm1) biogeoclimatic subzones (BEC WEB 2014). Given the disturbance history of the area, which includes infrastructure, industrial, commercial and residential development, and agriculture, vegetated areas within the LAA typically consist of young forests or intensively managed lands. Forested areas are generally limited to the riparian areas on Deas Island. All of the ecosystems mapped in the CWHxm1 are anthropogenic.

The TEM study identified seven types of vegetated ecosystems in the LAA, comprising six wetland types, seven forested types, and one sand dune ecosystem. Four agricultural land cover types and eight non-vegetated or anthropogenic land cover types constitute the remainder of the LAA. **Appendix B** provides a summary of all mapped land cover types in the LAA.

At-risk Ecosystems

Seven at-risk ecosystems, as summarized in **Table 4.7-6** and described below, occur in the LAA (**Appendix A, Figures 1b to 1p**).

Table 4.7-6 Summary of At-risk Ecosystems within the LAA

| At-risk Ecosystem | | Description | Area within the LAA (ha) |
|--|---|---|--------------------------|
| Class Code (Polygon Number(s)) | Name (Status) | | |
| Em02 (295) | Glasswort – Sea-milkwort Herbaceous Vegetation (Red-listed) | Estuary marsh | 23.2 |
| Em05 (194 and 295) | Lyngbye’s sedge Herbaceous Vegetation (Red-listed) | Estuary marsh | 5.6 |
| Fm50 (157) | Black cottonwood – red alder/salmonberry flooded forest (Blue-listed) | Forest with long periods of seasonal flooding | 7.1 |
| Wm05 (117, 155, 367, 380, 428, 556, and 547) | Cattail marsh (Blue-listed) | Wetland dominated by emergent vegetation. Polygon 380: an artificial feature where cattails have established. | 22.6 |
| Ws51 (562) | Sitka willow – Pacific willow – Skunk cabbage (Red-listed) | Wetland ecosystem located on Deas Island, outside of Project alignment | 5.4 |
| Ws53 (564) | Western redcedar – Sword fern – Skunk cabbage (Blue-listed) | Wetland ecosystem located on Deas Island, outside of Project alignment | 6.0 |
| CDFmm/00 (427) | Large-headed sedge Herbaceous Vegetation (Red-listed) | Sandy beach dune ecosystem | 0.4 |

Notes: Class codes refer to Ecosystem class codes and are described in **Appendix B**. Numbered polygons are shown in **Appendix A, Figures 1b to 1p**.

Wetlands

Six of the seven at-risk vegetation communities identified in the LAA during the 2014 and 2016 field surveys are classified as wetlands (**Appendix A**), comprising Blue-listed cattail marsh (polygons 117, 155, 367, 380, 428, 556, and 547), Red-listed Lyngbye’s sedge salt marsh (polygon 194) and glasswort – sea-milkwort salt marsh (polygon 295), and Blue-listed black cottonwood – red alder/salmonberry flooded forest (polygon 157). Two additional wetland ecosystems, Red-listed Sitka willow – Pacific willow – skunk cabbage (polygon 562) and Blue-listed western redcedar – sword fern – skunk cabbage (polygon 564), are located on Deas Island and outside of the Project footprint.

Cattail communities are very common in the CDFmm and surrounding area, often occurring in association with shallow, open water, and roadside ditches. Such communities tend to consist of almost pure stands of common cattail (*Typha latifolia*) and often develop when cattail seeds, which germinate readily in open standing water, establish in a site. In general, such marshes can be readily created in artificial features such as roadside ditches and retention ponds. During consultation, Aboriginal Groups noted that cattails and bulrushes (tule, or 'wool' in Hul'qumi'numm) were common in the area and are important for cultural purposes (see **Section 10.1.3 Aboriginal Interests Assessment**). Aboriginal Groups have also noted that wapato, a wetland-dependent species, also occurs in the area and roots were harvested for food.

Optimal conditions for wetlands in the Lower Mainland are small (<0.5 ha) marshes within 200 m of each other, close to agricultural fields or forests with a 50:50 open water to dense vegetation cover ratio (SCCP 2015). Based on TEM and field observations completed as part of Project-related studies within the RAA, approximately 22.6 ha of cattail marsh are present along the Highway 99 corridor between Bridgeport Road in Richmond and the Highway 91 Interchange in Delta. Cattail marshes in the vicinity of the Project are isolated, characterized by dense vegetation cover with little to no open water, and thus do not provide optimal wetland conditions.

Conditions of the cattail marshes in the LAA are as follows:

- Polygon 380 (**Appendix A, Figure 1k**), situated at the Highway 99/Highway 17 interchange, is an example of a cattail marsh that has established in an artificial feature. Originally a depression created by construction of the SFPR project, this polygon now has an established cattail population that has expanded due to soil compaction and water accumulation. This marsh lacks the diversity of a natural marsh due to its young age.
- Polygon 428 (**Appendix A, Figure 1i**), situated between Green Slough and River Road, is a more natural cattail marsh than polygon 380, having been formed as part of a larger wetland complex. It supports common cattail, skunk cabbage (*Lysichiton americanum*), rein orchids (*Piper* sp.), sedges (*Carex* sp.), and rushes (*Juncus* sp.). Historical aerial photographs show this wetland was originally connected to Deas Slough but was isolated from the slough when Highway 99 was built. It is likely that this wetland is connected to Green Slough and influenced by groundwater and runoff from the surrounding area. Some standing water is also present, but pools are small and disconnected. The overall condition of this wetland is moderate to poor. There are pockets of standing water where cattails are dominant, but grasses and invasive species such as purple loosestrife (*Lythrum salicaria*) are present. The wetland margins are characterized by grassy verges dominated by sedges, agronomic grasses, and weedy herbaceous vegetation species (see **Figure 4.7-2**). The wetland is likely affected by contaminants from surface runoff associated with Highway 99 and River Road.

- Polygon 155 (**Appendix A, Figure 1l**), located on the south side of Highway 99, to the east of a series of greenhouses along Highway 10, and south of polygon 157. The wetland was likely developed as a detention pond or habitat compensation for the adjacent greenhouses, or may have been part of a historically larger wetland complex connected to Burns Bog to the north. This wetland is located just outside of the Project alignment.
- Polygons 117 and 367 (**Appendix A, Figure 1p**) on the east side of the Highway 99 and Highway 91 interchange. The wetlands appear to be constructed, either as part of the Delta Golf Course development, or during development of the highways, and are located within the highway rights-of-way. The wetlands are vegetated, with open water ditches flowing through the middle of each polygon. The ditches are likely connected by a culvert running underneath the rail tracks located parallel to Highway 99, and flow into Boundary Bay. The wetlands are dominated by reed canarygrass and the highway side is also regularly mowed. The current scope of the Project will not impact these polygons.
- Polygons 556, 547, and 562 (**Appendix A, Figures 1h and 1g**) are located on Deas Island outside of Project footprint and will not be impacted by the Project.



Note: Non-native grasses as well as cattails are visible in the foreground; willows and cottonwood are visible in the mid-ground and background.

Figure 4.7-2 Blue-listed Cattail Wetland at Highway 99 and River Road, near Green Slough (Polygon 428)

The Red-listed Lyngbye’s sedge estuary marsh in the LAA (polygon 194) is a 2.4-ha wetland located in Deas Island Regional Park (**Appendix A, Figure 1h and 1g**). This ecosystem has very limited distribution along B.C.’s coast, and requires very specific site conditions associated with estuarine systems (B.C. CDC 2013). This wetland is in good condition and is sheltered from disturbance by the park, given its location away from trails. Additional Lyngbye’s sedge estuary marsh is located at the eastern end of the LAA (polygon 295) at Boundary Bay. However, since the marsh is located on the water side of the dyke (i.e. outside of the proposed Project footprint), Project-related affects are not anticipated.

The Red-listed glasswort – sea-milkwort estuary marsh (polygon 295) is also located on the water side of the dyke at Boundary Bay and is not expected to be negatively affected by the Project footprint.

The black cottonwood – red alder/salmonberry association (Polygon 157) is a Blue-listed deciduous forest ecosystem that occurs on fluvial benches that are flooded frequently, perhaps annually, for moderately long periods, and have a high water table for prolonged periods. These conditions inhibit conifer establishment. In the LAA, this ecosystem comprises a 7.1-ha polygon near the north edge of Highway 99 (polygon 157; **Appendix A, Figure 1I**), south of Burns Bog. This ecosystem is dominated by balsam poplar (*Populus balsamifera*), willow (*Salix* sp.), red elderberry (*Sambucus racemosa*), and salmonberry (*Rubus spectabilis*). Several invasive species are present, including Himalayan blackberry, and reed canarygrass. Pools of standing water are present.

The two additional wetland ecosystems, Sitka willow – Pacific willow – skunk cabbage (polygon 562) and western redcedar – sword fern – skunk cabbage (polygon 564), are located on Deas Island and are not expected to be affected by Project-related activities since they are not within the Project footprint.

Other At-risk Ecosystems

One sand dune ecosystem, the Red-listed large-headed sedge Herbaceous Vegetation plant association, was identified during the 2014 field surveys in Deas Island Regional Park. This ecosystem is restricted to habitat found on sand beaches, dunes, and spits. It is characterized by sparse occurrences of large-headed sedge (*Carex macrocephala*) growing on medium to coarse, well-drained sand (B.C. CDC 2014). Occurrences are typically less than 0.5 ha but can occasionally cover larger areas in open dunes (0.5 to 2 ha). The occurrence in the LAA (polygon 427; **Appendix A, Figures 1h and 1g**) is a highly degraded area of about 0.4 ha that is bisected by several trails and invaded by several invasive species, including Scotch broom (*Cytisus scoparius*), and Himalayan blackberry.

At-risk Plant Species

No at-risk plant species were encountered in the areas observed during the 2014 rare plant surveys. Aboriginal Groups reported observations of two species of lupine: the native streambank lupine (*Lupinus rivularis*) and the introduced tree lupine (*Lupinus arboreas*). Streambank lupine is listed under Schedule 1 of SARA as endangered and is on the B.C. red list. The two are very similar in appearance, and it is unclear whether the observed species is the native or introduced species. One of these species has been seen in the Project LAA on

Deas Island. A critical habitat polygon is located on the east end of Deas Island (EC 2016) likely where the lupine was observed. There are no mapped occurrences of streambank lupine or critical habitat polygons within the Project alignment (iMapBC 2016, EC 2016) and no plants were observed during the at-risk plant surveys.. The suspected occurrence of streambank lupine in the LAA was not field-checked as it lies well outside of the Project alignment and no negative effects are anticipated.

Because of the highly disturbed condition of the habitats in the LAA, the occurrence of other at-risk plant species in the LAA is considered unlikely; therefore the at-risk plant species subcomponent of the vegetation VC is not considered further in this assessment. The remainder of the assessment focuses on at-risk ecosystems.

4.7.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with vegetation, and potential effects of such interactions on at-risk ecosystems. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.7.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 4.7.5**. A discussion of potential cumulative effects on vegetation is presented in **Section 4.7.6**.

4.7.3.1 Project Interactions

An overview of potential interactions between Project activities and at-risk ecosystems during the construction and operation of Project components is provided in **Appendix C**. A preliminary evaluation of the potential effects of Project interactions on at-risk ecosystems, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: Potential interactions of Project-related construction activities with at-risk ecosystems include the following:

- Potential disturbance of the cattail marshes, which are at-risk ecosystems, at polygons 367, 380, 428, and 117 during installation of temporary roads, bridges and detours, or clearing and grubbing of vegetation. There is also some potential for indirect disturbance through the introduction of invasive alien plants via construction vehicles or equipment.
- Potential overlap of Project components with at-risk ecosystems, including small portions of the cattail marsh located between Green Slough and River Road, adjacent to the support piers of the new bridge (polygon 428), the cattail marsh that has established at the Highway 17 interchange (polygon 380).

Operation: Once operational, Project activities (including routine maintenance) are not expected to affect at-risk ecosystems. The new bridge and interchanges will be designed in a manner that prevents the direct release of stormwater runoff from road surfaces into wetlands and waterbodies. Application of Ministry standard best practices for maintenance and vegetation management will ensure that maintenance of the new infrastructure does not affect at-risk ecosystems. Therefore, activities associated with Project operation are not expected to interact with vegetation and are not considered further in this assessment.

4.7.3.2 Potential Effects

To the extent possible, Project construction is proposed within the existing Highway 99 ROW. Potential effects to vegetation resulting from ground disturbance, clearing and grubbing, and other site preparation activities during Project construction will generally be minimized and restricted to within this ROW.

To identify at-risk ecosystems within the ROW that may be affected by the Project and determine the extent of potential effects, the areas of overlap between Project components and each at-risk ecosystem were calculated by overlaying the proposed alignment on the terrestrial ecosystem maps for the assessment area. As shown in **Table 4.7-7**, this exercise indicated that the Project alignment overlap with at-risk ecosystems is expected to be limited to small portions of two cattail marshes.

Table 4.7-7 Overlap between At-risk Ecosystems and Project Components

| Ecosystem Name | Location (Polygon Number) | Project Component Overlap (ha) |
|--|--|--------------------------------|
| Lyngbye's sedge Herbaceous Vegetation | Within Deas Island Regional Park (polygon 194) | 0 |
| Glasswort – sea-milkwort Herbaceous Vegetation | At Boundary Bay (polygon 295) | 0 |
| Large-headed sedge Herbaceous Vegetation | Within Deas Island Regional Park (polygon 427) | 0 |
| Cattail marsh | Adjacent to River Road and Green Slough (polygon 428) | 0.09 |
| | Along north edge of Highway 99, south of Burns Bog (polygon 157) | 0 |
| | East of Highway 99 and 91 interchange (polygons 117 and 367) | 2.0 |

A small portion of the cattail marsh adjacent to Green Slough at River Road (polygon 428) will be cleared of vegetation and grubbed during site preparation to accommodate installation of piles and piers for the new bridge (**Table 4.7-7**). This cattail marsh is already disturbed due to the presence of invasive plants, roadside runoff, and garbage (**Section 4.7.2.3**). Because this marsh is already degraded, due to previous activities and adjacent land uses, and is situated at the outer edges of the Project alignment, potential effects are considered minor.

The cattail marsh adjacent to the Highway 91 and Highway 99 interchange (polygons 117 and 367) could potentially be affected during Project construction (**Table 4.7-7**). The portion of the marsh polygons that overlap with proposed Project components are located within the existing ROW and are dominated by invasive plant species. Because the marshes are located within the existing highway ROW, regularly managed, and situated at the outer edges of the Project alignment, potential effects are considered minor.

Project components are not expected to overlap with the other at-risk ecosystems (polygons 194, 427, 157, and 295) identified within the Project alignment, and interaction with these polygons during site preparation activities can be avoided through appropriate planning and placement of temporary construction works and facilities.

The toe of the fill for the proposed Highway 17 off-ramp may encroach into the verges of the cattail marsh Highway 99/Highway 17 interchange (polygon 380). As described in **Section 4.7.2.3**, this cattail marsh, which has developed in a depression that was created during the construction of Highway 17, is surrounded by roads and a managed grassy verge and is currently subject to periodic disturbance for highway maintenance purposes.

4.7.4 Mitigation Measures

A hierarchical approach based on the four types of mitigation as outlined below was used in identifying strategies to avoid or minimize potential Project-related effects:

- **Avoidance:** Measures to avoid potential effects on the VC have been/will be incorporated into project considerations such as site and route selection, scheduling, design, and construction and operation procedures and practices.
- **Minimization:** Where potential effects on the VC cannot be avoided through project considerations, standard mitigation measures, best management practices (BMPs), and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels.

- Restoration or Habitat Enhancement: Where potential Project-related effects cannot be avoided or minimized through standard mitigation measures, best practices, or implementation of EMPs, affected components will be restored on-site to pre-Project conditions.
- Compensation/offset: Where on-site restoration is not feasible, appropriate means to counteract, or make up for potential Project-related effects on the VC will be identified.

4.7.4.1 Avoidance

The Project has been designed to be located largely within the existing Highway 99 ROW, in areas that contain minimal natural vegetation, thereby avoiding potential overlap with sensitive ecosystems. Temporary facilities, such as construction laydown areas and site access roads, will be designed to avoid overlap with at-risk ecosystems present within and adjacent to the Project alignment. Perimeters of at-risk ecosystems with the potential to be affected by Project construction activities will be annotated on construction drawings and flagged in the field to minimize accidental encroachment. These measures are expected to prevent any potential adverse effects on the at-risk ecosystems within Deas Island Regional Park (polygons 194 and 427) and along the north edge of Highway 99, south of Burns Bog (polygon 157).

4.7.4.2 Minimization

Project Design

Engineering considerations indicate that a slight overlap between the proposed bridge support piers and the cattail marsh adjacent to River Road (polygon 428) cannot be avoided; however, through Project design, this unavoidable overlap will be minimized and confined to the edges of the marsh, where it will not affect the functionality of the ecosystem.

Effects of Project construction on the recently-established cattail marsh near the Highway 17 Interchange (polygon 380) will also be mitigated by applying design considerations to minimize the amount of ground disturbance within the marsh.

Best Management Practices and Environmental Management

Environmental protection measures that will be implemented during Project construction and operation to prevent or minimize potential effects on vegetation will be outlined in a Construction Environmental Management Plan (CEMP), and subsequently in an Operational Environmental Management Plan (OEMP), as described in **Section 12.0 Management Plans and Follow-up Programs**. The CEMP will include a Terrestrial Vegetation and Wildlife Management Plan that will describe standard best practices and Project-specific mitigation measures to prevent or minimize potential adverse effects on vegetation that might otherwise result from the Project during construction. Key elements of the plan are discussed below.

Terrestrial Vegetation and Wildlife Management

A Terrestrial Vegetation and Wildlife Management Plan will be developed as part of the CEMP to minimize potential construction-related effects on vegetation and wildlife. The plan will describe measures to be implemented to minimize disturbance and loss of vegetation—specifically, the cattail marshes at River Road (polygon 428) and the Highway 17 Interchange (polygon 380). Such measures include, but are not limited to the following:

- Limiting access points for heavy machinery to prevent soil compaction within and adjacent the cattail marshes.
- Placing site infrastructure as close as possible to the road verges during detailed design to minimize the area to be cleared within the cattail marshes.
- Not storing machinery and construction materials in or on the edge of the marshes.
- Incorporating a collection and distribution system to convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.
- Replanting exposed soil and reclaimed areas with native plant species, including species of importance to Aboriginal Groups, such as cattails, wapato, and berry-producing species such as *Vaccinium* sp.

Implementation of mitigation measures listed above, which reflect standard mitigation and best management practices, is expected to prevent any effects associated with encroachment on the ecosystems.

Invasive Species Management

To reduce potential invasion of at-risk ecosystems by alien vegetation species, monitoring and, if necessary, control of invasive plant species will be undertaken during construction. Species for which there is a legal requirement to control under the B.C. *Weed Control Act*, R.S.B.C. 1996, c. 487, as well as species that are listed by the Invasive Species Council of Metro Vancouver will be targeted. Invasive species management measures, including site-appropriate monitoring and control methods for different species and conditions, will be prepared and implemented as part of the Terrestrial Vegetation and Wildlife Management Plan.

Equipment hygiene is essential to managing the spread of invasive species. Contractors will comply with *Best Practices Guide for Managing Invasive Plants on Roadways* (B.C. MOTI and ISC B.C. 2013), including cleaning, inspecting, removing, and safely disposing of propagules of invasive plants (e.g., roots, stems, segments) from vehicles and equipment prior to entering the Project construction area. To reduce the spread of invasives in other areas via dumping, the Terrestrial Vegetation and Wildlife Management Plan will also include the requirement for disposal of invasive species and soils contaminated with invasive species at appropriate facilities, in accordance with the BC Organic Matter Recycling Regulation.

The above measures are expected to prevent potential effects of introduction and propagation of invasive species on the extent and functionality of at risk ecosystems.

4.7.4.3 Habitat Enhancement

As discussed in **Section 4.7.2.3**, the cattail marsh adjacent to River Road (polygon 428), which overlaps with the Project, is currently in a highly disturbed state and is influenced by stormwater runoff from the adjacent road network. The following measures are proposed to improve the functionality of this ecosystem:

- Removal of invasive species and garbage from the marsh, and revegetation using native species as appropriate to improve habitat quality in the area surrounding the new bridge support piers.
- Installation of an appropriate stormwater management system for the upgraded highway and the new bridge to avoid potential introduction of contaminants into the ecosystem through road runoff.

The above measures are expected to improve the quality and viability of the ecosystem within polygon 428, and counteract potential effects of the small overlap with the proposed bridge support piers.

The cattail marsh near the Highway 17 interchange (polygon 380), which may also overlap with the Project, developed within the past three years as a result of colonization of standing shallow water by cattails (**Section 4.7.2.3**). It is anticipated that shallow water conditions will persist in and around this area during and after Project construction. Once Project construction is complete, available areas of open water will be revegetated with native cattails. Given the history of its development, this marsh is expected to be recolonized successfully and recover from construction-related disturbance if shallow-water habitat is retained during and after construction.

Habitat enhancement features are generally anticipated to become fully productive and viable within two to four years following restoration, based on cattail recolonization of the wetted area (Sojda and Solberg 1993) The biggest risk associated with using habitat enhancement as a mitigation measure, is if the habitat never becomes fully functional and consequently does not result in the rehabilitation of the cattail habitats. To address this risk, the effectiveness of the proposed enhancement features for the Project described above will be confirmed through a follow-up monitoring program.

4.7.4.4 Habitat Offsetting

Unavoidable Project footprint effects on the cattail marsh near River Road will be offset through the creation of comparable cattail marsh habitat within the Project alignment. This habitat will be determined in consultation with Aboriginal Groups and created during Project construction and will be subject to monitoring during and after construction to ensure that it is functioning as intended. The establishment of comparable cattail marsh within the Project alignment is expected to offset the partial loss of wetland area within polygon 428.

4.7.5 Residual Effects and their Significance

All potential Project-related effects on vegetation that cannot be avoided through Project design and implementation considerations are expected to be fully addressed through minimization, enhancement, and offsetting measures discussed in **Sections 4.7.4.2 to 4.7.4.4**, and result in no residual effects.

Measures proposed to avoid or minimize Project-related effects on vegetation, including minimizing construction-related disturbance, invasive species management, and stormwater management, were identified based on standard best practices and proven methodologies. Accordingly, there is a high level of confidence in the effectiveness of these measures and their ability to prevent Project-related effects on sensitive ecosystems.

As evidenced by the recent establishment of the cattail marsh at the Highway 17 intersection (polygon 380), viable conditions for the successful establishment of native cattail marshes exist within and adjacent to the Project alignment. Therefore, the likelihood of success of revegetation as part of restoration of the cattail marsh at Highway 17 and development of a comparable ecosystem to offset the partial loss of the cattail marsh along River Road, resulting in no adverse residual effect on at-risk ecosystems, is considered high.

There is a high level of confidence in the above predictions based on good understanding of the development of the wetland (anthropogenic vs. natural), an analysis of current condition, location relative to the Project area, and consideration of potential for recovery. Uncertainty surrounding this determination is the potential for failure of the ecosystem due to hydrology changes; however, if the landscape surrounding the wetland is not altered, there should be sufficient surface runoff to support cattail regrowth. Based on these criteria, and considering that no residual effect is anticipated, no risk analysis is required.

4.7.6 Cumulative Effects and their Significance

As discussed in **Section 4.7.5**, the Project is not likely to have any residual effect on vegetation. Therefore, a cumulative effects assessment is not necessary, and was not undertaken.

4.7.7 Follow-up Strategy

The habitat cattail marsh that will be established to offset the partial loss of wetland area within polygon 428, will be subject to monitoring during and after construction to ensure that it is functioning as intended.

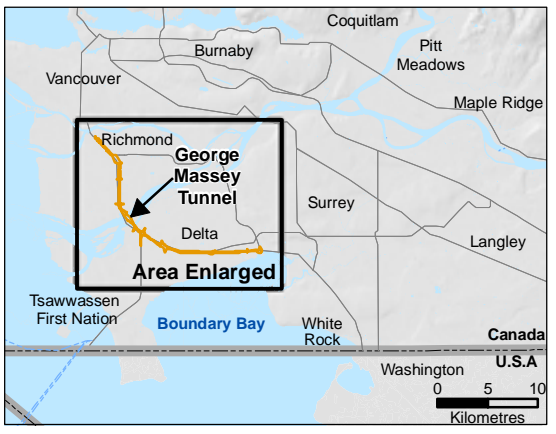
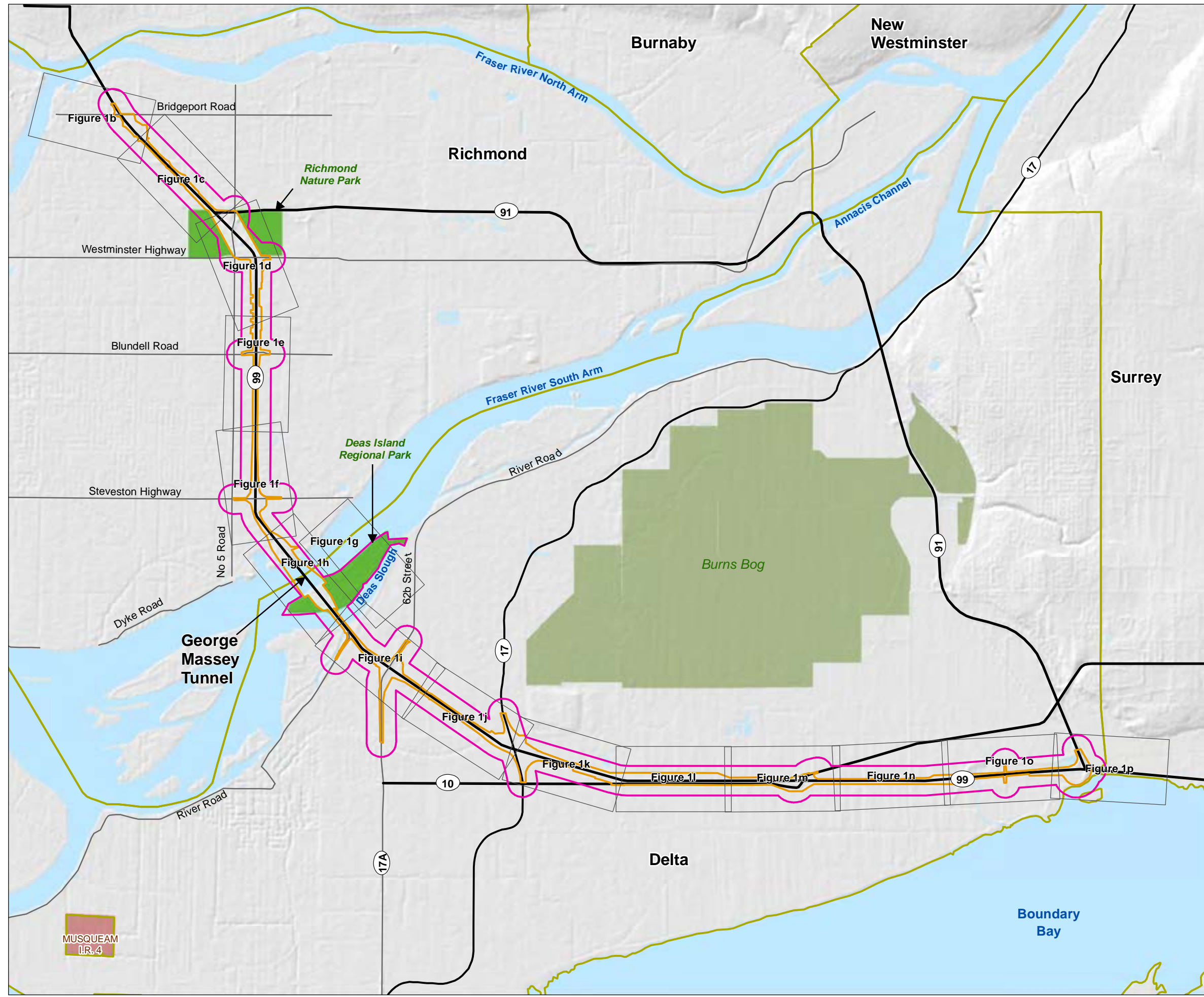
4.7.8 References

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APPENDIX A

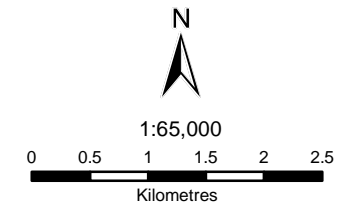
Terrestrial Ecosystem Mapping Figures



- Legend**
- Vegetation Local and Regional Assessment Areas
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

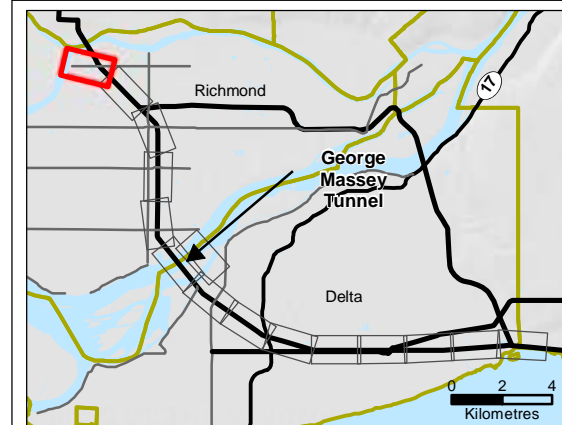
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| VEGETATION AND AT-RISK ECOSYSTEM MAPPING OVERVIEW | |
| Figure 1a | 13/05/2016 |
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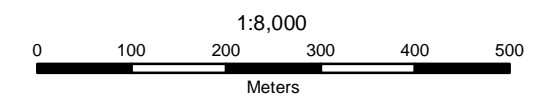


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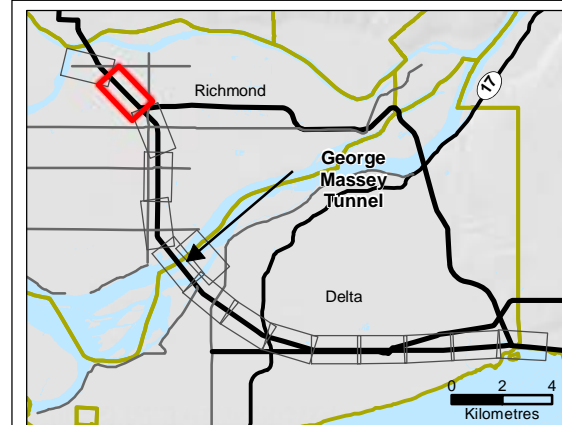
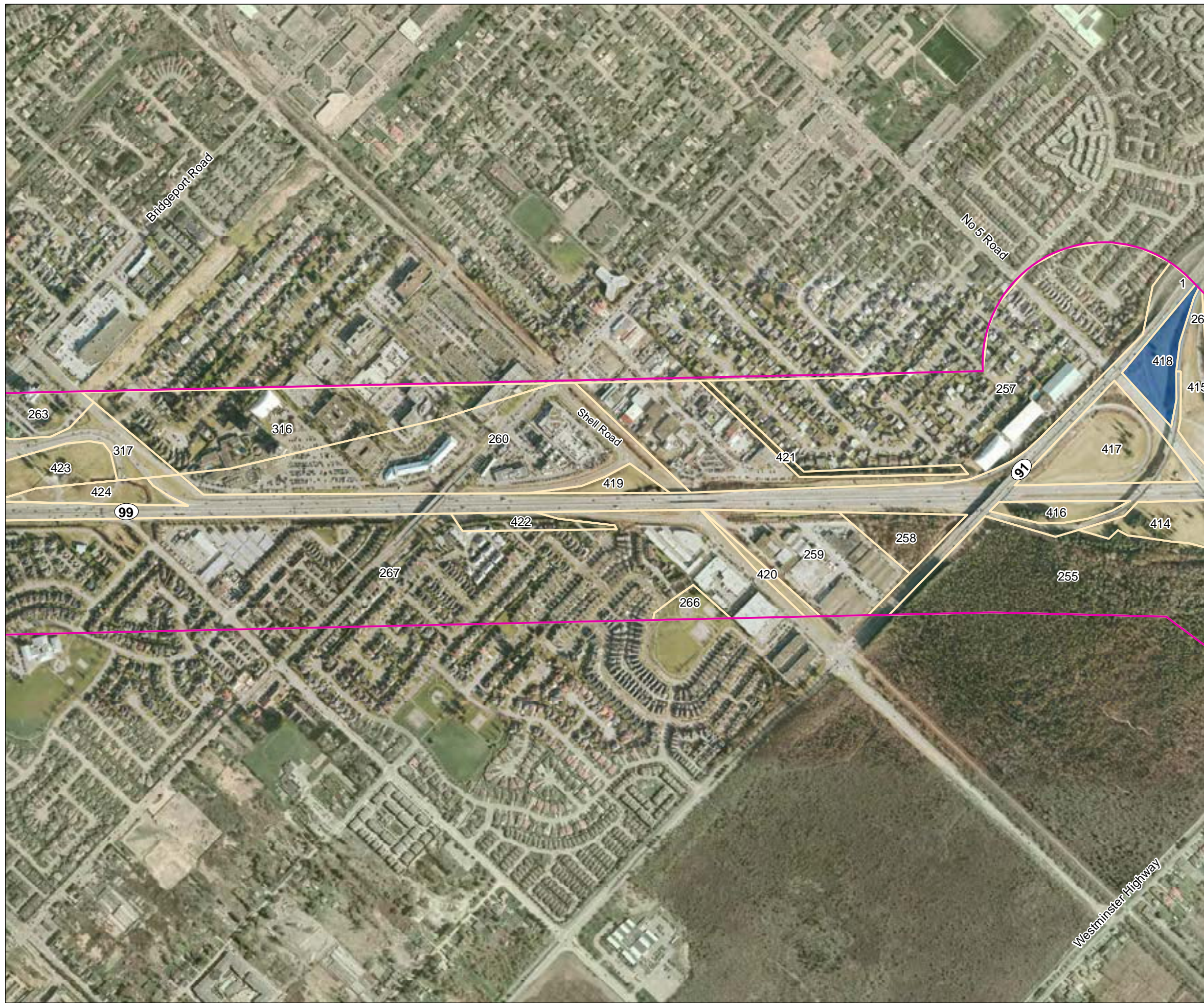
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- Vegetation Local and Regional Assessment Areas
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

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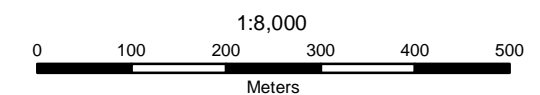


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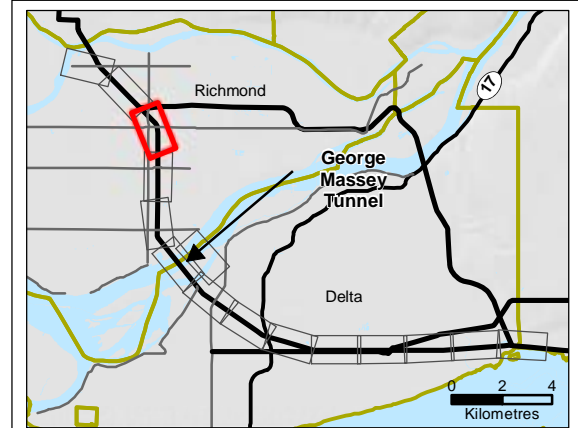
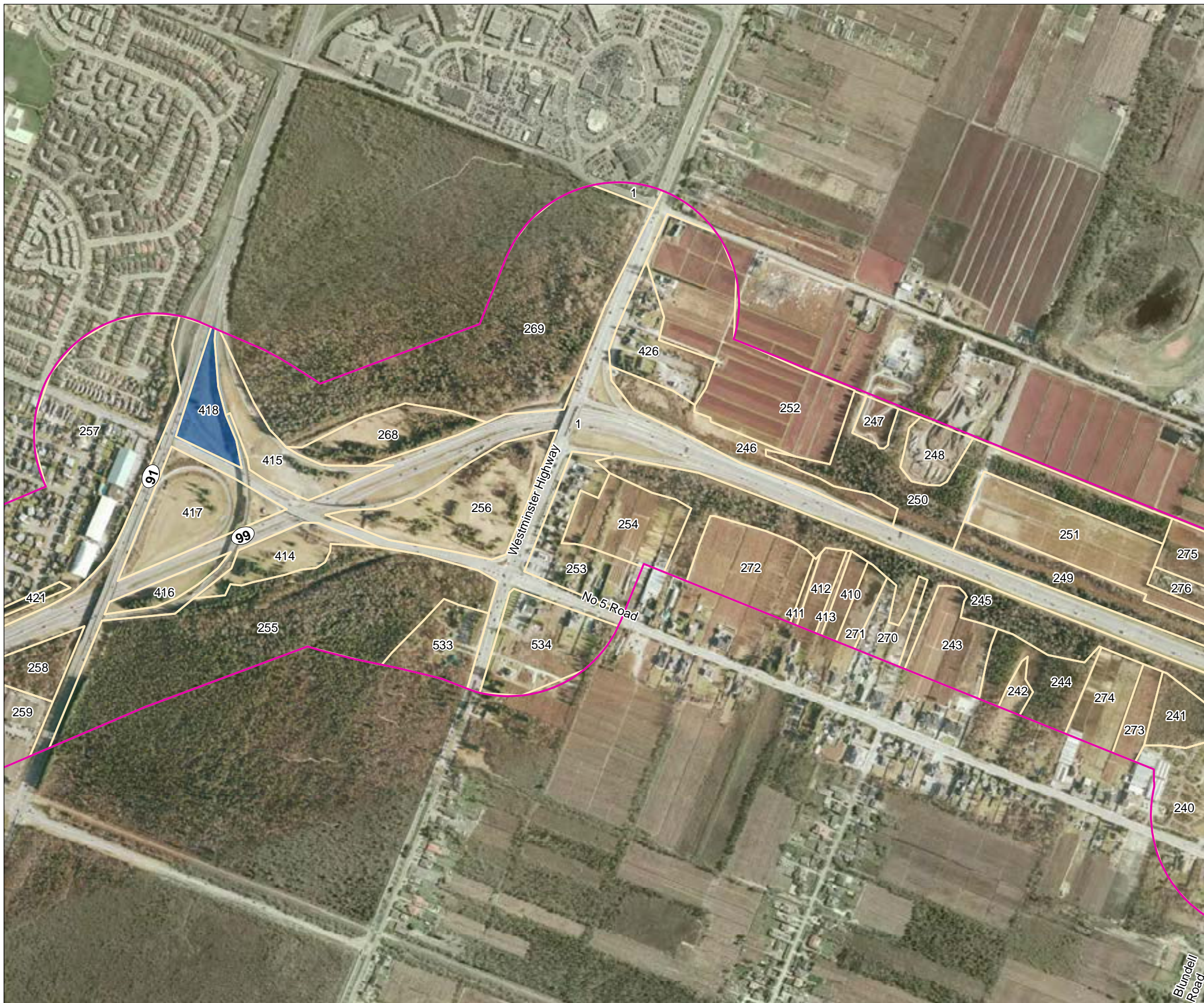
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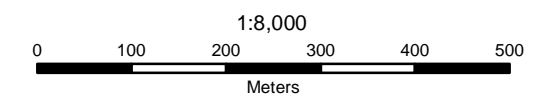


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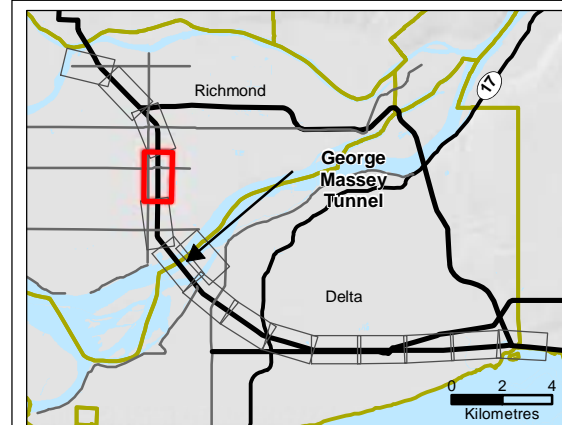
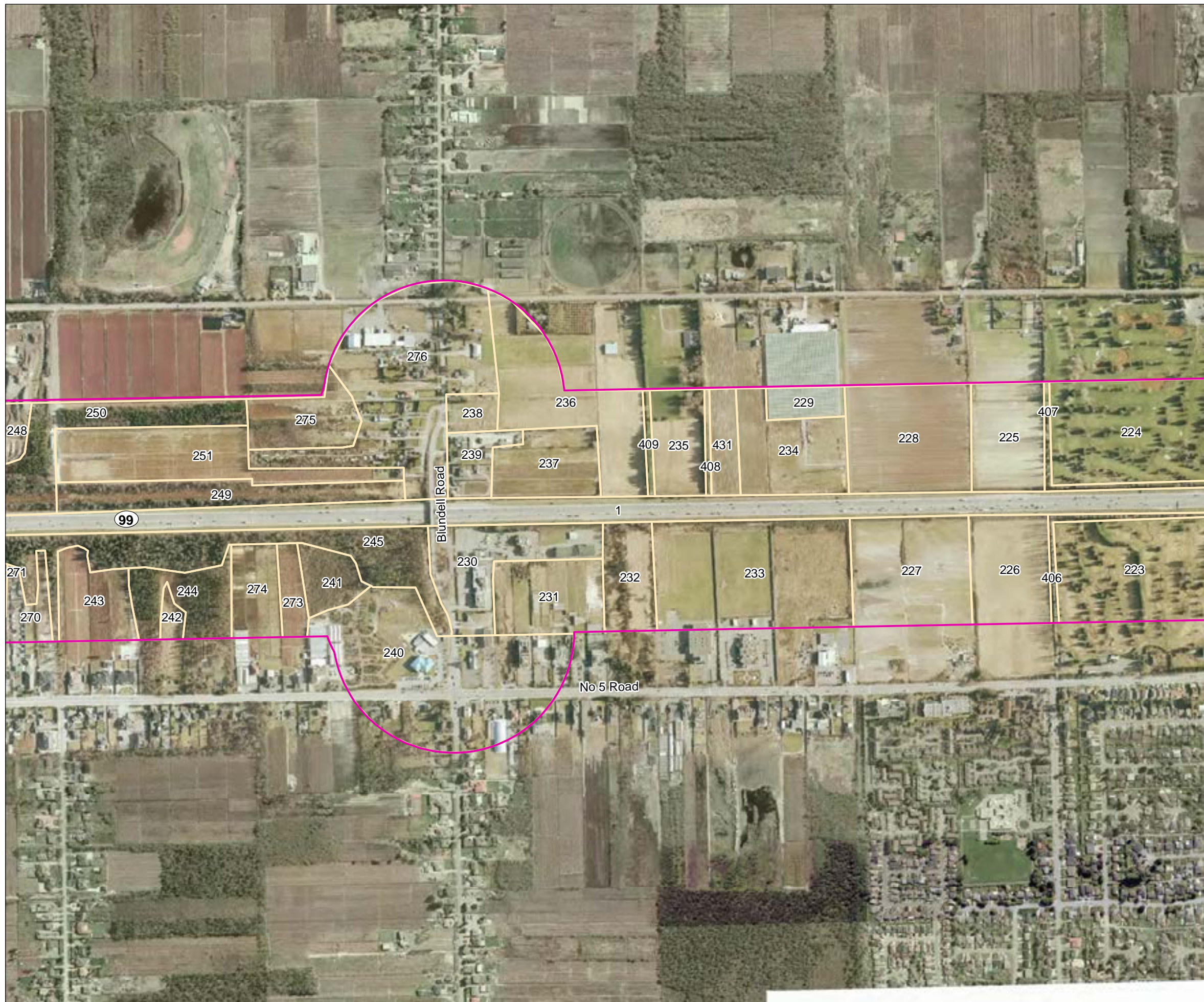
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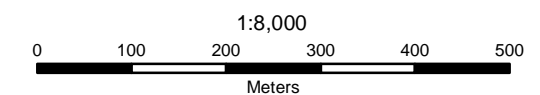


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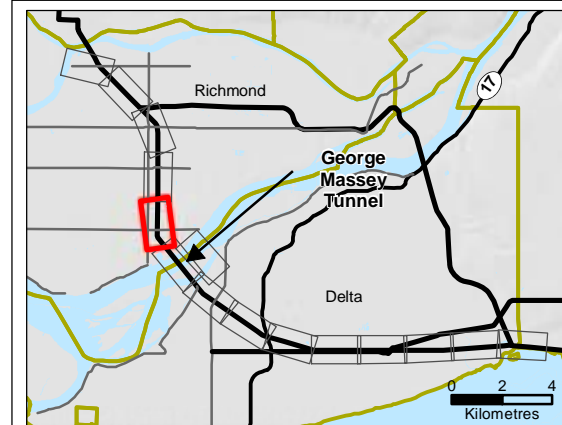
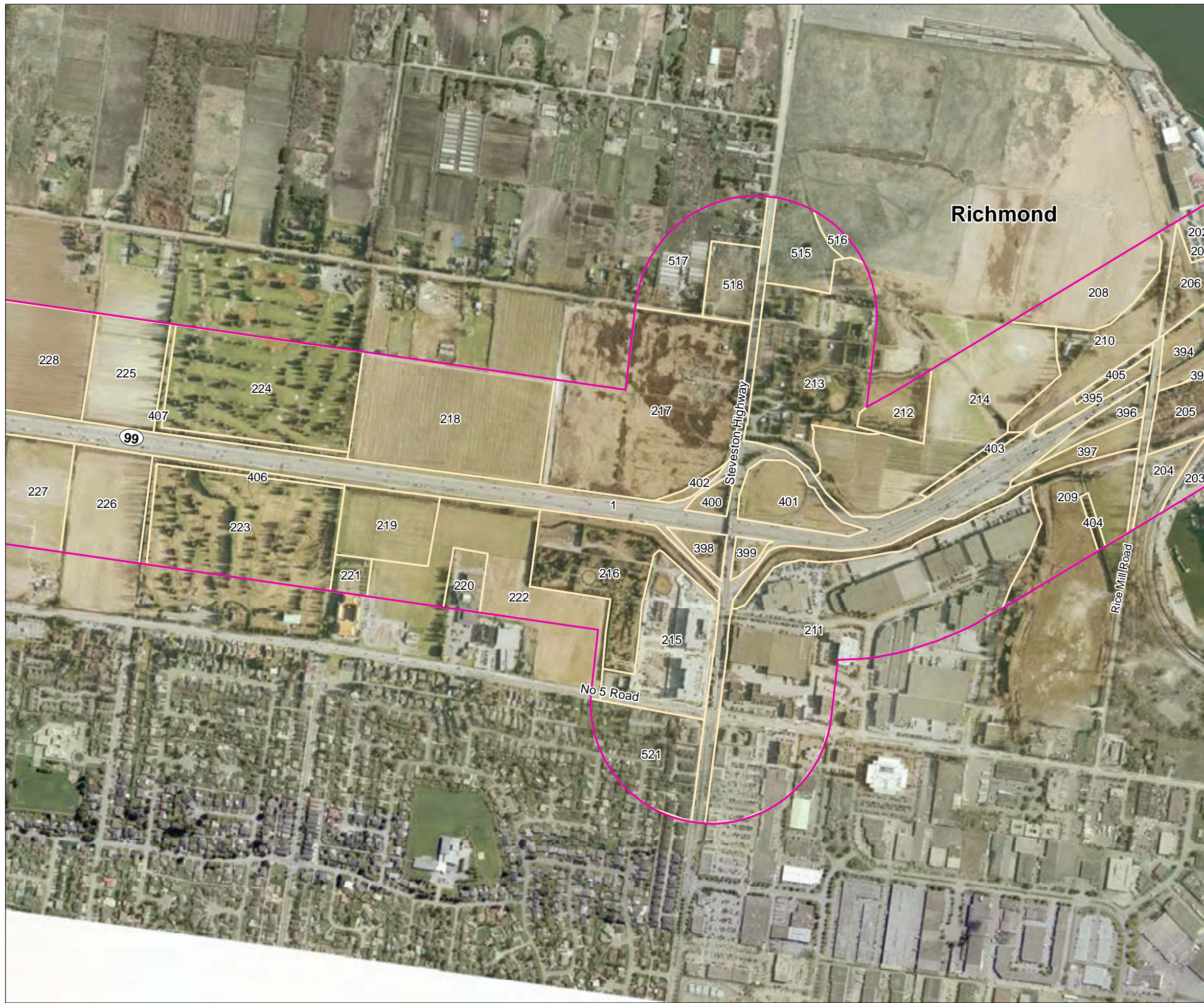
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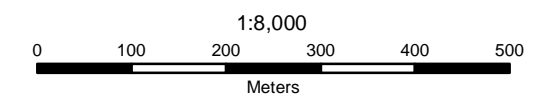


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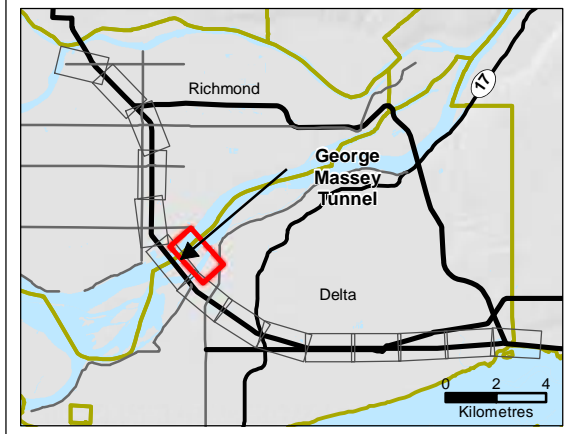
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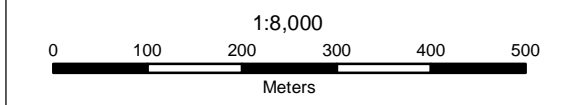
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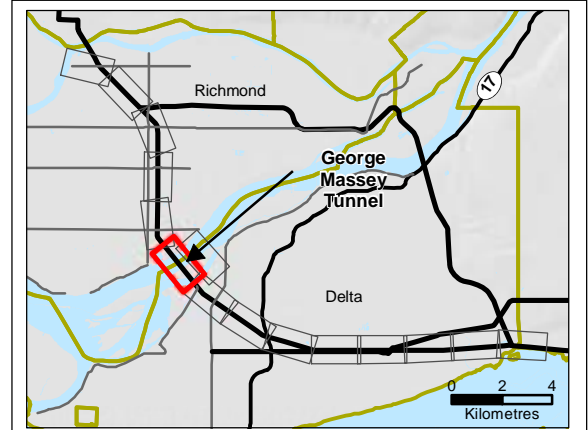
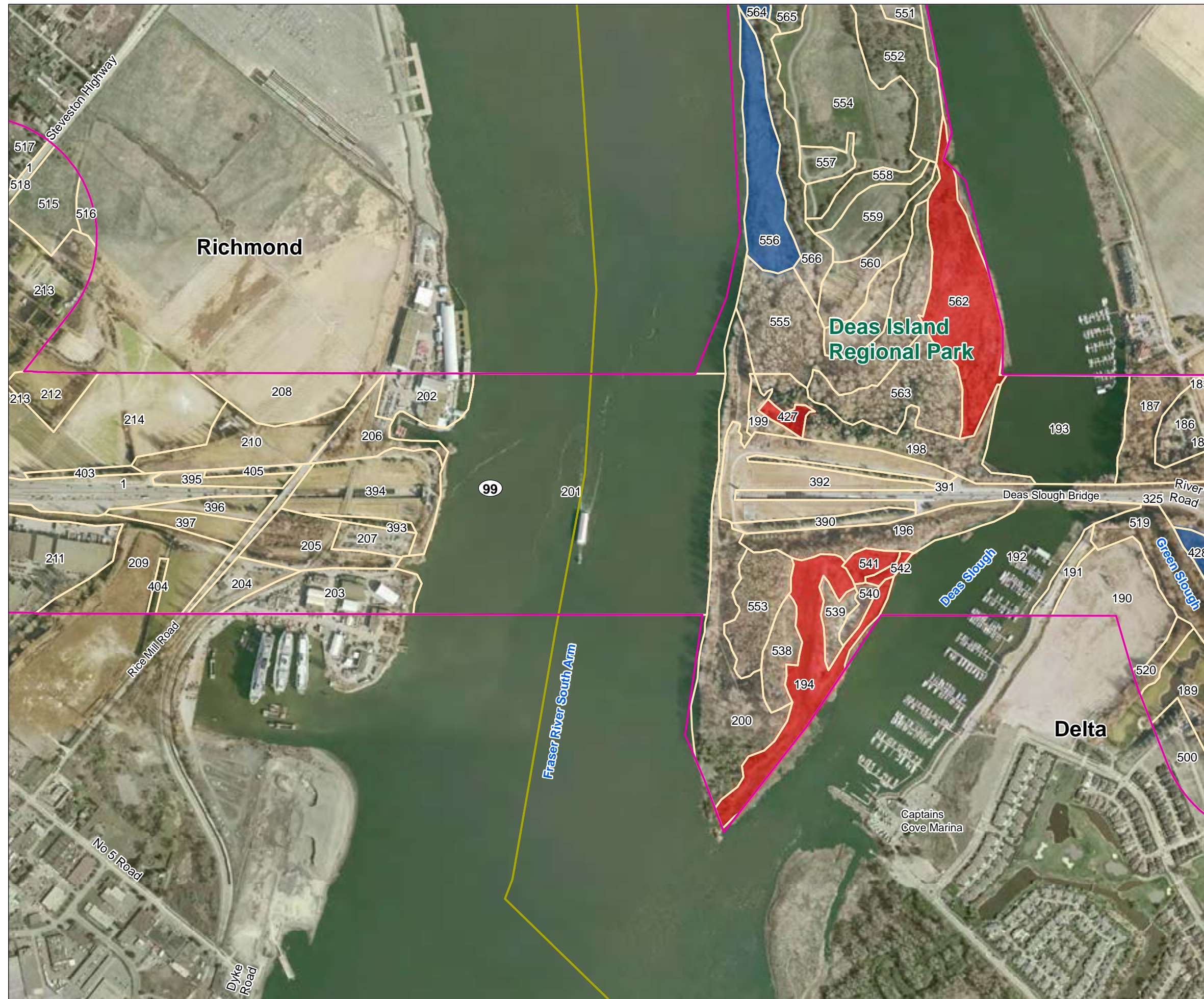


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

TERRESTRIAL ECOSYSTEM MAPPING
STUDY AREA

Figure 1g 13/05/2016

George Massey Tunnel Replacement Project BC 2005 Plan B.C. on the Move

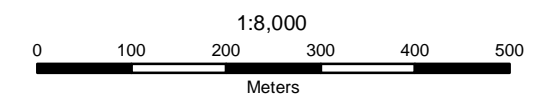


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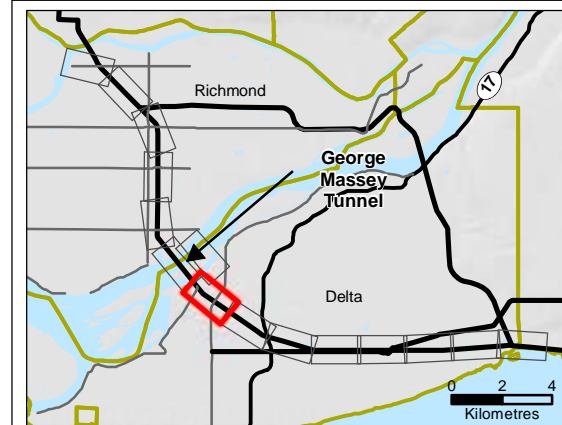
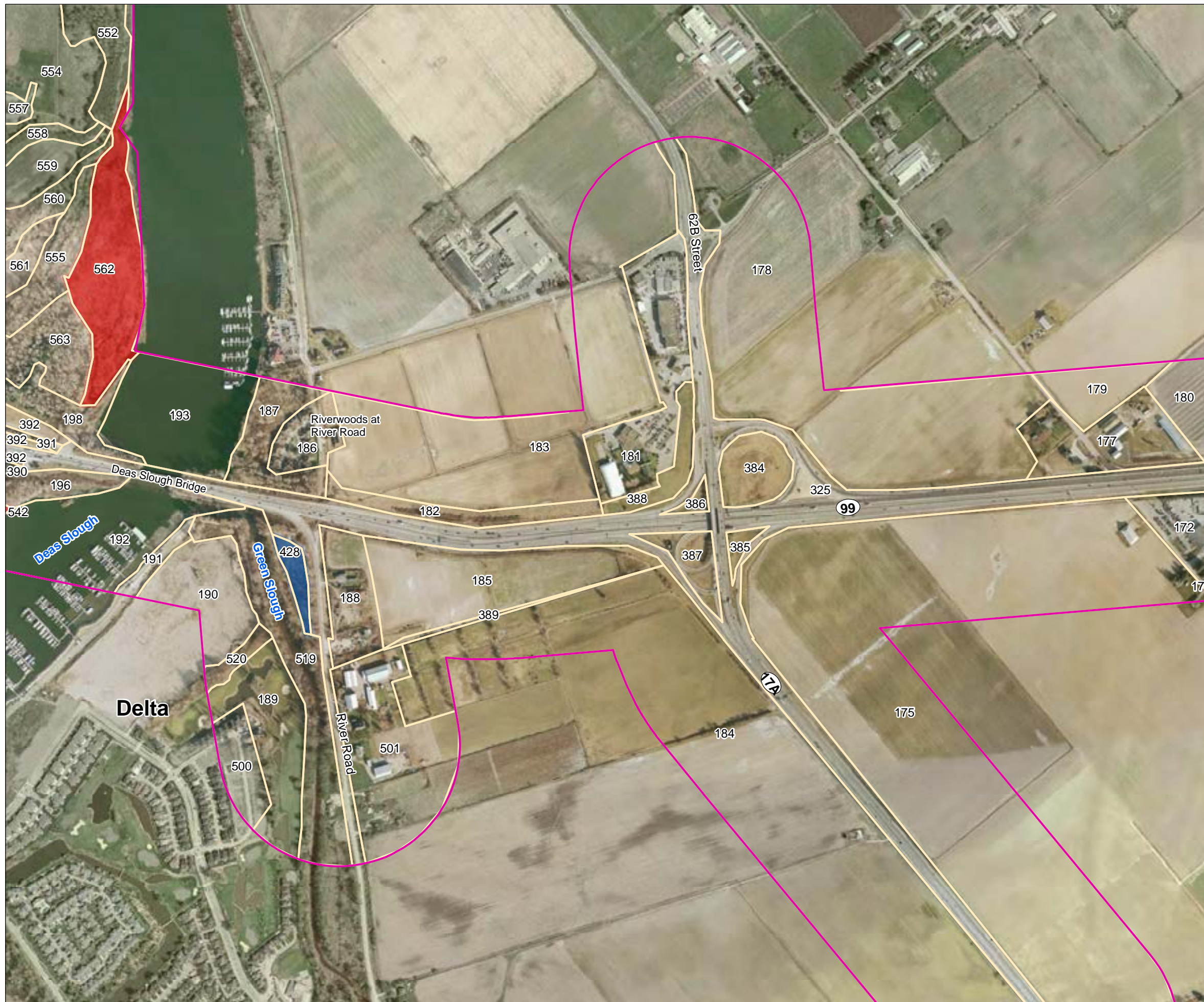
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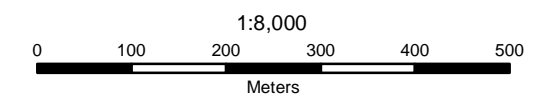


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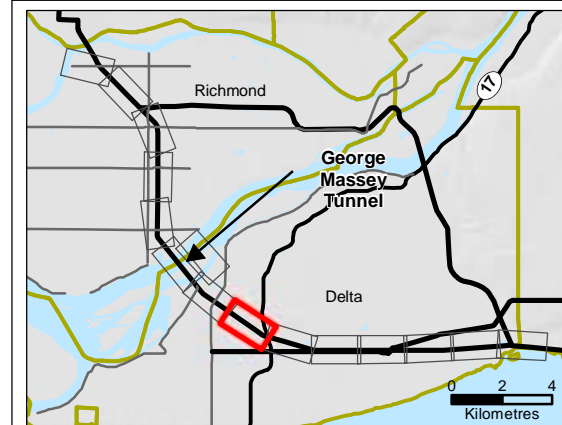
- 10 TEM Polygon and TEM Number
- Blue-listed TEM
- Red-listed TEM
- Vegetation Local and Regional Assessment Areas
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 1i | 13/05/2016 |
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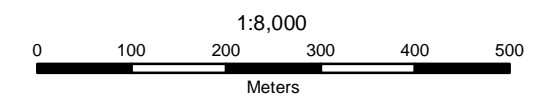


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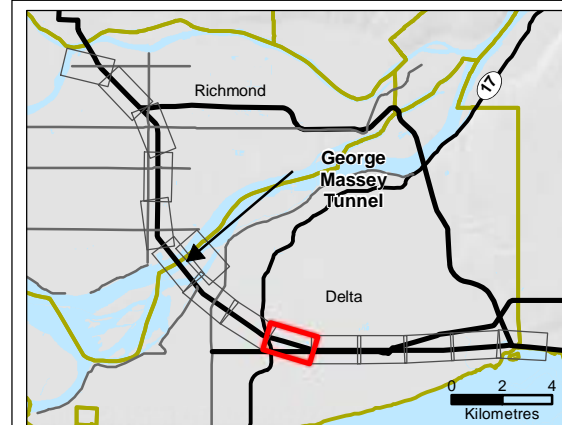
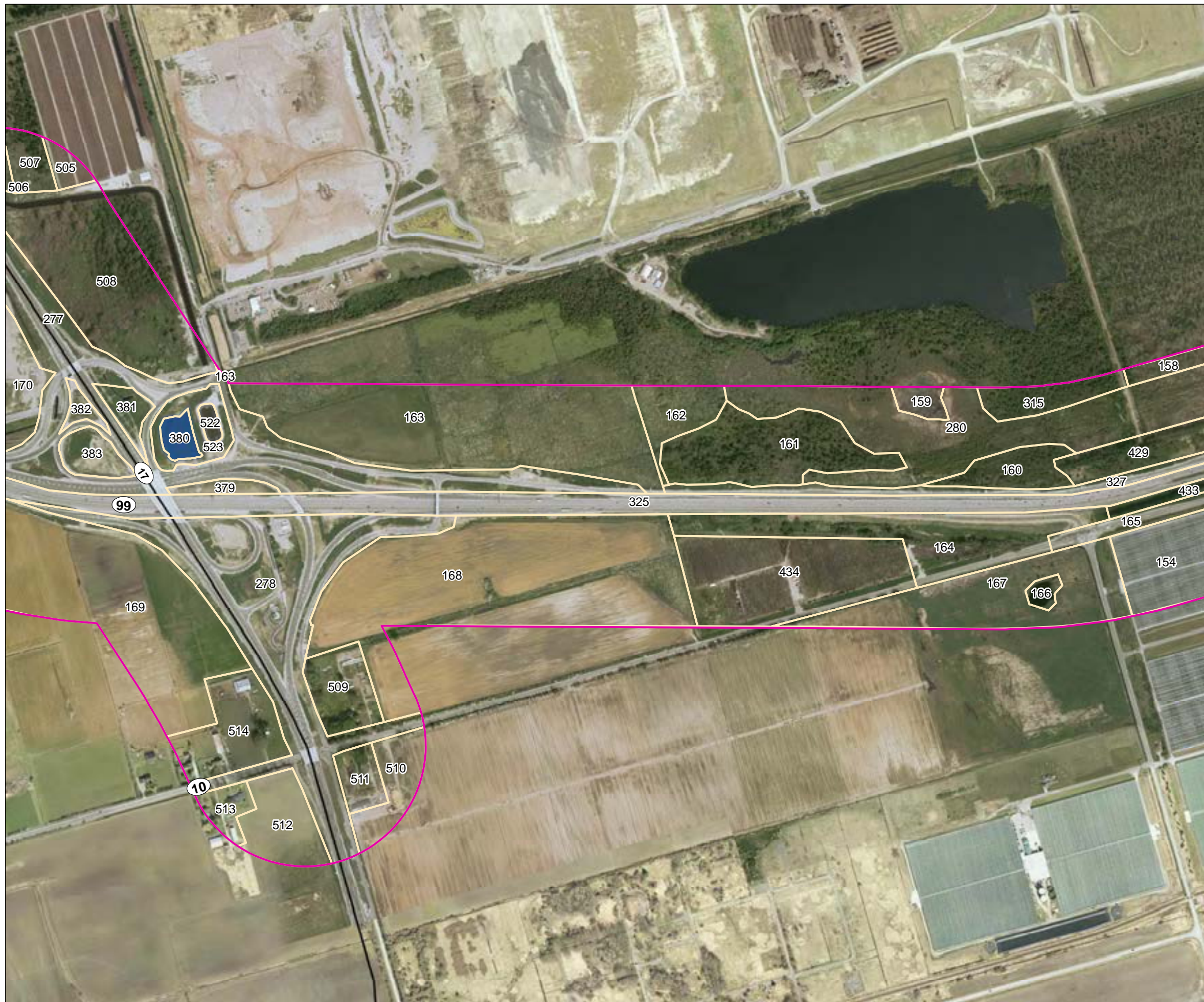
- 10 TEM Polygon and TEM Number
- Blue-listed TEM
- Red-listed TEM
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SOURCES

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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 1j | 13/05/2016 |
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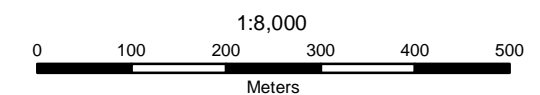


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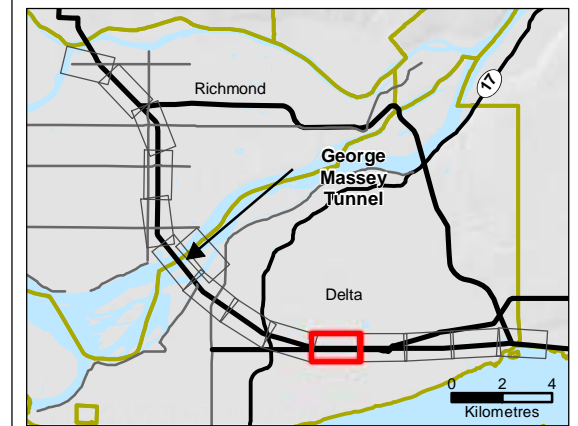
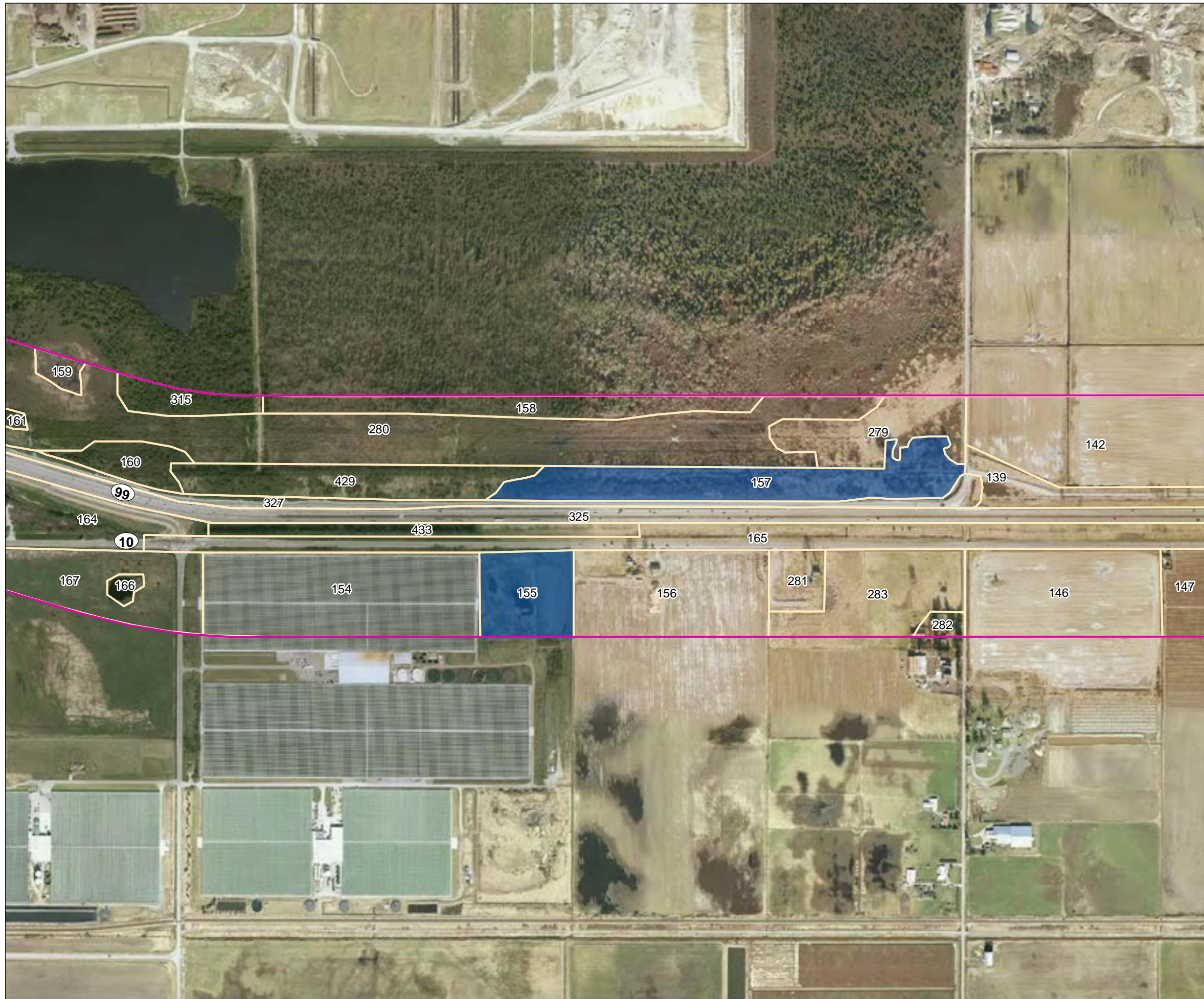
- 10 TEM Polygon and TEM Number
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- Red-listed TEM
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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 1k | 13/05/2016 |
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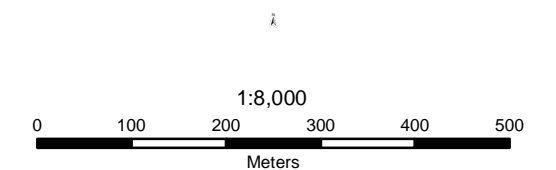


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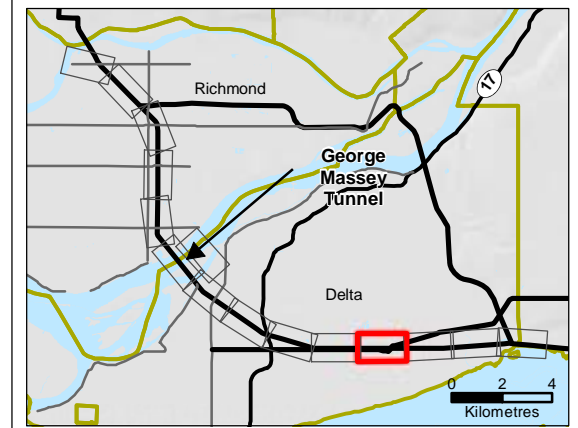
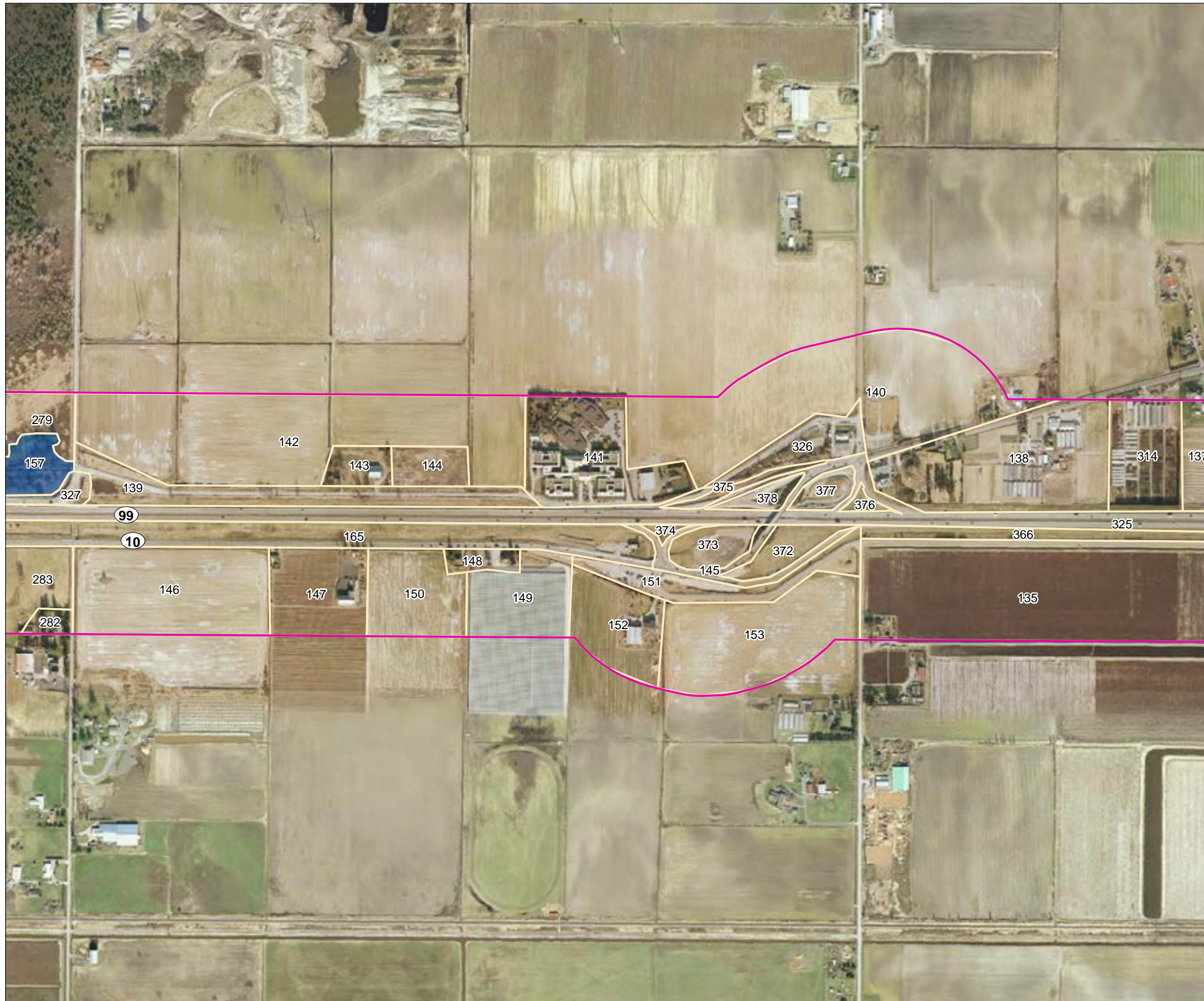
- TEM Polygon and TEM Number
- Blue-listed TEM
- Red-listed TEM
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SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 11 | 13/05/2016 |
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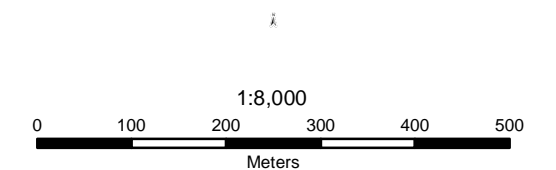


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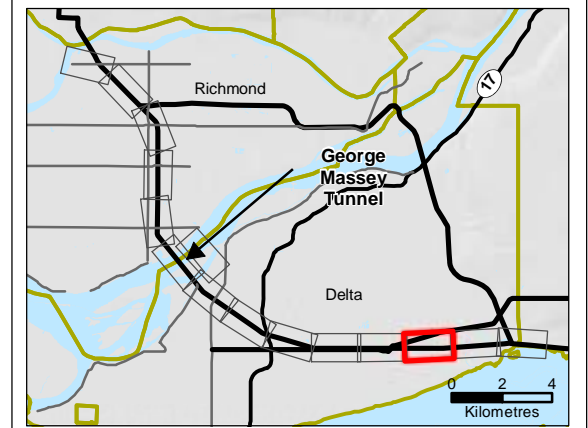
- TEM Polygon and TEM Number
- Blue-listed TEM
- Red-listed TEM
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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 1m | 13/05/2016 |
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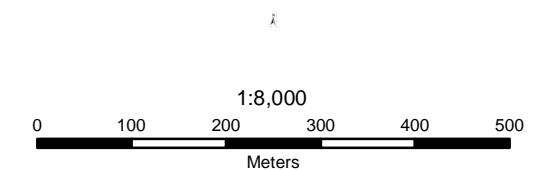


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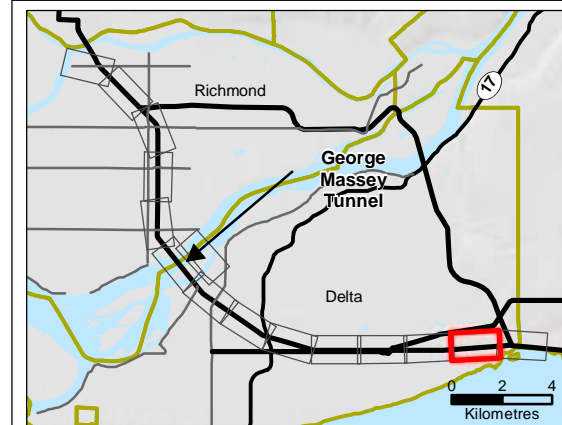
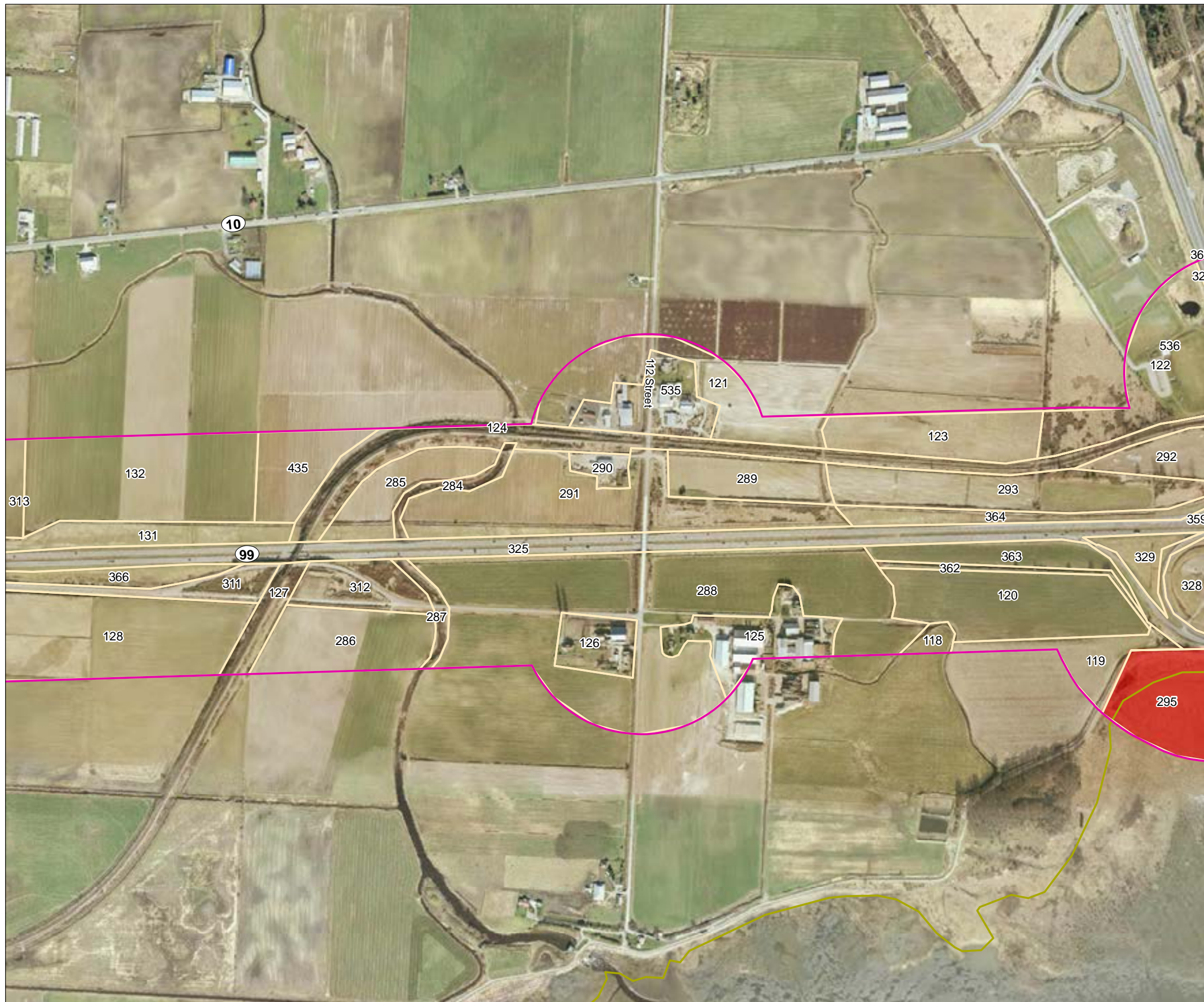
- TEM Polygon and TEM Number
- Blue-listed TEM
- Red-listed TEM
- Vegetation Local and Regional Assessment Areas
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SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 1n | 13/05/2016 |
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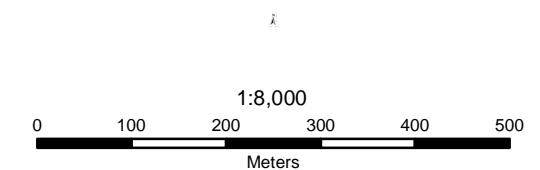


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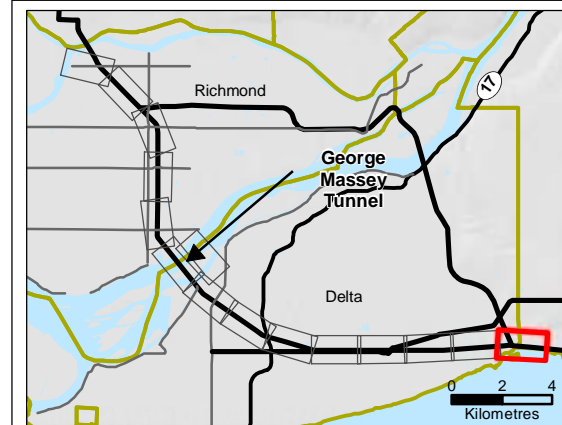
- TEM Polygon and TEM Number
- Blue-listed TEM
- Red-listed TEM
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- First Nation Reserve
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SOURCES

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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 1o | 13/05/2016 |
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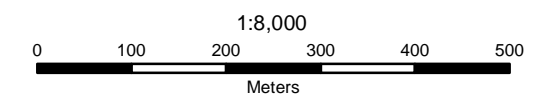


Legend

- 10 TEM Polygon and TEM Number
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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL ECOSYSTEM MAPPING STUDY AREA | |
| Figure 1p | 13/05/2016 |
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APPENDIX B

Terrestrial Ecosystem Mapping Methods, Objectives, and Results

Overview and Objectives

A review of the existing information and the state of knowledge pertaining to TEM was undertaken to identify key data gaps and areas of uncertainty regarding vegetation and other land cover in and around the LAA. Study components included searches of available online databases for at-risk ecosystems, as defined by B.C. MOE, and wetlands, as defined by regulations under the *FRPA*, and the *Federal Policy on Wetland Conservation* (CWS 1991).

The results of the TEM study provided information necessary to understanding not only the existing conditions of the vegetation VC and its sub-components, but also the value of habitat in the study area for terrestrial wildlife.

The TEM study area included a broader spatial scope than the Project alignment. The study area selected was of sufficient size to adequately represent existing vegetation conditions in and around the Project alignment and to capture local variability and area uniqueness. The study area comprised a 500-m wide corridor along the existing Highway 99 corridor and the interchanges associated with the Project (i.e., 250 m on either side of the highway and interchange centrelines), extending from Bridgeport Road to Highway 91 Interchange in Delta.

The study objectives were to develop a quantitative inventory of vegetated, non-agricultural land cover types, with emphasis on at-risk ecosystems and locations having potential for at-risk species. Several at-risk ecosystems, generally wetlands, occur within the Coastal Douglas-fir Moist Maritime (CDFmm) biogeoclimatic subzone variant that comprises the study area. Wetlands are sensitive to disturbance, are rare on the landscape, and have potential to contain habitat for at-risk plant and wildlife species that occur infrequently in the Lower Mainland, and typically in small, highly fragmented locations adjacent to developed areas.

Methods

Two ecological systems of classification were used to describe the ecology in the study area: Ecoregion Classification and the Biogeoclimatic Ecosystem Classification (BEC). Ecosystems were defined and delineated based on the methods outlined in the *Standard for Terrestrial Ecosystem Mapping in British Columbia* (RIC 1998). Much of the study area is disturbed, and some modifications to the standard were therefore necessary; for example, hedgerows and abandoned fields were identified because they may provide wildlife habitat. Classification of land cover was designed to support wildlife habitat suitability modelling.

TEM Pre-typing and Delineation

Preliminary typing of land cover was carried out using high-resolution ortho-imagery to delineate terrestrial ecosystems before field surveys were undertaken. Delineation was done by viewing each orthophoto and drawing polygons around homogeneous landform or vegetation elements to separate areas into similar-looking units. Factors considered in delineation included parent material, slope, aspect and vegetation cover. For the purposes of the vegetation surveys, farm fields were delineated based on crop type and level of activity (actively farmed vs. fallow or abandoned). Due to the low relief and highly disturbed nature of the landscape, stereoscopic air photo interpretation was not necessary, and polygon interpretation confidence was high.

Ecosystem Classification

Each ecosystem polygon was classified and the details entered into a Microsoft Excel TEM database. Core information entered in the ecosystem database for each polygon included:

- Polygon number.
- Biogeoclimatic zone, subzone and variant.
- Ecosystem labels (decile, site series, modifier(s) and structural stage: recorded up to two times per polygon).
- Polygon area (ha).
- Comments: additional information on the polygon, such as field check plot numbers.

Each ecosystem polygon was classified as either a single ecosystem unit (simple label) or a complex unit, with one to three (maximum) ecosystem units per polygon. Each unit included a number of site series. Each site series was further described using ecosystem site modifiers. Site modifiers are site-specific factors that can be directly related to management interpretations of different site series. These include factors such as aspect, soil texture, depth and certain specific terrain features.

Each polygon was assigned one or two site series, which were recorded as a two-digit number or letters and transcribed onto the map with their corresponding two-letter code, based on the characteristics listed above. A complete list of site series and additional non-vegetated codes for each polygon is stored in a TEM database. Vegetated ecosystems were defined as any forested, shrubby, or grassy ecosystem. Agricultural ecosystems are vegetated areas that are managed for crops or livestock. Non-vegetated and anthropogenic ecosystems include site series codes with sparse to no vegetation cover, such as exposed soil, developed areas and road surfaces. For the complex units, only those ecosystems estimated to cover approximately 10 per cent or more of the total polygon area were recorded. Anthropogenic disturbances, such as roads, buildings and rail lines, were assigned non-vegetated TEM codes.

TEM Field Sampling

In total, 490 polygons were mapped for the entire TEM study area (which is larger than the LAA). Of these, 110 polygons were excluded from field-checking because they were easily identified and classified on images as urban, rural, or road surface. The study area was further reduced to 100 polygons that are within the LAA. The entirety of Deas Island, was also included in the mapping in April 2016. Field-checking of the remaining polygons was done by a team of two, composed of a TEM mapper and an at-risk plant botanist or wildlife biologist, depending on location.

Mapping, field work, and data collection were based on provincial TEM standards and methods (RIC 1998, B.C. MOF and B.C. MOE 2010). Field-checking was conducted using level-five intensity (i.e., five to 15 per cent of polygons were field-checked), a level considered appropriate for the large size and disturbance history of the study area. A total of 11 ground inspection forms (Form No. FS882) cards were completed and 41 visual assessments were conducted equalling 55% of the Project footprint being field-checked.

Sampling was conducted within 20 m-radius plots. Within each plot, data were collected on stand structure, and vascular and non-vascular plant species composition, where applicable. Plants were identified to the genus level, at minimum, and per cent cover per species. Total cover for trees, shrubs and herbs was also recorded. In agricultural areas, information on age of the field (if abandoned or fallow) and cover crop type were recorded. Other data gathered at each plot included landscape form, ecosystem, crown closure (where applicable), and structural stage (where applicable).

Photographs were taken from the centre of each plot towards each cardinal compass point, with additional photographs showing crown closure and a general overview of understory vegetation. Coordinates of the centre of the plot were collected using a GPS.

To assess wetland plant communities that had been identified within the study area, systematic surveys of vegetation cover within these areas were conducted using the procedures for site description and identification described in the *Wetlands of British Columbia: A Guide to Identification* (MacKenzie and Moran 2004).

At-risk ecosystems were identified and field-checked to confirm presence and habitat quality. Sensitive ecosystems were defined to include old-growth forests, mature forest stands, and wetlands.

Vegetation field sampling involved the collection of detailed information on forest cover, shrub, and herb layers, and general site characteristics. Vegetation survey plots were completed in pre-selected (non-random) locations where the occurrence of at-risk plants was possible. The information collected in the field was then used to update and confirm the digital TEM product. Methods and data collection followed the *Field Manual for Describing Terrestrial Ecosystems* (RIC 1998, B.C. MOF and B.C. MOE 2010), using visual assessments to ground-truth vegetated ecosystems.

Results

The study area (described above) is in the Lower Mainland (LOM) Ecoregion (Demarchi 1996). The LOM ecoregion is divided into ecosections; the study area falls within the Fraser Lowland (FRL) ecosection, which comprises the Fraser delta, estuary, lowlands, and associated uplands. The FRL has been formed primarily by sediments washed down the Fraser River (Demarchi 1996). The assessment is within the Coastal Douglas-fir Moist Maritime (CDFmm) biogeoclimatic subzone.

In general, the vegetated areas within the study area are representative of young forests and intensely managed areas. Urban and agricultural development within the study area has resulted in a landscape that is highly modified from its natural state. In the study area, most of the land cover comprises cultivated fields and built-up areas (i.e., residential, industrial and commercial). Small areas of remnant forest occur, however the forests in these areas are young, having been logged or cleared one or more times in the last century. Patches of remnant forest are also located within protected areas such as Deas Island Regional Park, Richmond Nature Park, and Burns Bog.

Table 1a provides a summary of CDFmm ecosystems and other land cover types identified in the study area. Descriptions of the non-forested ecosystem types are provided in the main body of the vegetation VC assessment. Forested ecosystem types identified in the study area follow **Table 1a**.

Table 1a Summary of Ecosystems and Other Land Cover Types in the Study Area

| Coastal Douglas-fir Moist Maritime (CDFmm) | | | |
|---|--|---|------------------------------|
| Code | Name | Description | Area (ha)¹ |
| DS | Douglas-fir – salal (CDFmm/01) | Zonal | 14.1 |
| RK | Western redcedar / Douglas-fir – Kindbergia (CDFmm/05) | Very poor to medium, somewhat dry to fresh | 3.5 |
| RF | Western red cedar/grand fir – foamflower (CDFmm/06) | Rich to very rich, somewhat dry to fresh | 170.3 |
| RS | Western redcedar – Snowberry (CDFmm/07) | High bench floodplain | 7.4 |
| CD | Black cottonwood – Red-osier dogwood (CDFmm/08) | Medium bench floodplain | 7.4 |
| LS | Lodgepole pine – sphagnum (CDFmm/10) | Very poor to poor, wet, bog ecosystem | 99.4 |
| RP | Western redcedar – Indian-plum (CDFmm/13) | Site with strongly fluctuating water table | 12.0 |
| Em02 | Glasswort – sea-milkwort Herbaceous Vegetation (Red-listed) | Estuary Marsh | 23.2 |
| Em05 | Lyngbye’s sedge Herbaceous Vegetation (Red-listed) | Estuary marsh | 5.6 |
| Fm50 | Cottonwood/red alder – salmonberry flooded forest (Blue-listed) | Forest with long periods of seasonal flooding | 7.1 |
| Wm05 | Cattail marsh (Blue-listed) | Wetland dominated by emergent vegetation | 22.6 |
| Ws51 | Sitka willow – Pacific willow – Skunk cabbage (Red-listed) | Wet, rich to very rich wetland | 5.4 |
| Ws53 | Western redcedar – Sword fern – Skunk cabbage (Blue-listed) | Wet, rich to very rich wetland | 6.0 |
| CDFmm/00 | Large-headed sedge Herbaceous Vegetation (Red-listed) | Sandy beach dune ecosystem | 0.4 |
| Sub-Total | | | 384.4 |

| Non-vegetated Areas and Codes | | |
|-------------------------------|--------------------|------------------------|
| Code | Name | Area (ha) ¹ |
| AF ² | Abandoned field | 40.6 |
| BC ² | Berry crop | 108.6 |
| CF | Cultivated field | 536.9 |
| ES | Exposed soil | 27.6 |
| GC | Golf course | 49.4 |
| HR ² | Hedgerow | 13.2 |
| MU | Mudflats | 25.7 |
| OF ² | Old field | 15.5 |
| OW | Shallow open water | 34.1 |
| PD | Pond | 0.6 |
| PK ² | Park | 14.2 |
| RE | Reservoir | 0.3 |
| RI | River | 51.6 |
| RN | Rail tracks | 12.9 |
| RW | Rural | 178.7 |
| RZ | Road surface | 261.0 |
| UR | Urban | 230.6 |
| VE ² | Verge | 130.6 |
| Sub-Total | | 2117.0 |

Notes: ¹ Values rounded to nearest number. Discrepancies between individual areas and totals are due to rounding
² Unique label used for the Project

The Coastal Douglas-fir Moist Maritime Douglas-fir-Salal (**CDFmm/01**) sites are zonal (neutral slope) forested sites characterized by slightly dry to fresh soil moisture regime, with very poor to medium nutrient levels within the soil. These sites occur around mid-slope on gently sloping landforms (Meidinger and Pojar 1991). Soils on these sites vary depending on parent material ranging from Regosols on lava flows and recent burns to Podzols in forested ecosystems.

Western redcedar/Douglas-fir – *Kindbergia* (**CDFmm/05**) are considered medium sites. These have very poor to medium soil nutrients, and somewhat dry to fresh moisture.

Richer site series are represented by the Western redcedar/Grand fir–Foamflower (**CDFmm/06**). These contain rich to very rich soil nutrients and moderately dry to very moist soil moisture. Vigorous vegetation growth and species diversity, including a greater number of herbaceous species in the understory, are characteristic of these ecosystems.

Poor, wet bog sites (Lodgepole pine – sphagnum (**CDFmm/10**) occur mainly in Richmond Nature Park. These sites have poor soil nutrients and saturated soils. Vegetation diversity tends to be low, restricted to only a few species that are tolerant of fluctuating water levels. Soils are generally organic peat mosses.

Floodplain sites are represented by western redcedar – Snowberry (**CDFmm/07**) (high bench floodplain) and black cottonwood – Red-osier dogwood (**CDFmm/08**) (medium bench floodplain). High bench sites are most infrequently flooded (>5 years), while medium bench floodplains are flooded at least every five years and often annually.

Sites with strongly fluctuating water tables, western redcedar – Indian-plum (**CDFmm/13**), have a soil moisture regime that fluctuates over the growing season. These sites are usually saturated during wet winter months and dry during the summer.

Table 1b Summary of Ecosystems and Other Land Cover Types in the Study Area

| Coastal Western Hemlock Eastern Very Dry Maritime (CWHxm1) | | |
|---|--------------|------------------------------|
| Non-vegetated Areas and Codes | | |
| Code | Name | Area (ha)¹ |
| RW | Rural | 5.4 |
| RZ | Road surface | 6.0 |
| UR | Urban | 24.3 |
| VE ² | Verge | 3.0 |
| Sub-Total | | 38.7 |

Notes: ¹ Values rounded to nearest number. Discrepancies between individual areas and totals are due to rounding
² Unique label used for the Project

Appendix C

Overview of Potential Project Interactions with At-risk Ecosystems

Table 1 Overview of Potential Project Interactions with Vegetation

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Pre-Construction / Site Preparation | | | |
| Pre-construction / site preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Conducting additional site investigations (i.e., a geotechnical drilling program • Acquiring property for the Project | Nature of Interaction: No interaction anticipated. |
| | No effect | N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction | <p>Nature of interaction:</p> <ul style="list-style-type: none"> • Potential for reduced extent of at-risk ecosystems. • Temporary activities and works may physically disturb habitat. • Potential for introduction of invasive alien plant species to ecosystem. <p>Comment:</p> <ul style="list-style-type: none"> • Project is within an existing transportation corridor and land cover in the LAA is already of a disturbed nature. • At-risk ecosystems are situated at the outer edges of the LAA and not located within the Highway 99 corridor. • Potential effects may be mitigated through Project design and other measures. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction:</p> <ul style="list-style-type: none"> • Potential for reduced extent of at-risk ecosystems. • Potential permanent effects on ecosystem through placement of structures in habitat. • Potential for introduction of invasive alien plant species to ecosystem. <p>Comment:</p> <ul style="list-style-type: none"> • Piers will be installed in the cattail marsh adjacent to River Road (polygon 428), an ecosystem that is degraded due to proximity to existing roadways. • Potential for mitigation through Project design or habitat creation/improvement. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|---|
| Highway 99 improvements, including interchange upgrades | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction:</p> <ul style="list-style-type: none"> • Potential for introduction of invasive alien plants by equipment or in soil and gravel. • Potential for reduced extent of at-risk ecosystems through physical disturbance and introduction of invasive plants. • These activities may disrupt water flows to wetland ecosystem and displace habitat. <p>Comment:</p> <ul style="list-style-type: none"> • Existing runoff management practices will continue. • Potential for mitigation through Project design and other measures. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|--|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection. • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | Nature of Interaction: No interaction anticipated. |
| | No effect | N/A | N/A |
| | Potential effect | N/A | N/A |
| Decommissioning of Deas Slough Bridge | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | Nature of interaction: Placement of materials or operation of equipment during decommissioning may damage or destroy habitat. Comment: Ecosystems can be entirely avoided through flagging. |
| | Potential effect | N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|---|---|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | Nature of Interaction: No interaction anticipated. |
| | No effect | N/A | N/A |
| | Potential effect | N/A | N/A |
| New bridge | No interaction | <ul style="list-style-type: none"> • Operating the new bridge • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | Nature of Interaction: No interaction anticipated. |
| | No effect | N/A | N/A |
| | Potential effect | N/A | N/A |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.8 Terrestrial Wildlife Assessment Highlights:

- Terrestrial wildlife along Highway 99 consists primarily of common species of raptors, riverine birds, and small mammals.
- Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge.
- No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.
- The application of best practices during future stages of design and construction will largely avoid or mitigate Project-related effects on wildlife and wildlife habitat.
- Installation of flight deflectors such as hedgerows at appropriate locations along the highway will mitigate potential Project-related increase in traffic collision risk for barn owls.
- Nesting opportunity provided by the new bridge will offset the loss of barn swallow nesting habitat due to removal of the Deas Slough Bridge.
- Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed.
- No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

4.8 Terrestrial Wildlife Assessment

This section presents the results of the assessment of potential effects of the Project on terrestrial wildlife, and includes a description of existing conditions, potential Project-related effects and proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects.

Terrestrial wildlife includes the birds and mammals that live predominantly or entirely on land. Amphibians are addressed in **Section 4.5 At-Risk Amphibian Assessment**, and plants and ecosystems are addressed in **Section 4.7 Vegetation Assessment**.

4.8.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on terrestrial wildlife in terms of the Project, and defines and rationalizes the spatial, temporal, administrative and technical assessment boundaries.

4.8.1.1 Assessment Context

Terrestrial wildlife species and their associated habitat occur within the Project alignment, and could interact with activities associated with proposed highway widening and interchange upgrades, construction of the new bridge, and decommissioning of the Deas Slough Bridge. Terrestrial wildlife that may be affected by Project-related activities includes species that are of interest to the public, Aboriginal Groups or regulatory agencies. In addition, there are legally binding requirements that protect certain species and, in some cases, their habitat (see **Section 4.8.2.2**).

The VC selection for wildlife species is briefly described below (**Table 4.8-1**), and in greater detail in **Section 3.1 Issues Scoping and Selection of Valued Components**. The following species / species groups were excluded as VCs:

- Sandhill crane (*Grus canadensis*), short-eared owl (*Asio flammeus*), and grouse are unlikely to occur within the Project alignment because no suitable habitat has been identified.
- Ring-necked pheasant (*Phasianus colchicus*) have been identified as important to Aboriginal Groups but is not a native species.
- Red fox (*Vulpes vulpes*), American black bear (*Ursus americanus*), elk (*Cervus elaphus*), North American porcupine (*Erethizon dorsatum*), snowshoe hare (*Lepus americanus*), and grey wolf (*Canis lupus*) were traditionally harvested by Aboriginal Groups but are believed to be extirpated from the Project alignment.
- American beaver (*Castor canadensis*), common muskrat (*Ondatra zibethicus*), American mink (*Neovison vison*), American marten (*Martes americana*), striped skunk (*Mephitis mephitis*), Douglas's squirrel (*Tamiasciurus douglasii*), and raccoon (*Procyon lotor*) have been identified as important to Aboriginal Groups and likely occur within the Project alignment; however, Project-related Highway 99 improvements are not anticipated to impact their habitat requirements.
- Deer are found in nearby habitats (e.g., Burns Bog) and are important to Aboriginal Groups; however, Project-related Highway 99 improvements are not anticipated to result in an increase of current collision risk, based on the review of existing Ministry collision data.

Project-related effects anticipated to have a direct influence on terrestrial wildlife include habitat loss, habitat alteration, and mortality. Changes to habitat availability and function may occur during Project construction as a result of habitat loss or alteration. Indirect effects to terrestrial wildlife may occur through changes to other environmental components such as sediment and water quality (**Section 4.2 Sediment and Water Quality**), atmospheric noise (**Section 4.10 Atmospheric Noise**), and vegetation (**Section 4.7 Vegetation Assessment**).

Where appropriate, information from these sections has been cross-referenced in this assessment. Information on Project design, construction, and operation as it relates to potential terrestrial wildlife effects have also been included (**Section 1.1 Description of the Proposed Project**). There is no indication that river hydraulics and morphology changes as a result of the Project will have any influence on wildlife habitat. There are no in-river piers and Tunnel decommissioning will be a temporary activity that is not anticipated to alter the riparian area (**Section 4.1 River Hydraulics and River Morphology**). For example, sedimentation as a result of Tunnel decommissioning will likely be within the range of what occurs naturally during freshet. Accordingly, river hydraulics and morphology effects on terrestrial wildlife are not considered further.

4.8.1.2 Methods

The assessment of terrestrial wildlife follows the methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Building on this approach, the assessment of terrestrial wildlife was designed to focus on specific wildlife species considered most appropriate, given existing conditions within and adjacent to the Project alignment. In this context, the assessment of terrestrial wildlife focuses on three sub-components: upland birds, riverine birds and bats, and mammals (**Table 4.8-1**).

Table 4.8-1 Sub-components for the terrestrial wildlife VC

| Sub-component | Rationale for Selection |
|---------------|--|
| Upland birds | <p>Individual birds, eggs, and active nests are protected under the <i>Migratory Birds Convention Act</i> (MBCA), S.C. 1994, c. 22.</p> <p>Section 34 of the <i>Wildlife Act</i>, R.S.B.C. 1996, c. 488 prohibits possessing, taking, or destroying (i) a bird or its egg, (ii) the nest of an eagle, peregrine falcon, osprey, or heron, or (iii) the nest of a bird not mentioned in (ii), when the nest is occupied by a bird or its egg.</p> <p>American bittern, great blue heron (<i>fannini</i> subsp.), rough-legged hawk, peregrine falcon (<i>anatum</i> subsp.), barn owl, short-eared owl, olive-sided flycatcher, common nighthawk, and barn swallow are federally or provincially listed as at-risk and have been observed in the local assessment area (LAA) or regional assessment area (RAA). Raptors (e.g., bald eagle and osprey) and herons have been identified as culturally important to Aboriginal Groups. During consultation activities, Aboriginal Groups have noted that bald eagle have been observed within the LAA.</p> |

| Sub-component | Rationale for Selection |
|-------------------------|---|
| Riverine birds and bats | As above for the MBCA and section 34 of the <i>Wildlife Act</i> . Double-crested cormorant, cackling goose, tundra swan, Caspian tern, and western grebe are provincially listed as at-risk (Red or Blue), and have been observed in the LAA. Bat species occur in the LAA, including at least one federally or provincially listed at-risk species (little brown myotis, <i>Myotis lucifagus</i>). Riverine birds (e.g., ducks, loons, grebes, murre, cormorants, geese, swans, and seagulls) have been identified as culturally important to Aboriginal Groups. |
| Mammals | Trowbridge’s shrew, southern red-backed vole, <i>occidentalis</i> subspecies, Olympic shrew, and Pacific water shrew are provincially listed (Red or Blue) and are considered potentially present within the Project alignment. Pacific water shrew is an identified wildlife species under the <i>Forest and Range Practices Act</i> (FRPA), S.B.C. 2002, c. 69 and is federally listed. River otter (<i>Lontra canadensis</i>) was identified as a species that is culturally important to Aboriginal Groups during consultation activities and is included for assessment. |

4.8.1.3 Indicators

Habitat loss, sensory disturbance, and collision risk were used as indicators to assess trends of terrestrial wildlife within the assessment area and evaluate potential Project-related effects.

Table 4.8-2 presents the indicators chosen for the assessment of Project-related effects on the three terrestrial wildlife sub-components, and the rationale for their selection.

Table 4.8-2 Indicators for the Terrestrial Wildlife VC

| Sub-component | Indicators | Rationale for Selection |
|---|--|---|
| Upland birds, riverine birds and bats, and mammals | Habitat loss: Amount and quality of foraging or breeding habitat that overlaps with Project components | The area of lost habitat, and anticipated reductions to its quality, is quantification of potential Project-related changes to foraging and/or breeding for upland birds, riverine birds and bats, and mammals. |
| Upland birds, riverine birds and bats, and mammals | Sensory disturbance: Changes to usability of foraging or breeding habitat within the Project alignment | Access to usable foraging and breeding habitat affects the distribution and abundance of upland birds, riverine birds and bats, and mammals. |
| Upland birds, riverine birds and bats, and mammals. | Collision mortality: Risk of mortality | Mortality affects population size and sustainability; a qualitative assessment of mortality due to vehicle collisions with wildlife, and collisions with the bridge for upland birds and riverine birds and bats. |

4.8.1.4 Assessment Boundaries

The assessment boundaries for terrestrial wildlife are defined below.

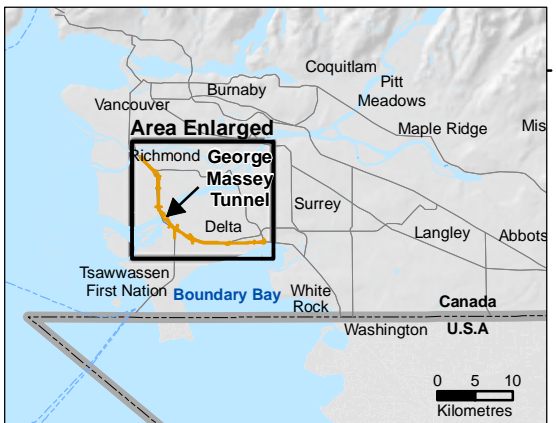
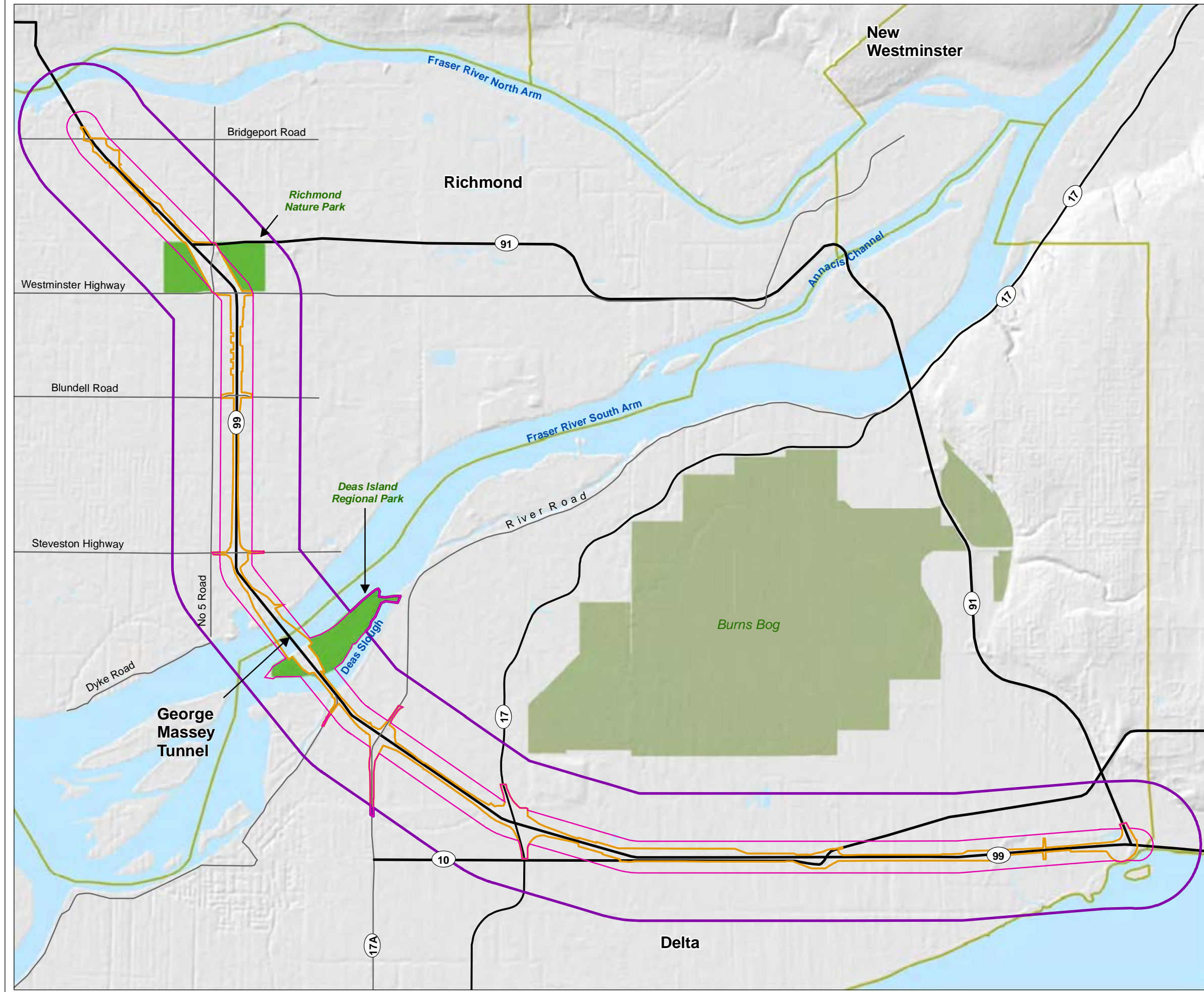
Spatial Boundaries

The LAA and RAA for terrestrial wildlife (**Table 4.8-3** and **Figure 4.8-1**) take into account the scale and spatial extent of potential environmental effects appropriate for the three sub-components.

The LAA encompasses the area within which the Project is expected to interact with and potentially affect terrestrial and semi-aquatic wildlife. In determining LAA boundaries, consideration was given to the nature and characteristics (i.e., sensitivities) of terrestrial wildlife, their potential exposure to various influences (e.g., habitat loss, traffic, infrastructure), and the maximum geographic extent of potential adverse effects on terrestrial and semi-aquatic wildlife given the existing environment. The RAA was established to provide a regional context for the assessment of Project effects.

Table 4.8-3 Spatial boundary definitions for terrestrial wildlife

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|---|
| Local assessment area (LAA) | Upland birds: Project alignment. Riverine birds and bats, and mammals: Project alignment plus 250 m on either side of the Highway 99 centreline, extending over the length of the Project. The area for all subcomponents is expanded in the vicinity of the new bridge to include Deas Island and Deas Slough, some of which extends beyond 250 m on either side of the highway. |
| Regional assessment area (RAA) | A 2 km wide corridor (1 km on either side of the Highway 99 centreline) over the length of the Project, and including all of Deas Island, part of which extends beyond 1000 m upstream of the Highway 99 centreline. |

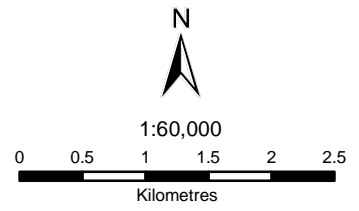


Legend

- Terrestrial Wildlife Local Assessment Area
- Terrestrial Wildlife Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|--|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TERRESTRIAL WILDLIFE LOCAL AND REGIONAL ASSESSMENT AREAS | |
| Figure 4-8.1 | 13/05/2016 |
| | |

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Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on terrestrial wildlife were established based on the potential for each phase of the Project to interact with and affect terrestrial wildlife. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, this includes both the construction and operational phases of the Project. The following temporal boundaries were defined for terrestrial wildlife assessment:

- Existing conditions
- Project construction (including Tunnel decommissioning)
- Project operation (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.0 Overview of the Proposed Project**. Specific temporal considerations for the assessment of terrestrial wildlife (e.g., nesting periods) are documented and considered in the existing conditions (**Section 4.8.2 Existing Conditions**), and Project interactions and potential Project-related effects (**Section 4.8.3 Potential Effects**).

Administrative Boundaries

No jurisdictional, economic, or social constraints that could limit the assessment of potential Project-related effects on wildlife have been identified; no administrative boundaries were identified.

Technical Boundaries

Constraints that could limit predictions of Project-related effects on wildlife have been identified. Such limitations are standard in biology impact assessment and relate to the absence of a full-knowledge of species and their distributions and the representative sampling that is implicit and commonplace in biological surveys. Predictive modelling is also used and such methods incorporate assumptions. Most of the methods used are supported by government-sponsored documentation that suggests they are standard procedures for surveying and sampling. These technical boundaries are not considered to limit the predictions.

4.8.2 Existing Conditions

This section provides an overview of the methods for collecting baseline data, and describes the existing wildlife conditions in the assessment areas. An overview of the regulatory context for management of wildlife relevant to the Project is also provided.

4.8.2.1 Baseline Data Collection

In 2014, the Ministry initiated studies on terrestrial wildlife to support Project planning and environmental assessment (**Table 4.8-4**). These studies were designed to augment existing knowledge and address known data gaps.

Table 4.8-4 Terrestrial Wildlife Studies

| Study Name | Purpose of Study |
|--|--|
| Upland Birds | |
| Barn owl habitat suitability assessment | Determine suitability of the LAA as foraging habitat for barn owl by assigning habitat suitability rankings. |
| Raptor and heron surveys | Document the presence of conspicuous raptors and herons and nest activity in the LAA in spring, summer, autumn, and winter. |
| Songbird surveys | Establish species presence in areas proposed for clearing or construction using point count methods. |
| Common nighthawk call-playback surveys | Establish baseline data for common nighthawk in the Project alignment (Deas Island only) using call-playback methods. |
| Structure survey for nesting swallows | Map presence of swallow nests in structures that would be removed or altered during Project construction. |
| Riverine Birds and Bats | |
| Marsh bird call-playback surveys | Identify marsh bird species presence in areas proposed for clearing or construction using call-playback methods. |
| Radar, standwatch, and ultrasonic acoustic surveys for riverine birds and bats | Identify collision risk for avian and bat species relative to the new bridge and associated infrastructure. |
| Mammals | |
| Small mammal habitat suitability modelling | Determine the ability of habitat in the LAA to provide life requisites for small mammal focal species using habitat suitability modelling. |
| Pacific water shrew eDNA studies | Establish presence/not detected status of Pacific water shrew in the LAA using eDNA sampling. |
| River otter assessment | Establish presence of river otter in the LAA and assess late-spring (breeding period) use and activity using meander transect survey methods to identify active latrines (river otter high-use areas). |

Studies for Upland Birds

Barn Owl Habitat Suitability Assessment

Barn owl (*Tyto alba*) are not known to nest in, or immediately adjacent to, the Project alignment. Accordingly barn owl studies in the LAA focussed on modelling suitable foraging habitat in accordance with provincial standards (RIC 1999a). Habitat suitability ratings were assigned to ecosystem units defined in the terrestrial ecosystem mapping (TEM; **Section 4.7 Vegetation Assessment**). A four-class rating scheme (i.e., high, moderate, low, nil) was used, based on each unit's potential to provide barn owl foraging requisites (i.e., habitat suitable for Townsend's vole, *Microtus townsendii*) within 250 m of the Highway 99 centreline. The values for each ecosystem unit were analyzed and mapped to create a barn owl habitat suitability model.

Raptor and Heron Surveys

Roadside surveys were conducted to document raptor and heron species in the LAA. A total of 16 surveys (four surveys per season) were conducted in 2014, following methods adapted from the *Inventory Methods for Raptors* (RIC 2001). For each survey, two driving transects (one in each direction) along Highway 99 were completed. The methods employed adhered to the standards with the exception of not exceeding a vehicular speed of 40 km/hr. Driving transects were conducted at approximately 60 km/hr, which allowed the surveyors to effectively search for raptors and herons while travelling safely on Highway 99.

The location of each bird observed, the species, age and sex (if possible), behaviour (perching, standing, or flying), and the perpendicular distance from the highway were recorded. Agricultural areas were scanned from a vehicle, and treed areas near the Tunnel and on Deas Island were surveyed on foot. For each nest detected, the location, condition, activity level, substrate, and species were recorded.

Songbird Surveys

Point counts (visual and aural observations) were conducted at 15 stations in the LAA in accordance with provincial standards to establish species presence (RIC 1999b), with the exception that standards recommend point counts of five-minute duration, but a 10-minute duration was used because high noise levels associated with existing Highway 99 traffic interfered with bird detectability. Bird detections were classified within or beyond a 50-m radius of each station. Nine point count stations in the LAA were surveyed three times: May 2015, June 2015, and May 2016. One point count station was added in June 2015 and only surveyed once. Five additional point count stations were surveyed on Deas Island in May 2016.

Common Nighthawk Call-playback Surveys

Common nighthawk (*Chordeiles minor*) call-playback surveys were completed in accordance with provincial standards (RIC 1998a) in June 2015 at Deas Island to establish presence/not detected during the breeding period. Common nighthawk have been recorded infrequently at Deas Island (eBird 2015). Two call-playback surveys in mid- and late-June were conducted on a 3.5-km transect on Deas Island, based on historical presence in the area and potential for interaction with the Project.

Structure Survey for Nesting Swallows

Surveys for colonial nesting swallows using highway infrastructure for nesting were conducted in 2015 and 2016. All Highway 99 interchange and bridge structures, and the bridges on intersecting roads and railway lines, in the LAA were surveyed in winter or spring (January or May 2015). Those structures that had confirmed or possible use were re-surveyed in summer (June and July 2015). Presence of nests or nesting activity by barn (*Hirundo rustica*), cliff (*Petrochelidon pyrrhonota*), and northern rough-winged (*Stelgidopteryx serripennis*) swallow was documented. Incidental observations of other nesting species were also documented.

Studies for Riverine Birds and Bats

Marsh Bird Call-playback Surveys

The presence of wetland birds was surveyed in the only likely habitat for such species, Green Slough. Call-playback surveys to elicit responses from American bittern (*Botaurus lentiginosus*), Virginia rail (*Rallus limicola*), and sora (*Porzana carolina*) were conducted using standard survey techniques (Gibbs and Melvin 1993, RIC 1998b). Two surveys were during the peak breeding season (May 20 to July 10) to take advantage of enhanced detectability associated with territorial or nesting behaviours. To avoid replication (RIC 1998b), call-playback stations were spaced 250 m apart.

Radar, Stand-watch, and Ultrasonic Acoustic Surveys for Birds and Bats

Replacement of the Tunnel with a new bridge could result in new obstructions for avifauna. A collision risk study was conducted to understand seasonal use and behaviours by birds, and to estimate collision risk at the new bridge crossing location in the LAA. Studies of species present, and their flight patterns and behaviours (e.g., flight direction, flight height, obstacle avoidance reaction) were conducted in 2015 at the new bridge crossing location and at a reference site (Port Mann Bridge, which is of similar design to the Project). The study was conducted across four seasons (i.e., spring migration, breeding season, autumn migration,

early winter), representing four time periods with different bird species present and distinct behaviours for those species. Studies were conducted in the day (standwatch) and night (radar surveys), using approaches adapted from Environment Canada (2007) to accommodate the urban situation and the Project objectives.

Stand-watch surveys were conducted twice per site in each period, starting at or just before dawn, for four hours duration, and for approximately four hours preceding dusk on the same day. Data were summarized at the flock level rather than individual level to ensure sample independence. Each individual bird and all groups of birds flying together were considered a single flock observation.

During the spring and autumn survey periods, nocturnal radar surveys were conducted twice per site (eight total surveys). During radar surveys, two observers assessed bird and bat movement on vertical and horizontal axes from 30 minutes before sunset for three hours, and again from approximately 2.5 hours before dawn until 30 minutes after dawn. Radar surveys used two high-frequency marine radar units (Burger 2001, 2002). Concurrent ultrasonic bat call detection units (Echometer Touch) recorded, where possible, the species of bat that were observed on radar.

Potential risk of interaction with existing and proposed Project structures was categorized as:

- At risk: flight paths intersecting the projected bridge airspace
- Undetermined risk: flight path or behaviour indicating a potential interaction that the observer cannot confidently assess
- Not at risk: flight path not intersecting the projected bridge airspace

The heights used to determine this risk were:

- Port Mann Bridge min. 45 m, max. 160 m
- Proposed new bridge min. 60 m, max. 220 m

Collision risk at the reference site (Port Mann Bridge) was assessed by documenting obstacle avoidance behaviour categorized as follows:

- Collision: collision with structure
- Abrupt: avoidance reaction initiated within five metres of a structure
- Delayed: avoidance reaction initiated between 5 and 15 m from a structure
- Gradual: avoidance initiated more than 15 m from a structure
- None: no avoidance required, flying height maintained

Studies for Mammals

Small Mammal Habitat Suitability Modelling

Habitat suitability modelling was conducted to rate the available habitat in the LAA for providing the life requisites for small mammal species. The LAA was rated in accordance with provincial standards (RIC 1999a) for each focal species: southern red-backed vole, *occidentalis* subspecies (*Myodes gapperi occidentalis*), Olympic shrew (*Sorex rohweri*), Pacific water shrew and Trowbridge's shrew (*Sorex trowbridgii*). Habitat ratings for each species were assigned to ecosystem units identified in the TEM (**Section 4.7 Vegetation Assessment**). The ratings were based on the ability of each unit to provide the life requisites for each species. Information for Pacific water shrew, and Trowbridge's shrew allowed the use of a four-class rating scheme (i.e., high, moderate, low, or nil habitat value). Limited information for southern red-backed vole, *occidentalis* subspecies and Olympic shrew only allowed for the use of a two-class rating scheme (i.e., habitat useable, or likely of no value). The values for each ecosystem unit were analyzed and mapped using GIS software to create species-specific habitat suitability models.

Pacific Water Shrew Environmental DNA Study

Environmental DNA (eDNA) studies were conducted in sites with suitable habitat within the footprint to detect presence of Pacific water shrew (**Appendix B, Figures 1a to 1c**). This method samples water features used by Pacific water shrew to search for shed genetic material (i.e., DNA) such as feces, exfoliation, mucus, and urine. Three sites in the LAA were deemed suitable habitat for Pacific water shrew, and were sampled on May 28 and 30, 2014, a time of year when Pacific water shrew actively forage in water. One sample at Fergus Creek in Surrey (with 12 replicates) was also collected. While outside the study area, this is a location where Pacific water shrew is historically known to occur (B.C. CDC 2008) and served as a reference site. Environmental DNA sampling methods followed a modified¹ standard eDNA protocol (Goldberg and Strickler 2013) to address the specifics of the species under study. Details on eDNA methods (identical to the proposed RISC standard) are provided in **Section 4.5 At-Risk Amphibian Assessment**.

River Otter Assessment

Meander transect surveys were conducted in April 2016, by boat and on foot, to assess river otter use of riverine and riparian habitats within the Fraser River portion of the LAA and RAA. Evidence of use focussed on latrine sites. At each latrine site photographs were taken of scat

¹ Minor modifications to the pump and other equipment did not influence the validity of the process or results.

and sign (tracks, trails and borrow/den entrances) to document species use, sign abundance, and habitat values. Search intensity was focused on areas of perceived high and moderate habitat potential (i.e., steep complex rip-rap shorelines with riparian forest). The methods followed recommendations from researchers in the USA and BC (Cait Nelson and Kim Sagar *pers. comm.*) and used modified provincial standard data forms to accommodate river otter specifics (RIC 1998c).

4.8.2.2 Regulatory Context

Terrestrial wildlife in B.C. is protected under federal and provincial legislation. Management of wildlife and wildlife habitat is the responsibility of provincial and federal regulatory agencies, including the B.C. Ministry of Forests, Lands and Natural Resource Operations (MFLNRO), and Environment Canada – Canadian Wildlife Service (CWS).

Regulation and management of terrestrial wildlife occurs primarily through:

- The federal *Species at Risk Act* (SARA), S.C. 2002, c. 29
- The federal *Migratory Birds Convention Act* (MBCA), S.C. 1994, c. 22
- The B.C. *Wildlife Act*, R.S.B.C. 1996, c. 488
- The B.C. *Forest and Range Practices Act* (FRPA), S.B.C. 2002, c. 69

The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) and the B.C. Conservation Data Centre (CDC) assess, designate, and recommend species at risk for protection under the SARA and the *Wildlife Act*, respectively.

Federal

The SARA protects species, subspecies, and distinct populations listed on Schedule 1 of the SARA as endangered, threatened or extirpated. Species listed on Schedule 1 are afforded protection by the SARA on federal lands where critical habitat has been identified in a recovery strategy or action plan. There is no federal land or critical habitat within the Project alignment.

The federal MBCA regulates human activities that may be harmful to migratory birds, protecting species (and their eggs and nests) that are listed under Occasional Paper No. 1 (CWS 1991) on all federal, provincial, and private land. Raptors are not protected by the MBCA.

Provincial

In B.C., wildlife² are protected from direct harm, except as allowed by regulation (e.g. hunting or trapping) by the provincial *Wildlife Act*. The *Wildlife Act* extends to virtually all vertebrate animals, including raptor species not protected under the MBCA. Any vertebrate other than fish can be legally designated as endangered or threatened under the *Wildlife Act*.

Habitat protection is offered to specific species under the provincial FRPA through the Identified Wildlife Management Strategy. This strategy guides the establishment of Wildlife Habitat Areas (WHA) and general wildlife measures for species at risk.

4.8.2.3 Existing Conditions

This section describes existing conditions of terrestrial wildlife in the LAA and surrounding environment, and factors influencing terrestrial wildlife.

Aboriginal Groups have identified traditional use of terrestrial wildlife in the LAA, including the harvesting of waterfowl and mammal species. The South Arm of the Fraser River was a prime spot for hunting waterfowl and trapping American beaver, American mink, river otter, and common muskrat. Grouse were hunted in the open fields of Lulu Island. Deer and bear have been taken at Burns Bog within living memory, and American beaver and bear are said to have been taken at the heads of the Serpentine and Nicomekl rivers. Consistent and long-term trend monitoring of wildlife is not conducted by governments in the RAA. A small number of species and or discrete locations have had dedicated one-off sampling conducted (i.e., for species at risk inventory). The majority of current projects and activities in the RAA that affect terrestrial wildlife VCs are not required to monitor and report on their effects (Highway 17 data used in this assessment is one exception). While localized parts of the RAA have some monitoring for one or two of the VCs, (e.g., Christmas Bird Counts, wildlife collision impacts on highways, and Delta Farm and Wildlife Trust effectiveness monitoring), collectively these efforts are limited and insufficient to establish an ecological trend for terrestrial wildlife VCs.

Despite the absence of long-term trend monitoring, it is clear that species that are present in the Project alignment are tolerant of or adaptable to the effects of the existing highway, agriculture, and urban development. These species tolerate the existing activities, and in some cases utilise project footprints for day to day or seasonal life requisites. For example; great-blue heron use of highway ditches, and red-tailed hawk foraging in highway rights-of-way). Species that are not tolerant of such activity, and were intolerant of the historical conversion of the study area to

² Except “controlled alien species”, plants and invertebrates as defined by the *Wildlife Act*.

agriculture, are largely absent. Barn owl was likely not present in the study area before about the 1930s when large-scale agricultural conversion created open farm fields and barns suitable for establishment of a population in the Lower Mainland.

Current trends in species presence based on professional judgement and inference from previous monitoring suggests mostly stable to increasing populations for those species that are present (esp. raptors such as bald eagle and red-tailed hawk). Habitat availability and the trend toward cranberry and blueberry crops versus vegetable crops and hedgerow removal has a large influence on wildlife presence. The Delta Farm and Wildlife Trust's efforts in creating medium-term set-asides for wildlife and hedgerows have had a positive influence. Exceptions to that general rule of population stability include barn owl, for which barn demolition and highway mortality have a negative influence, and aerial insectivorous birds (i.e., swallows) which are understood to be facing continent-wide declines (Environment Canada 2012).

Upland Birds

Barn Owl

Barn owl presence in the Lower Mainland is limited to agricultural areas. The highest known barn owl densities in the Lower Mainland occur in agricultural lands of southwest Delta (Campbell et al. 1990a).

Barn owl generally forage in open fields, grasslands, and agricultural areas where they prey almost exclusively on small mammals, particularly Townsend's vole (CDC 2015). In the Lower Mainland, barn owl habitat is positively correlated with habitat suitable for Townsend's vole, and includes moist fields and sedge meadows (Campbell et.al. 1987). Townsend's vole are common in fields, especially less-disturbed ones, in and adjacent to the LAA (Hemmera 2013a).

Barn owl typically breed from April through August, but with abundant food and warm weather may nest outside this period (COSEWIC 2010). Availability and use of nest and roost sites in southwest Delta has remained relatively consistent since 1990 (Andrusiak 1994, Hemmera 2013b). Barn owl nest and roost mainly in man-made structures such as barns, silos, and industrial buildings. Nesting was documented in 2014 on the steel substructure supporting the old Port Mann Bridge (Hagmeier 2014). During 2012 and 2013 field surveys conducted for the Highway 17 and the Roberts Bank Terminal 2 (RBT2) projects, collectively identified, 49 barn owl occupied sites were identified, of which 31 had evidence of breeding, seven were occupied but breeding was not confirmed, and 11 were identified as roost sites only (Hemmera 2014). No occupied nest sites have been identified in the LAA, but there are many in the RAA.

Based on the barn owl habitat suitability model, 15.7% (245.6 ha) of the LAA was estimated to provide moderate- to high-suitability foraging habitat for barn owl. Low-suitability foraging habitat comprised 48.8% (766.5 ha) of the LAA, whereas 35.5% (557.7 ha) was rated as nil-quality, offering no estimated foraging habitat for barn owl (Table 4.8-5; Appendix B, Figures 5b to 5p).

Table 4.8-5 Amount (in ha and % of LAA) of foraging barn owl habitat within each suitability rating class

| Life Requisite | Barn Owl | | | | | | | |
|---------------------------|----------|-----|----------|------|-------|------|-------|------|
| | High | | Moderate | | Low | | Nil | |
| | ha | % | ha | % | ha | % | ha | % |
| Living – Foraging Habitat | 39.7 | 2.5 | 205.8 | 13.1 | 766.5 | 48.8 | 557.7 | 35.5 |

Literature sources estimate the rate of mortality on high-use roads such as Highway 99 in agricultural areas at between 1.64 to 1.85 barn owl per km per year (Boves and Belthoff 2012, Bishop and Brogan 2013). Highway traffic exposure and the length of highways was shown to be the strongest predictor of collisions in a Lower Mainland study (Hindmarch et al. 2012). The collision risk is highest in highway segments through open pasture (Bond et al 2004, Moore and Mangel 1996).

Applying a median rate of 1.7 mortalities per km per year over the 11.5 km of concentrated barn owl habitat in the LAA (between Highway 17A and Highway 91 in Delta) translates to an estimated twenty mortalities per year in the LAA. Although barn owl mortality data along Highway 99 is not formally collected, incidental mortalities that confirm a current collision risk are regularly noted. Since 2010, three to seven mortalities per year have been noted in the LAA between Highway 17A and Highway 91 (S. Hindmarch and C. Palmer personal observation and non-systematic survey data). Mortalities on Highway 17 (SFPR) are monitored daily and, since monitoring started in late 2013, no barn owl mortalities have been reported along the section of Highway 17 that falls within 1km on either side of the Project alignment.

Raptors

The Fraser River delta is home to Canada’s highest concentration of wintering raptors, including bald eagle (*Haliaeetus leucocephalus*), rough-legged hawk (*Buteo lagopus*), red-tailed hawk (*Buteo jamaicensis*), and northern harrier (*Circus cyaneus*). In the winter there are winter resident species, overwintering species, and species that occur rarely or accidentally

(Butler and Campbell 1987). The open grassy verges and ditches of the Highway 99 right-of-way provide small mammal, amphibian, and minnow prey, which attract foraging raptors. Red-tailed hawk and bald eagle breed in the Lower Mainland, and can be observed along Highway 99 year-round. Trees and tall structures in and near the right-of-way provide nesting and perching sites for red-tailed hawk and bald eagle. Some raptor species, and possibly some individual raptors, have fidelity to nest sites, however nest site locations change from year to year. Most other raptor species are usually only present along Highway 99 in winter.

Studies undertaken in 2003 and 2004 for the South Fraser Perimeter Road (SFPR, Highway 17) documented 15 raptor species, including bald eagle, red-tailed hawk, northern harrier, American kestrel (*Falco sparverius*), peregrine falcon (*F. peregrinus*), and rough-legged hawk. In 2004, six raptor nests that belonged to either bald eagle or red-tailed hawk were identified in black cottonwood (*Populus trichocarpa*) or paper birch (*Betula papyrifera*) (B.C. MOTI 2006) near the bridge where Highway 17 traverses Highway 99.

During roadside surveys conducted for the Project in spring, summer, autumn, and winter 2014, raptor species observed along the Highway 99 corridor included bald eagle, red-tailed hawk, northern harrier, American kestrel, peregrine falcon, rough-legged hawk, and Cooper's hawk (*Accipiter cooperii*) (**Table 4.8-6; Appendix B, Figures 2a to 2d**). The most abundant species observed was bald eagle, followed by red-tailed hawk. Turkey vulture (*Cathartes aura*) was not detected in the LAA during the 2014 surveys; however, this species is likely present.

In spring, raptors were detected along most of Highway 99, but in greater concentrations near the Vancouver Landfill and Deas Slough. During summer, raptors were seen primarily near the landfill. No raptors were detected between Westminster Highway and the north end of the LAA in summer. In autumn, raptors were observed in low numbers (one to three detections) throughout the LAA except between Deas Slough and the west side of the Vancouver Landfill where no raptors were observed. Winter distribution was similar to spring, with raptors detected along most of Highway 99 with greatest concentrations near the Vancouver Landfill.

Nine raptor nests were identified in the LAA, including four nests that were confirmed to be active during the 2014 breeding season (**Table 4.8-7; Appendix B, Figure 3**). The activity of the five remaining nests was not determined, but no birds or signs of nesting activity were documented at these nest sites during spring or summer. Four nests were observed in the Project alignment. Of these, only one, a bald eagle nest adjacent to the Highway 91 / Highway 99 interchange, was confirmed to be active in 2014. A red-tailed hawk nest approximately 30 m from the alignment in Green Slough was also confirmed active in 2014 and 2015. Great horned owl nests are likely present in forested areas outside the study area (Delta Naturalists pers.comm.).

Active bald eagle nests are regularly present in Deas Island Regional Park. Aboriginal Groups have previously noted bald eagle breeding habitat along the Highway 99 corridor on Lulu Island. Elders have indicated that eagle numbers in the Richmond area have been declining.

Great Blue Heron

The Fraser River delta supports the largest winter resident great blue heron (*Ardea herodias* ssp. *fannini*) population in B.C (Campbell et al. 1990b). Herons forage in a variety of wetland habitats; including ditches and agricultural fields. In autumn and winter they roost alone or in small groups in coniferous trees, and in early spring (i.e., mid-March) breeding birds return to nesting colonies that are typically located in disturbance free mature coniferous and deciduous trees within eight kilometres of suitable foraging habitat (Campbell et al. 1990b). In the lower Fraser River, nest-building can begin as early as February (Butler and Baudin 2000, Vennesland 2004). There are no colonies in the LAA or RAA, but there is a large colony with several hundred nesting pairs in Tsawwassen (Delta Farmland and Wildlife Trust 2014).

During roadside surveys conducted for the Project in spring, summer, autumn, and winter 2014, 33 great blue herons were detected within the LAA (**Table 4.8-6; Appendix B, Figure 4**). The majority (18 total) were detected in the winter. Herons were most often seen adjacent to the stretch of Highway 99 that is closest to Boundary Bay. Very few herons were observed in areas where Highway 99 is bordered by residential or industrial development, though this is confirmed habitat for the species. No great blue heron nests were detected in the LAA (**Table 4.8-7**).

Table 4.8-6 Seasonal abundance of conspicuous raptors and herons in the LAA during 2014 roadside surveys

| Common Name | Scientific Name | Spring | | Summer | | Autumn | | Winter | |
|------------------------------|---------------------------------|------------|-----------|------------|-----------|-----------|-----------|------------|-----------|
| | | Count | Mean ± SD | Count | Mean ± SD | Count | Mean ± SD | Count | Mean ± SD |
| American kestrel | <i>Falco sparverius</i> | 2 | 1 ± 1 | 0 | - | 0 | - | 0 | - |
| Bald eagle | <i>Haliaeetus leucocephalus</i> | 646 | 162 ± 44 | 174 | 44 ± 13 | 1 | <1 ± 1 | 157 | 39 ± 9 |
| Cooper's hawk | <i>Accipiter cooperii</i> | 0 | - | 0 | - | 1 | <1 ± 1 | 0 | - |
| Northern harrier | <i>Circus cyaneus</i> | 1 | <1 ± 1 | 0 | - | 1 | <1 ± 1 | 2 | <1 ± 1 |
| Peregrine falcon | <i>Falco peregrinus</i> | 1 | <1 ± 1 | 0 | - | 0 | - | 0 | - |
| Rough-legged hawk | <i>Buteo lagopus</i> | 0 | - | 0 | - | 0 | - | 1 | <1 ± 1 |
| Red-tailed hawk | <i>Buteo jamaicensis</i> | 26 | 7 ± 1 | 34 | 9 ± 1 | 19 | 5 ± 3 | 44 | 11 ± 5 |
| Unidentified <i>Buteo</i> | - | 0 | - | 0 | - | 1 | <1 ± 1 | 3 | 1 ± 1 |
| Unidentified falcon | - | 0 | - | 1 | <1 ± 1 | 0 | - | 0 | - |
| Unidentified raptor | - | 1 | <1 ± 1 | 3 | 1 ± 1 | 0 | - | 4 | 1 ± 2 |
| Great blue heron | <i>Ardea herodias fannini</i> | 6 | 2 ± 1 | 4 | 1 ± 1 | 5 | 1 ± 1 | 18 | 5 ± 3 |
| Total count by season | | 683 | | 216 | | 28 | | 229 | |

Note: Count is the total detections per season.
 Mean is the mean count by season (four surveys per season) plus or minus the standard deviation (SD).

Table 4.8-7 Raptor nests observed in the LAA

| Nest ID | Species | Structure | General Area | Distance from Alignment (m) | Activity Status ¹ |
|---------|---------------------|------------------|---|-----------------------------|------------------------------|
| 01 | Unidentified raptor | Black cottonwood | North side of the Tunnel | 9 | Unknown |
| 02 | Red-tailed hawk | Black cottonwood | Forest near the Hwy 99 S-bound off-ramp to River Rd | 33 | Active |
| 03 | Bald eagle | Black cottonwood | Deas Island | 869 | Active |
| 04 | Bald eagle | Black cottonwood | Deas Island | 255 | Active |
| 05 | Unidentified raptor | Black cottonwood | South of Westminster Hwy | Within alignment | Unknown |
| 07 | Unidentified raptor | Deciduous tree | Golf course | 606 | Active |
| 08 | Bald eagle | Deciduous tree | NW side of Highway 91 / Highway 99 interchange | Within alignment | Active |
| 09 | Bald eagle | Deciduous tree | South of Vancouver Landfill, near 88 Street | 294 | Active |
| 10 | Unidentified raptor | Deciduous tree | South of Vancouver Landfill, near 88 Street | Within alignment | Unknown |
| 11 | Unidentified raptor | Black cottonwood | Highway 17 on-ramp to Highway 99 southbound | Within alignment | Unknown |
| 12 | Bald eagle | Deciduous tree | Near Highway 17 on-ramp to Highway 99 southbound | 172 | Active |
| 13 | Unidentified raptor | Black cottonwood | Near Highway 17 and Ladner Trunk Road | 64 | Unknown |
| 14 | Red-tailed hawk | Black poplar | Golf course north of Steveston Highway | 54 | Active |

Note: ¹ Activity status was determined based on bird presence or signs of nesting observed during summer 2014 surveys.

Songbirds

The Fraser River delta is an important feeding and resting stop for migratory birds travelling along the Pacific Flyway (FREMP 2003). Bird surveys conducted for Highway 17 (SFPR) in 2003 and 2004 documented 62 passerine species in terrestrial habitats along the 40 km-long Highway 17 corridor (B.C. MOTI 2006), a small part of which overlaps with the LAA. Monitoring for Highway 17 (2009-2014) shows 42 species in the closest sampling stations to the LAA; the majority of bird species detected are considered common occurrences in the Lower Mainland. Only two listed species were detected at these stations: barn owl and barn swallow. In farm fields the most abundant songbird species accounting for nearly 92% of total observations were European starling (*Sturnus vulgaris*), savannah sparrow (*Passerculus sandwichensis*), barn swallow, American robin (*Turdus migratorius*), and house sparrow (*Passer domesticus*). During songbird surveys conducted in 2015 and 2016 for the Project, 39 species were detected at the survey stations (Table 4.8-8). All species observed were common birds of developed locations in the Lower Mainland. Caspian tern (*Hydroprogne caspia*) is a provincially blue-listed species, the only federally or provincially listed species at risk observed flying over the Project area during songbird surveys.

Table 4.8-8 Bird species observed during songbird bird surveys conducted in the LAA (spring and summer 2015 and spring 2016)

| Songbird species in the LAA | | |
|-----------------------------|------------------------|--------------------------|
| American goldfinch | Common yellowthroat | Pacific-slope flycatcher |
| American robin | Dark-eyed junco | Pine siskin |
| Anna's hummingbird | Downy woodpecker | Red-winged blackbird |
| Bald eagle | Eurasian-collared dove | Rufous hummingbird |
| Bewick's wren | European starling | Song sparrow |
| Black-capped chickadee | House finch | Spotted towhee |
| Black-headed grosbeak | House sparrow | Swainson's thrush |
| Brown creeper | Marsh wren | Violet-green swallow |
| Brown-headed cowbird | Mourning dove | Western wood-pewee |
| Bushtit | Northern flicker | White-crowned sparrow |
| Caspian tern | Northwestern crow | Willow flycatcher |
| Cedar waxwing | Orange-crowned warbler | Yellow warbler |
| Chipping sparrow | Pacific wren | Yellow-rumped warbler |

Across Canada, approximately 35 birds per kilometre of road are estimated killed during the breeding and fledging season due to vehicle collisions; mostly these are perching songbirds and owls (Bishop and Brogan 2013). For upland birds, changes to Highway 99 are not expected to markedly alter the level of effects over those currently seen. Traffic volumes are currently high, and will stay high with or without the Project.

Common Nighthawk

Common nighthawk have been infrequently observed within the LAA and RAA (eBird 2015). Between 1985 and 2013, eight sightings have been documented in the RAA, seven in the LAA, all on or near Deas Island. Two surveys at Deas Island in June 2015 did not find any evidence of presence or breeding. Due to the infrequent observations of this species, and the absence during species-specific surveys, it is concluded that common nighthawk is an infrequent visitor to the Project alignment and, as such, is not considered further in this assessment. Quality breeding habitat for common nighthawk is un-vegetated areas in open situations.

Swallows

Three swallow species (tree swallow (*Tachycineta bicolor*), violet-green swallow (*T. thalassina*), and barn swallow) commonly occur during the summer in Delta and Richmond. Cliff swallow are uncommon, while northern rough-winged swallow, and bank swallow (*Riparia riparia*) are rare visitors (Campbell et al. 1997). Of these, cliff swallow and barn swallow, which typically nest in mud nests attached to buildings, cliffs, and bridges, are of interest. Three occupied barn swallow nests and a single cliff swallow nest were observed beneath the Deas Slough Bridge on May 14, 2014. During follow-up surveys in spring and summer 2015, 13 barn swallow nests and three cliff swallow nests were observed under the Deas Slough Bridge, and barn swallow nesting activity was documented. Nesting activity was detected on other infrastructure near the LAA (e.g., boathouses, barns, building eaves). The cliff swallow nests were not observed to be active, and no cliff swallows were noted. Nine to 15 barn swallows were observed during the surveys. On July 16, 2015 two fledgling barn swallows were observed. Quality breeding habitat varies among swallow species, key for consideration in this project are cliff / structure nesting species which variously require clay or other banks for their cavities, or mud to build nests on vertical structures (natural or man-made).

Riverine Birds and Bats

Marsh Birds

During marsh bird surveys conducted at Green Slough in May and June 2015, no bittern, rail, or sora were detected. While reasonable habitat appears to be present, it is neither large in extent nor free of nearby disturbances; a general requirement for these species.

Riverine Birds and Bats

Based on results from radar and stand-watch surveys in May 2015, bird diversity and abundance were greater at the Project’s proposed bridge crossing (LAA) relative to the Port Mann Bridge reference site (**Table 4.8-9**).

Table 4.8-9 Bird diversity and abundance day (stand-watch) and night (radar) in the new bridge crossing portion of the LAA and the Port Mann reference site

| Site | Day/night | Diversity and Abundance |
|----------------|-----------|---|
| LAA | Day | 58 species, 1,598 flocks, and approximately 7,736 individuals recorded. |
| | Night | 3,925 on horizontal radar and 4,792 on vertical radar. |
| Reference site | Day | 43 species, 748 flocks, and approximately 3,267 individuals recorded. |
| | Night | 2,297 on horizontal radar and 1,808 on vertical radar. |

At the new bridge crossing site in the LAA, more nighttime-active birds were observed on vertical radar flying at elevations that could intersect with the proposed bridge structure (60 - 220 m) than those above or below and therefore not intersecting (**Figure 4.8-2**). However, swallows (violet-green, barn, and tree swallow), and pigeons (in “other”) comprised the majority (>71%) of the intersecting birds, and these species are not considered at any collision risk because they use structures for nesting and roosting. At the Port Mann reference site there were very few birds in the interaction zone (45 - 160 m), most were above, some were below (**Figure 4.8-2**). This avoidance is likely a result of learned behavior and observation.

During the daytime, less than a third of flocks observed were flying in the interaction zone at the proposed new bridge crossing site in the LAA (**Table 4.8-10**). Many in the interaction zone were species not considered at risk of impact because they regularly use structures for nesting and roosting; pigeons, swallows and cormorants (part of the diving waterbirds group).

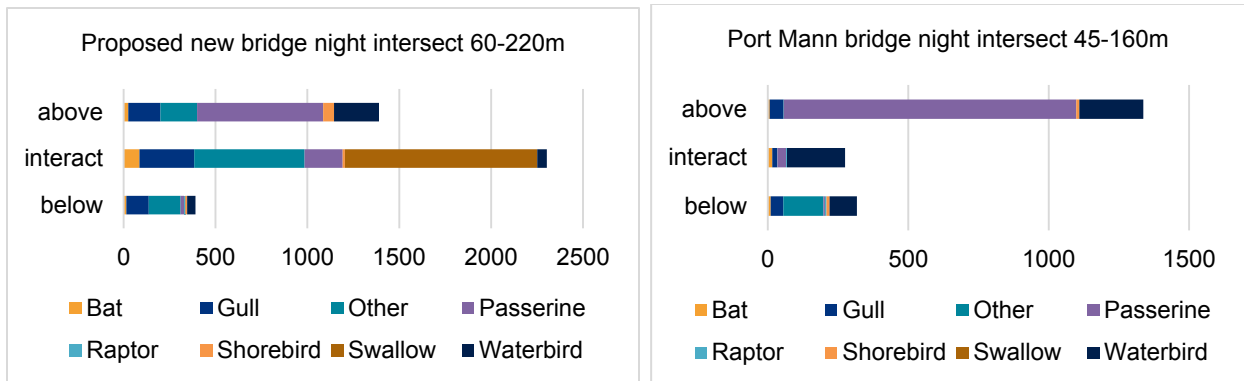


Figure 4.8-2 Nighttime bat and bird flight heights relative to proposed bridge infrastructure in the LAA and at existing infrastructure at the Port Mann reference site.

Table 4.8-10 Proportions of species group flocks in the potential interaction zone (height and trajectory) at the new bridge crossing in the LAA.

| Species Group | No. of flocks | % of flocks flying at 60-220 m |
|----------------------------|---------------|--------------------------------|
| Cranes | 2 | 100% |
| Crows, Jays, and Ravens | 67 | 46% |
| Dabbling Waterbirds | 35 | 64% |
| Diving Waterbirds | 13 | 18% |
| Geese | 6 | 30% |
| Gulls and Terns | 186 | 23% |
| Hérons and Bitterns | 10 | 29% |
| Kingfishers | | 0% |
| Pigeons and Doves | 22 | 51% |
| Raptors | 26 | 42% |
| Shorebirds | 9 | 43% |
| Songbirds and Hummingbirds | 10 | 27% |
| Swallows and Nighthawks | 15 | 31% |
| Swans | 0 | 0% |
| Woodpeckers | 0 | 0% |
| Total | 401 | 29% |

The behaviours of birds at the Port Mann reference site was noted during day and night surveys, however the daytime observations provided more reliable data. Most birds appeared to be aware of the bridge structure either flying above or below it, or exhibiting planned or gradual avoidance flight paths (**Figure 4.8-3**). Collisions were rare, and only a small number, under 10%, exhibited abrupt or delayed avoidance behaviours that suggested a lack of awareness of the structure.

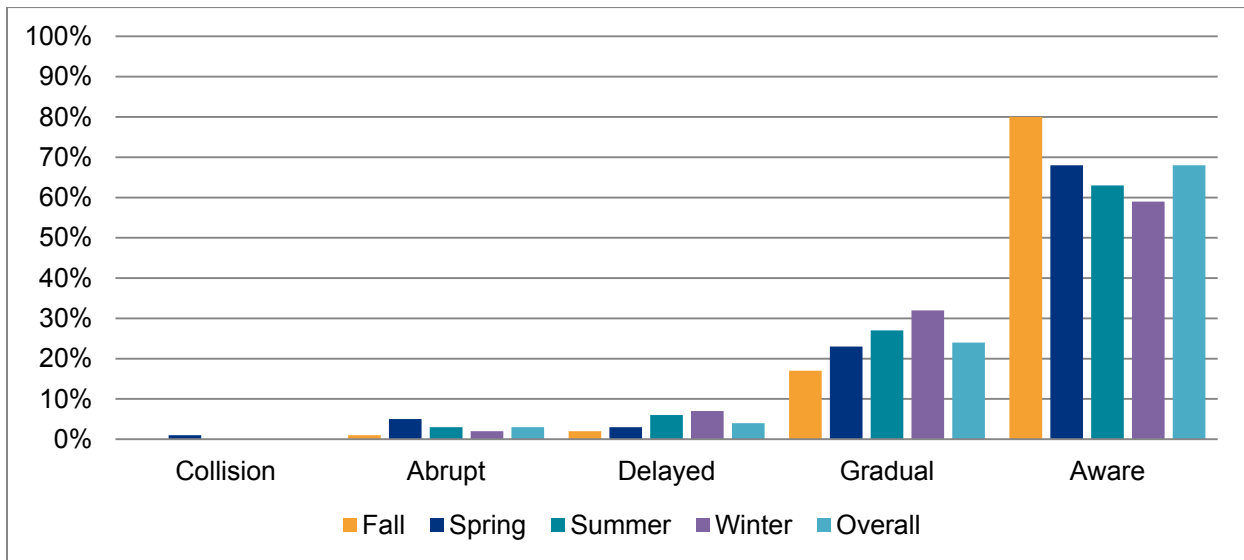


Figure 4.8-3 Seasonal avoidance behaviours exhibited by bird flocks (daytime) at the Port Mann reference site.

Seven at risk species were observed during the diurnal standwatch and nocturnal radar studies; great-blue heron, California gull (*Larus californicus*), Caspian tern (*Sterna caspia*), barn owl, barn swallow, double-crested cormorant (*Phalacrocorax auritus*) and common nighthawk. Aside from barn swallows which were often in flocks of multiple birds, most of the observations were individual birds. Except for barn swallow, most of the observations were above or below the interaction zone for existing or proposed new structures.

- Barn swallow; 30 flocks all at the Project site, multiple observations in the flocks (up to 25 individuals), just over half the individuals in the interaction zone for proposed structures.
- Barn owl; one individual at the project site and below the interaction zone of proposed structures.
- California gull; 13 flocks, all single bird observations except a flock of 14, half at the reference site, half at the new bridge crossing site, only two individuals in the interaction zone of the current structures.

- Caspian tern, eight flocks, mostly single bird observations, half at the reference site, half at the project site, mostly below the interaction zone for current or proposed structures.
- Great-blue heron; 92 flocks, mostly single bird observations, half at the reference site, half at the project site, ~70% below the current or proposed structures.
- Common nighthawk; one individual at the project site and below the interaction zone of proposed structures.
- Double crested cormorant; 56 flocks, all in the day, and most (80%) outside of the interaction zone.

Spring and fall acoustic and radar sampling surveys (four nights and four morning surveys) confirmed bat presence around the proposed location of the new bridge. The evidence collected also indicated an absence of uncommon species, and suggested that interactions with the new bridge were likely to be minimal. The most common species present were Yuma and California myotis (*Myotis yumanensis* and *Myotis californicus* respectively). They were observed at, below, and above the proposed new bridge. Many of the below-bridge observations were at the river surface and difficult to detect on radar due to reflection. Bat activity at the surface of the Fraser River is likely more common than those at altitude, as evidenced by the ultrasonic call detection data and the common feeding practices of these species – both are over-water feeders predominantly focussed on caddisflies and mayflies. There is a Yuma myotis, and possibly little brown and California bat, maternity colony approximately 1 km from the Project alignment in Deas Island Regional Park. The large distance between the colony and the Project footprint, and the small potential for interaction in time indicates little potential for interaction with the colony. Bats are summer only and nighttime active. Because nighttime work will occur in areas of Deas Slough that are already well lit and noisy, characteristics that indicate low bat use (Fensome and Matthews 2016), no interactions are predicted.

Mammals

Small Mammals

Although approximately 83% of the LAA was mapped as sparsely or non-vegetated, and human-disturbed, these types of habitat (i.e., agricultural fields, roadside verges, hedgerows) support an assemblage of small mammals, including Townsend's vole, long-tailed vole (*Microtus longicaudus*), creeping vole (*M. oregoni*), deer mouse (*Peromyscus maniculatus*), and shrews such as common (*Sorex cinereus*), dusky (*S. monticolus*), and vagrant (*S. vagrans*) (B.C. CDC 2015a). Of these, Townsend's vole is the most abundant found in the old field, pasture, and grassy verge habitats common in the LAA (Hindmarch et al. 2012). This species is considered to be the highest value to the raptors, herons, and owls that forage in the area.

Based on habitat suitability modelling conducted for the Project, high and moderate suitability habitat for Trowbridge's shrew were four and six per cent, respectively (**Appendix B, Figures 6b to 6q**). Approximately nine per cent of the habitat in the LAA is rated as moderate suitability for Pacific water shrew; less than one per cent is high-rated habitat (**Appendix B, Figures 7b to 7q**). For southern red-backed vole (**Appendix B, Figures 8b to 8q**) and Olympic shrew (**Appendix B, Figures 9b to 9q**), 13 and nine per cent of the LAA for each species, respectively, is rated as usable habitat. Townsend's vole modelling is presented in the barn owl habitat section (above).

The most suitable Pacific water shrew habitats in the LAA are located in Richmond Nature Park, immediately south of the Vancouver Landfill, and north of Highway 99 between Highway 91 and the Delta Golf Club (**Appendix B, Figures 7b to 7q**). However, Pacific water shrew DNA was not detected at any of the surveyed locations, suggesting no occurrence of Pacific water shrew in these aquatic features at the time of the surveys or for up to three months previously. The lack of positive detections in this study prevented the calculation of detection probabilities using water chemistry data. There is no evidence that false positives were generated in the control samples, indicating that the procedures were effective at eliminating potential sources of contamination during collection, filtration and extraction methods.

River Otter

Meander transects were completed on April 12 (by boat) and April 13, 2016 (on foot). During 22.2 km of boat transects, river otter was observed three times in the same general location (2.1 and 0.8 km upstream of the proposed bridge location and 0.4 km downstream of the proposed bridge location). Land-based transects covered 9.1 km of riparian shoreline. During these two surveys, two latrine sites were noted within the Project alignment. One latrine was located in Green Slough, near the River Road off-ramp on the west side of Highway 99 within the proposed Project alignment. Evidence of use by river otter at this site appeared minimal; a beaver was also observed using this site. The second latrine was located on Fraser River rip-rap, adjacent to the north Tunnel portal (near the end of Rice Mill Road), on the east side of Highway 99. Sign of extensive use (feces) was noted at this latrine site.

In general, habitat in the survey area, characterized by gently sloping banks, grassy beaches and minimal security, is considered to be low-suitability river otter habitat. The areas where the two latrines were found contain a small amount of moderate-suitability habitat, characterized by steeper (or overhanging) banks, abundant coarse woody debris, and associated forested upland habitat.

4.8.2.4 Quality and Reliability of Data

Quality and reliability of the existing or baseline data and its applicability for the purpose used was rated as high, moderate, low, or nil, as defined below:

- High - data collected and analyzed using government-approved methods (e.g., RISC) and/or for the purpose of identifying or establishing trends in the VC under consideration. Includes modelling with field verification.
- Moderate - data collected and analyzed using established methods (e.g., biology best practices) and/or for the purpose of identifying or establishing trends in the VC under consideration. Includes two, four or six-scale modelling (RISC 1999a) without field verification.
- Low - data collected and analyzed using novel methods and/or for the purpose of identifying or establishing trends in species other than the VC but for which there are linkages or proxies that give predictive ability. Includes two-scale modelling.
- Nil - poor or unreliable data collection and analysis

The quality and reliability of the data collected and analysed for the wildlife VC are as follows:

- Upland birds:
 - Barn owl – Moderate. Four-scale modelling with no field verification (to avoid capture myopathy). Collision mortality based on Canada-wide and BC-specific rates that have error associated with searcher efficiency and scavenger effects.
 - Raptors – High. Government approved RISC methods used.
 - Great blue heron – High. Government approved RISC methods used.
 - Songbirds – High. Government approved RISC methods used. Note traffic noise affected detectability.
 - Swallows – Moderate. Established method for barn and cliff swallow nest counts as per RISC standard no. 16, modified for site and study-specific needs. Only high-potential sites were surveyed.
- Riverine birds and bats:
 - Marsh birds – High. Government approved RISC methods used.
 - Riverine birds and bats – High for daytime stand-watches, which is an Environment Canada approved collision-risk survey technique. Moderate for nighttime radar studies, which is a modified government approved survey technique for seabirds and collision-risk estimates. High for ultrasonic acoustic bat surveys, which used standard survey techniques.

- Small mammals:
 - Olympic shrew and southern red-backed vole, occidentalis subspecies – Low. Government-approved modelling techniques used although limited data available.
 - Pacific water shrew and Trowbridge’s shrew - Moderate. Government-approved modelling techniques used with moderate data availability.
 - River otter – High. Survey methods were developed in consultation with two published senior river otter biologists and field personnel included staff with previous river otter latrine survey experience.

4.8.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with terrestrial wildlife, and potential effects of such interactions on upland birds, riverine birds and bats, and mammals. Concerns raised by Aboriginal Groups to the Ministry during consultation on the Project are addressed in this section, including concerns regarding availability of resources (see also **Section 10.1.3 Aboriginal Interests Assessment**). Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.8.4 Mitigation Measures**. Potential residual effects (i.e., effects remaining following the implementation of mitigation) are described in **Section 4.8.5 Residual Effects and their Significance**. A discussion of potential cumulative effects on wildlife is presented in **Section 4.8.6 Cumulative Effects and their Significance**.

4.8.3.1 Project Interactions

An overview of potential interactions between Project activities and terrestrial wildlife during the construction and operation of Project components is provided in **Appendix A**. An evaluation of the potential effects of Project interactions on terrestrial wildlife, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: Potential effects on terrestrial wildlife during Project construction (including pre-construction and site preparation) were of three types: habitat loss, habitat alteration (sensory disturbance and water quality), and direct mortality.

Loss of terrestrial wildlife habitat may occur as a result of clearing and grubbing for permanent and temporary Project-related infrastructure associated with highway widening and interchange upgrades, and installation of new bridge piers.

Habitat alteration may result from Project-related construction activity that elevates ambient noise levels (e.g., pile driving, ground improvements, demolition of existing infrastructure, construction of new infrastructure), or creates visual and olfactory stimuli (e.g., due to presence and movement of construction personnel, movement of machinery and equipment). These changes may result in sensory disturbance to terrestrial wildlife, creating sub-optimal habitat, or leading to temporary or permanent habitat abandonment.

Direct mortality of terrestrial wildlife might occur during vegetation clearing and grubbing, stripping, and soil excavation along Highway 99, as well as during decommissioning of the Deas Slough Bridge, and may result from:

- Destruction or failure of an active bird nest.
- Mortality of small mammals that inhabit woody debris, litter, and soil.

Operation: Potential effects on terrestrial wildlife during Project operation include traffic use of the reconfigured Highway 99 and associated interchanges, operation of the new bridge, and periodic maintenance of infrastructure leading to:

- Mortality of upland birds due to destruction of active nests during maintenance.
- Mortality of terrestrial wildlife as a result of collision with vehicles.
- Mortality of upland birds and riverine birds and bats as a result of collision with the new bridge.
- Habitat alteration – sensory disturbance due to changes in the light and noise environment associated with incremental traffic growth, new bridge operation, and water quality changes associated with ditch and watercourse alterations.

4.8.3.2 Potential Effects

Habitat Loss

Construction Phase

The area that will be occupied by Project components is small, and the available habitat for wildlife is dominated by highway road verges with generally low diversity and abundance. During field studies completed for the Project, 39 species of songbirds were recorded within the LAA. Diversity and abundance (abundance data not presented but available on request) of songbirds was noted to be low when compared to results of surveys associated with other recent Lower Mainland highway projects (e.g., Highway 17, where 62 species were detected). At some survey stations, less than 10 individual birds from only three species were recorded during point counts where upwards of 30 individuals from one species were recorded from point

count stations during Highway 17 follow-up monitoring (BC MOTI 2016). All species observed in the footprint of the Project were birds common in developed locations in the Lower Mainland. For most of the upland birds, riparian birds and bats, and mammals present, the reduction in habitat as a result of the Project is considered to be negligible. The habitat that could potentially be lost is sub-optimal and contains no unique elements required for populations, and other similar habitat is present nearby. For species using ditches (e.g., great-blue heron) the relocation of ditches is self-compensating, and habitat loss will be minimal. For the species present, the remaining habitat is considered sufficient to maintain populations. The rationale for this conclusion is summarized in **Table 4.8-11**.

Habitat loss effects on species groups assessed as negligible will not be considered further, except loss of nest sites for barn swallows (**Table 4.8-11**). During 2015 surveys conducted for the Project, barn swallow nests were detected under the Deas Slough Bridge. Decommissioning of the bridge will remove this habitat; however this will be done appropriately to avoid mortality if swallows are nesting during bridge removal. For these colonial, structure-nesting species, re-establishment of nesting at an alternate site is possible, if it is nearby and similar.

The Project is anticipated to result in a 0.75 ha reduction in highway verge and interchange interstitial habitat. This habitat is considered sub-optimal for foraging raptors, especially barn owl. These areas contribute to their risk of collision with vehicles and consequent population declines (traffic mortality). The infrequently disturbed grass with Townsend's vole and other small mammals attracts barn owl and other raptors (especially red-tailed hawk). Red-tailed hawk and other diurnal raptors generally appear to notice and avoid vehicles; however, barn owl behaviours frequently bring them into contact with vehicles while foraging in these areas. Highway widening and interchange development proposed as part of the Project will reduce the size of such risky, sub-optimal habitat characterized by areas that are attractive for foraging but prone to vehicle-related mortality (Hindmarch et al. 2012). Therefore, the anticipated reduction of this foraging habitat, where collision risk is high, is expected to result in a reduction in barn owl mortality.

Table 4.8-11 Rationale for characterization of habitat loss to terrestrial wildlife

| Species Group | Rationale | Nature of Effect |
|-------------------------|---|--|
| Barn owl | Reduction in sub-optimal habitat that enhances collision risk may reduce mortality. | Neutral |
| Raptors | Habitat loss is minor in the context of similar areas being available and its sub-optimal character. | Negligible |
| Great blue heron | Ditch relocation in advance of construction is included in Project design, and is self-compensating for habitat loss. | Negligible |
| Songbirds | Low diversity, sub-optimal habitat, low abundance. | Negligible |
| Swallows | No change to foraging habitat; potential loss of overall nesting habitat as a result of Deas Slough Bridge decommissioning. | Potential effect (carried forward in the assessment) |
| Marsh birds | None observed, and small habitat losses in Green Slough only, < 1 ha in total (5,707 m ² of instream and 1,654 m ² of riparian habitat). | Negligible |
| Riverine birds and bats | Habitat loss is minor in the context of similar areas being available and its sub-optimal character. | Negligible |
| Small mammals | Little high-rated habitat in the LAA for southern red-backed vole, <i>occidentalis</i> subspecies, Olympic shrew, Pacific water shrew and Trowbridge's shrew; areas where there is potential for loss of habitat is small. The proposed Project components overlap with 10% and 6% of habitat rated as Useable for southern red-backed vole, <i>occidentalis</i> subspecies, and Olympic shrew, respectively. There is 3% overlap with habitat rated as High for Trowbridge's shrew and no overlap with habitat rated as High for Pacific water shrew. | Negligible |
| River otter | River otter latrine sites near proposed bridge pier locations are not located in areas with unique habitat features, and river otter are not habitat-limited in the LAA. There is potential for temporary habitat loss at these precise locations, but the two latrine sites are likely to be reoccupied once construction is complete and habitat features are reestablished. | Negligible |

There is a 17.3 ha overlap between proposed Project components and ESA identified by the Corporation of Delta and City of Richmond. This overlap, most of which is in Richmond, is primarily within the Ministry's right-of-way that has been identified as ESA, and the rest, within private land. In Delta, a total of 0.28 ha overlap, on nine separate ESA, was identified. This is expected to be the result of minor overlaps and mapping anomalies between the boundaries of ESA and the adjacent Highway 99 right-of-way. Similarly, the overlaps for Metro Vancouver parks (Deas Island Regional Park) are very small and are likely an artifact of mapping inaccuracies. The Project alignment does not overlap with Burns Bog, an ESA that is cooperatively managed by municipal, regional, provincial, and federal governments.

There are potential interactions with 17 ESA in the City of Richmond (17.0 ha). The City of Richmond has established a five-scale priority ranking for conservation of their ESA, and all of the affected ESA are ranked at the lower end of the range, e.g., "3" to "5." These lower rankings are consistent with field observations that generally found the affected ESA to be (i) small isolated / non-connected ESA sites, or (ii) highway right-of-way areas on the periphery of an ESA. Refinements to the project alignment through the course of project have reduced the effects on ESA by approximately 50% (was 30.3 ha).

Operation Phase

Habitat losses during Project operation from maintenance activities have the potential for very minor effects to upland birds and mammals; this includes ditch clearing, bridge and structure cleaning and repair activities affecting foraging mammals, nesting songbirds, and raptors. The activities that lead to these effects will be similar in the future as they are currently, and as a result no additional effects are expected provided that the current standards and level of mitigation for maintenance activities is continued.

Once the Project becomes operational, bats will continue to find habitat available in the LAA, with only a very small portion (the portion close to the bridge deck lit by vehicles) of the airspace they currently use for foraging being unavailable. Bat foraging habitat will remain available above, below (especially at the Fraser River interface which has the highest recorded use currently), and adjacent to the new bridge. Other portions of the LAA will see no change in bat foraging activity when the Project is in operations as it is not appreciably different in nighttime noise and activity levels to that currently experienced. Further, no suitable roosting habitat (i.e., trees) adjacent to the Project alignment is affected by the Project.

Habitat Alteration (Sensory Disturbance and Water Quality)

Construction Phase

Construction noise might affect wildlife using the Project alignment by forcing abandonment of currently used habitat (Dooling and Popper 2007, Barber et al. 2010, Siemers and Schaub 2011). The level of effect depends on the extent and duration of from those activities over the current baseline, which is dominated by a busy and noisy highway. The predicted noise and visual disturbances during construction are considered to be only slightly greater than the current baseline of activity in the LAA, which is dominated by three high-volume highways; Highways 99, 17A, and 17 (**Section 4.10 Atmospheric Noise**). Sensory disturbance during Project construction will also be temporary, and intermittent over the five year construction period, with the greatest noise experienced in the first year when clearing, grubbing, and ground preparation is conducted.

The species that occur in and around the Project alignment are generally common, and are habituated to human activities that occur in such developed areas. The existing level of sensory disturbance on wildlife along the Project alignment is very high, and the species present are acclimated to noise and light disturbance associated with an active transportation corridor and agricultural production. A temporary increase in ambient noise levels due to construction activities is unlikely to alter the ability of species currently present to use the area permanently. Temporary abandonment around construction sites will occur (i.e., raptors and great blue heron within 100 m of construction sites), but re-establishment after construction is complete is anticipated. Beyond 100 m, given current human activity (noise and movement) the abandonment of habitat by wildlife is unlikely.

The potential for Project construction-related changes in water quality (and quantity) to affect wildlife is extensively addressed in relation to amphibian effects (**Section 4.5 At-Risk Amphibian Assessment**). The mitigation proposed for amphibians will also address potential Project-related effects for upland and riparian birds and mammals, and no additional effects, or mitigation is considered necessary to address terrestrial or semi-aquatic wildlife. As such, water quality effects on terrestrial and semi-aquatic wildlife will not be considered further.

Operation Phase

The additional light and noise sensory disturbance effects on wildlife over and above that from the existing Highway 99 in the LAA is considered to be negligible, and will not be considered further except in relation to bird impacts with the new bridge. Vehicle activity, noise, and lighting from highway operations have the potential to cause abandonment of otherwise useable wildlife

habitat. However, existing operation of Highway 99 has created a baseline level of effects such that Project-related increases in traffic are not expected to result in substantial changes in disturbance to wildlife.

Noise levels in the LAA are dominated by traffic noise and are currently high (**Section 4.10 Atmospheric Noise**). The species that use the LAA have adapted to such conditions. Songbirds, a wildlife group that relies on auditory signals for communications, are depressed in distribution and abundance in the LAA over what might be expected, likely due to the current noise levels. Point count observations in the LAA found limited numbers of only common species (**Table 4.8-8**). Peak noise levels up to 90 dB were recorded during surveys, which is considered high in relation to the needs of bird communication (threshold value of 45 dB; Reijnen and Foppen 2006, Dooling and Popper 2007, Barber et al. 2010). For highways that introduce new noise, there is potential for effects, however, in an environment with existing noise levels between 51.5 and 75.0 dBA, and with maximum predicted increases of 2.2 dBA (**Section 4.10 Atmospheric Noise**), effects are considered negligible. Future increases in road traffic will increase noise with or without the Project. The difference between the maximum increases with the Project (2.2 dBA) and without the Project (1.8 dBA) is small, and is further evidence that potential Project-related changes in sensory disturbance to terrestrial wildlife are negligible.

Sensory disturbance to terrestrial and semi-aquatic wildlife as a result of Project-related changes to the light environment is considered negligible. Light from vehicles is considered a small incremental increase because the current traffic volumes are high, and after completion of the Project the increase will be unnoticeable as it relates to sensory disturbances. Interchange lighting will be similar to that of the existing highway in the LAA (**Section 1.1 Description of Proposed Project**), and no changes to wildlife effects are expected. New Project lighting design will include standard practices (e.g., shielding interchange and bridge pier lighting to reduce light trespass or glare onto adjacent areas) that will minimize sensory disturbance to terrestrial wildlife, and avoid changes at the currently lit areas of Highway 99 (B.C. MOTI 2013). Accordingly potential sensory disturbance from changes to the ambient light environment will not be considered further.

Potential attraction of avian wildlife to the new bridge that could lead to mortality as a result of Project-related changes in the light environment is addressed below under Wildlife Mortality.

Wildlife Mortality

Construction Phase

Wildlife present in the Project alignment are mostly highly motile, and therefore considered less at risk from mortality during site preparation activities (e.g., vegetation clearing and grubbing, Deas Slough Bridge decommissioning).

Upland and riparian bird populations in the affected footprint are not unique and many similar habitats for foraging and nesting occur nearby. These species will vacate the affected areas during construction, and will likely re-occupy the new ditch areas once construction is complete and ditch vegetation has re-established. During nesting, riparian and upland birds have high fidelity to their nest sites, and are less mobile (Demarchi and Bentley 2005). As such, clearing and grubbing, and bridge removal at Deas Slough have the potential to affect bird nests and eggs. During 2015 field surveys conducted for the Project, barn swallow nests were detected on the Deas Slough Bridge. Implementation of mitigation measures (e.g., bridge removal outside of the breeding season, placement of exclusion netting) during bridge removal will prevent mortality of nesting swallows, if present. Also, mitigation to prevent construction-related effects on nesting raptors will minimize effects on a red tailed hawk nest at Green Slough, and others that occur within or close to prescribed protection buffers (Demarchi and Bentley 2005).

Small mammal populations within areas that overlap with Project components are not considered to be unique, and no at-risk species were found to be present. Because Project construction associated with highway widening and interchange upgrades in and around upland ditches will be undertaken in accordance with the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012), the impacts on small mammal populations are considered to be negligible. In this respect the mitigation for reducing potential effects on amphibians (**Section 4.5 At-Risk Amphibians Assessment**) is considered to also reduce the effects on mammals. Potential construction-related mortality effects on mammals will not be considered further.

Operation Phase

During operation of the Project, wildlife has the potential to be impacted by vehicle collisions, and by colliding with the bridge while in transit to other locations. Across Canada, approximately 35 birds per kilometre of road are killed during the breeding and fledging season through vehicle collisions; mostly these are perching songbirds and owls (Bishop and Brogan 2013).

For upland birds, changes to Highway 99 are not expected to markedly alter the level of effects over those currently seen. Traffic volumes are currently high, and after completion of the Project will continue to be high. Given the current traffic volumes, incremental future Project-related collision mortality increases are considered negligible over the current baseline. Collision mortality effects are not considered further, with the exception of the at-risk upland bird species addressed below.

Bats use sight and acoustic senses to find prey, and avoid collisions. Most species avoid lit areas, and in unlit areas their senses are sufficient to avoid collisions with stationary objects. Collision mortality effects are not expected to increase during the operational phase of the Project and are not considered further. The at-risk listed great blue heron commonly forages in ditches in the Project alignment. The current level of effects on this species is not fully known, but their behaviours in the Project alignment (i.e., walking or wading in ditches in pursuit of prey, rarely flying unless forced to do so by disturbances) suggest that effects are uncommon. Traffic-related effects are not listed as impacting this species (Vennesland 2004). Great blue heron collision effects are considered negligible currently, and in the future are likely to be similar given the modest difference between the increases in traffic volumes with and without the Project along the corridor. Collision-related mortality effects on great blue heron are not considered further.

Barn owl are known to be affected by road collision mortality (Ramsden 2003, Marti et al. 2005, Preston and Powers 2006, Boves and Belthoff 2012). These mortalities are a result of collisions during forced (no other habitat available) or voluntary use of highway verges where their primary prey, voles, is found in high densities (Taylor 1994, Hindmarch et al. 2012), or from crossing roads between suitable habitat. Relevant mitigation was included in the design for the nearby Highway 17 to minimize effects on barn owl (B.C. MOTI 2006).

For birds travelling along the Fraser River, replacement of the Tunnel with a bridge will result in a new obstruction, and potentially increased collision risk. Collision with such structures often occur in association with smaller, less-visible components (e.g., cables), and during periods of low light/visibility (e.g., dawn, dusk, night, fog). Injuries and mortalities from transmission wires and other obstructions are well documented, and tend to be focused in the following species groups: wading birds, waterfowl, gulls, shorebirds, cranes, terns, corvids and raptors (Savereno et al. 1996, Janss 2000, Manning Cooper 2004, EDM 2008).

Many of these groups are present at the proposed new bridge crossing location, and many are currently flying at elevations that could place them at some risk. Most (>71%) of the birds that are currently flying at elevations that place them at risk are from species groups that are known

to have combinations of characteristics such as awareness of structures, faster reactions and greater maneuverability such that they avoid collisions more than others. This includes species groups with good flying abilities and known use of such structures for roosting and nesting such as pigeons, swallows and cormorants. Collision effects to these groups are considered unlikely. For the others, behavioral observations at the Port Mann bridge reference site show that most birds avoid collisions by flying above or below structures (**Figure 4.8-3**), likely as part of planned avoidance. A similar outcome is expected to be shown by Fraser River birds in the LAA. Structure lighting required for safety, with controllable LED and shielding or directionality such that the bridge deck is lit, and flashing navigation safety lighting on the top of the towers will be included in the design of the new bridge. Appropriate mitigation measures to minimize the attraction of birds, including provision of minimum necessary lighting and flashing navigation safety lighting (Gaston et.al. 2012, Gehring et.al. 2009), will be considered in the design of the new bridge.

4.8.4 Mitigation Measures

Selection of mitigation measures was informed by standard industry and best management practices (BMP); mitigation measures and follow up programs undertaken for past developments by the Ministry of Transportation and Infrastructure; input from regulators, public and Aboriginal Groups; and evaluation of technical and economic feasibility of mitigation. Standard industry practices proposed to avoid or reduce adverse effects on terrestrial wildlife were based on a review of the following key sources:

- *2012 Standard Specifications for Highway Construction* (B.C. MOTI 2012).
- *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010).
- *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (B.C. MOE 2014a).
- *Best Management Practices for Raptor Conservation during Urban and Rural Land Development in British Columbia* (Demarchi and Bentley 2005).
- *Best Management Practices Guidelines for Pacific Water Shrew in Urban and Rural Areas* (Craig et al. 2010).
- *Best Management Practices for Priority Species at Risk in the South Coast Region of British Columbia* (B.C. MOE 2009).
- *Riparian Restoration Guidelines* (B.C. MOE 2008).
- *Tree Replacement Criteria* (B.C. MELP 1996).
- *Recovery Plan for the Barn Owl (Tyto alba) in British Columbia* (B.C. MOE 2014b).
- *National Guide to Erosion and Sediment Control on Roadway Projects. Transportation Association of Canada* (TAC 2005).

A hierarchical approach based on the four types of mitigation as outlined below was used in identifying strategies to avoid or minimize potential Project-related effects. Avoidance mitigation is highly effective, and the mitigation gets less and less effective moving down the hierarchy.

- **Avoidance:** Measures to avoid potential effects on the VC have been/will be incorporated into project considerations such as site and route selection, project scheduling, project design, and construction and operation procedures and practices.
- **Minimization:** Where potential effects on the VC cannot be avoided through project considerations, standard mitigation measures, BMPs, and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels.
- **Restoration or Habitat Enhancement:** Where potential Project-related effects cannot be avoided or minimized through standard mitigation measures, best practices, or implementation of EMPs, affected components will be restored on-site to pre-Project conditions.
- **Compensation/offset:** Where on-site restoration is not feasible, appropriate means to counteract, or make up for potential Project-related effects on the VC will be identified.

4.8.4.1 Avoidance

Highway 99 improvements are proposed to occur within the existing Highway 99 right of way, in large part avoiding effects on previously undeveloped areas. Ongoing refinement of the Project alignment has resulted in approximately 50 % reduction in effects on municipal ESA, including the high-value hub habitat identified by the City of Richmond. Utilizing some of the sub-optimal barn owl foraging habitat in the existing Highway 99 right-of-way to accommodate Project components will avoid to some degree, the collision effects on barn owl that are currently attracted to these areas.

4.8.4.2 Minimization

Project Design

The Project design will incorporate standard practices for lighting systems for highways and roadways under the jurisdiction of the Ministry (B.C. MOTI 2013). The lighting design will address safety requirements while including standard practices (e.g., shielding interchange and bridge lighting to reduce light trespass or glare onto adjacent areas) to minimize sensory disturbance to terrestrial wildlife from changes in the ambient light environment the bridge, and the currently lit areas of Highway 99 (B.C. MOTI 2013).

Where avoidance is not possible, the effects on terrestrial wildlife habitat from clearing and grubbing of vegetation will generally be minimized and restricted to the minimum necessary.

Highway width will be in accordance with applicable geometric standards, and the right-of-way will be minimally vegetated. Minimally-vegetated road shoulders and adjacent slopes limit the extent of infrequently-disturbed grass habitat that is suitable for barn owl prey resources (i.e., small mammals including Townsend's vole), reducing the attractiveness of the Project alignment for barn owl hunting and therefore lowering the collision risk. A similar approach is being used on Highway 17.

Best Management Practices and Environmental Management

Environmental protection measures that will be implemented during Project construction and operation to avoid or minimize potential effects on vegetation will be outlined in a Construction Environmental Management Plan (CEMP), and subsequently in an Operation Environmental Management Plan (OEMP), see **Section 12.0 Management Plans**. The CEMP will include vegetation and wildlife management, and invasive species management approaches. The plans will describe standard best practices and Project-specific mitigation measures to prevent or minimize potential adverse effects on wildlife that might otherwise result from the Project during construction. Key elements of these plans are discussed below. Many of these measures are required by legislation, government directive or are industry standards (see **Section 4.8.4**). Through their application on many Lower Mainland projects they are considered to be highly effective in managing effects.

Terrestrial Vegetation and Wildlife Management

Terrestrial vegetation and terrestrial and semi-aquatic wildlife management will include measures, such as avoidance (spatial and temporal), and minimization strategies to mitigate potential adverse effects to terrestrial wildlife and semi-aquatic wildlife, including pre-construction requirements such as nest survey protocols, otter latrine and den surveys, timing window restrictions, buffer zones, and wildlife salvage procedures that may be required. Offsetting measures, if warranted, will also be described. Most of these measures are required by legislation, government directive or are industry standards and are therefore are considered to be highly effective in managing effects.

Scheduling Activities to Avoid or Minimize Effects

To the extent feasible, Project construction activities will be planned to coincide with least-risk timing windows for wildlife; a technique recognised to be highly effective in managing effects. Management approaches will define timing windows during which there is potential for adverse

effects on terrestrial and semi-aquatic wildlife, and recommend low risk scheduling for construction and operation activities. In the event that least risk windows cannot be adhered to, mitigation to minimize the effects will be described. The CEMP will be developed in parallel with finalizing Project design and construction methods.

For example, site clearing and grubbing is expected to be conducted outside of the bird breeding season, approximately March 15 or earlier (February 1) for raptors, until July 31, in accordance with *Wildlife Act* and MBCA requirements. Avoiding bird breeding season is preferred to surveying to establish nest absence prior to within-season site clearing.

If the removal of Deas Slough Bridge cannot be scheduled to avoid the active nesting season for swallows (i.e., April 1 to July 31), then the underside of the bridge structure will be netted-in prior to the breeding season and prior to bridge decommissioning to exclude nesting swallows.

Pre-Construction Surveys

Where clearing and grubbing must proceed during the bird breeding season, nest surveys will be conducted prior to the start of such works to confirm the presence/not detected status of breeding birds, and location of nesting sites. Construction can proceed if identified nests are unoccupied and are not of a species protected year-round by the *Wildlife Act*.

Details of the timing and extent of pre-clearing surveys will be outlined in the CEMP for the Project, and will address the likely dates of clearing, known nest sites, early-breeding raptors and later-breeding songbirds, and federal and provincial guidance (Demarchi and Bentley 2005). Follow-up actions in the event of occupied nests being identified include monitoring responses to construction activity, gradual starts to habituate birds to activity, or temporary cessation of activity until the nest is inactive. These approaches follow industry best management practices and, depending on the species / species group are moderately to highly effective in managing effects.

Wildlife Salvage and Translocation

Prior to clearing and grubbing, wildlife salvage may be undertaken if there are locations of known small mammal occurrences. Salvages will be conducted in an enclosed area to prevent trapped species from returning to the area once removed. Salvage trapping and removal will be undertaken in accordance with *Wildlife Act* permits. These approaches follow industry best management practices and, depending on the species / species group are moderately to highly effective in managing effects.

Flagging and Management of Sensitive Wildlife Sites

Sites important to wildlife species, including raptor nest trees and river otter maternity den locations, will be flagged in the field and marked on Project plans to provide a visual barrier to contractors indicating that such areas need special provisions (as specified in Environmental Protection Plans for the site) during construction. This is a highly effective mitigation technique.

Around active raptor nests and occupied otter maternity dens, buffers will be delineated, and activities will be restricted outside these buffers if Project construction is to proceed during the raptor or otter breeding season (i.e., the period when female otters are using maternity dens for rearing). The size of buffers will be determined in consultation with MFLNRO, generally taking into account the time of year, species, type of construction activity, and proximity of construction to the nest or den site.

Wetland areas (e.g., Green Slough) will also be demarcated (see **Section 4.5 At-Risk Amphibian Assessment** and **Section 4.7 Vegetation Assessment**).

4.8.4.3 Habitat Enhancement

Increased traffic volume (see **Section 5.1 Traffic**) is anticipated to result in a very small increased collision risk for barn owl within the Project alignment. Experience in addressing such risk, during the development of Highway 17, has demonstrated that hedgerows and fences erected to force over-flights by barn owl at elevations greater than the heights of vehicles, have been effective in reducing such mortality risk. The effectiveness of such mitigation is supported by academic studies (Massemin and Zorn 1998, Pons 2000). Hedgerows and fences will be erected in high-risk areas to reduce the increased collision risk for barn owl within the Project alignment. Full effectiveness requires that hedgerows are approximately 2-3 m, which may require up to ten years to attain. Experience on Highway 17 shows that planting in advance of construction reduces the time to achieve effective height.

4.8.4.4 Habitat Offsetting

Decommissioning and removal of the Deas Slough Bridge will remove a structure currently used for nesting by barn swallows. Suitable replacement structures for nesting will be provided in advance of Deas Slough bridge removal, with the construction of the new bridge, and within the access route for maintenance of the new piers. Consultation with biologists during the design of the new bridge will ensure that suitable bridge features close to water (Green Slough and Deas Slough) are included and will offset effects from the decommissioning of the Deas Slough Bridge. This mitigation is considered effective, as evidenced by high-use of Highway 17 structures by barn swallows (>15 nests on the new Burlington Northern Santa Fe Railway overpass for Highway 17 in June 2015).

Construction activities associated with bridge pier footings at the north Tunnel portal and along Green Slough will not directly affect the two documented extant river otter latrine sites within the Project alignment. Indirect effects during the construction period (temporary abandonment of the sites) is expected, with re-use of these sites or a shift to other suitable nearby areas (of which there is evidence of many) expected. Follow-up monitoring will be conducted to confirm this prediction.

4.8.5 Residual Effects and their Significance

4.8.5.1 Characterization of Residual Effects

Residual effects are those adverse effects that remain following implementation of mitigation measures. Potential residual effects on terrestrial wildlife are characterized by quantitatively or qualitatively assessing the direction, magnitude, extent, duration, frequency, and reversibility of the effects. Definitions for ratings applied to residual effects criteria, developed with specific reference to terrestrial wildlife have been developed (**Table 4.8-12**). The potential residual effects to terrestrial wildlife considered further in this assessment are:

- Habitat loss for barn swallows (upland birds) during Project construction only
- Direct mortality to barn owl (upland birds) during Project operation only

Table 4.8-12 Criteria used to characterize residual effects on terrestrial wildlife

| Characteristic and Description | | Rank and Description of Associated Effect | | | |
|--------------------------------|--|---|---|--|---|
| Direction | Whether an effect is positive, neutral, or negative (adverse) | Adverse | Positive | Neutral | |
| | | Negative effect as a result of the Project | Beneficial effect as a result of the Project | Neutral effect as a result of the Project | |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible Magnitude | Low Magnitude | Moderate Magnitude | High Magnitude |
| | | No measurable change in avian or small mammal relative abundance (mortality), habitat quantity or quality (i.e., area of habitat shifting from high- to low-quality | A measurable change relative to baseline conditions, but not affecting wildlife population viability (presence maintained, <10% reduction in high or medium quality habitat in LAA) | A measurable change relative to baseline conditions outside the range of natural variability, but not posing a risk to population viability (presence maintained, 10-15% reduction in high or medium habitat in LAA) | A measurable reduction in relative abundance outside the range of natural variability that may affect long-term population viability (extirpation, >15% reduction in high or medium habitat in LAA) |
| Extent | Geographic extent/distribution of the effect | Specific Extent | Local Extent | Regional Extent | |
| | | Effect is restricted to the immediate Project footprint | Effect is restricted to the LAA | Effect is restricted to the RAA | |
| Duration | Likely duration of the potential effect e.g., how long the stressor impacts the VC | Transient-term | Short-term | Medium-term | Long-term |
| | | Effect occurs once during construction or operation | Effect occurs throughout construction or operation | Effect to the indicator continues to the end of the operation phase | Effect to the indicator continues beyond the life of the Project |

| Characteristic and Description | | Rank and Description of Associated Effect | | | |
|--------------------------------|---|--|--|---|--|
| Frequency | Nature of the occurrence of the effect; e.g., how often the stressor impacts the VC | Rare | Uncommon | Frequent | Continuous |
| | | Effect occurs once during construction or operation | Effect occurs intermittently (once per month) during construction or operation | Effect occurs once per week during construction or operation | Effect occurs daily during construction or operation |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after removal (or after a period of time after removal) | Reversible | Irreversible | Change | |
| | | Baseline conditions will be naturally restored after disturbance has ceased, or offsetting can restore | Baseline conditions will not be naturally restored after disturbance has ceased, and cannot be restored artificially | Effect may fluctuate between positive and adverse for the duration of the Project | |

Residual Effect #1: Barn Swallow Habitat Loss

The removal of the Deas Slough Bridge will result in the loss of barn swallow nesting habitat, thus the effect is considered adverse in direction and specific in extent. In 2015, the Deas Slough Bridge hosted 13 barn swallow nests, of which, approximately a third (or five nests) appeared to be actively used. Between 9 and 16 barn swallows were frequently observed foraging around the Deas Slough Bridge in summer 2015. Barn swallows are closely associated with humans and human structures, and may be using other nearby locations such as boat houses at Captain's Cove Marina, barns on River Road, and under eaves on the River House development, where nesting was also observed. Mud, an essential habitat requirement for nest building, is abundantly available in the LAA, especially Deas and Green sloughs.

Habitat loss associated with the removal of Deas Slough Bridge is considered of moderate magnitude, as the bridge is one of the few barn swallow nesting locations available within the LAA. Because it is a developed corridor, the LAA provides very few opportunities for barn swallow nesting; however, a large number of other suitable nesting habitat, particularly barns, boathouses, and other buildings, are available just outside the LAA, which is expected to minimize the magnitude of habitat loss effects associated with decommissioning of the Deas Slough Bridge.

The loss of barn swallow nesting habitat is of temporary duration because the new bridge will be constructed and new nesting habitat will become available before the Deas Slough Bridge is removed. The new bridge, which will be built in the same location as the existing Deas Slough Bridge, may provide nesting opportunities on features appropriate for barn swallow nest establishment (e.g., vertical walls with ledges close to water and a source of mud). It is anticipated that Project-related construction will provide more area for potential nest establishment than is currently available. Therefore, the effect is considered reversible and may be avoided altogether if the new structures are used by barn swallows before the Deas Slough Bridge is removed. In the event that the new bridge does not provide such habitat, because it will be a greater height above the river than the Deas Slough Bridge, artificial structures can be constructed to supply the necessary habitat. A summary of the criteria ratings for possible barn swallow residual effects has been provided (**Table 4.8-13**).

Table 4.8-13 Criteria ratings for barn swallow habitat loss residual effect

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|--|
| Direction | Adverse | Removal of nesting habitat is a negative effect. |
| Magnitude | Moderate | Nesting habitat loss occurs naturally; restoration onsite, or other nesting locations nearby will maintain the population. |
| Extent | Specific | Effect to one small area of the Project alignment. |
| Duration | Transient-term | Habitat loss will likely be transient-term – replacement structures (e.g., new bridge) will be available in advance of the loss due to Deas Slough Bridge decommissioning. |
| Frequency | Rare | The effect occurs only once. |
| Reversibility | Reversible | Effects are reversible through establishment of replacement nesting habitat (the new bridge or an artificial structure). |

Residual Effect #2: Barn Owl Mortality

Highway 99 will continue to see traffic growth (**Section 5.1 Traffic**). While this may be considered to lead to additional barn owl mortality, such increases would be very small, and difficult to estimate given the existing levels of mortality. Vehicle collisions with barn owls on Highway 99 in the Highway 17 to 91 portion of the Project alignment are currently estimated at around twenty barn owls per year (actual numbers observed are lower). With or without the Project, higher traffic volumes are expected in the future. Current traffic volumes are already high and the increase with the Project (as compared to without the Project) is a negligible additional risk because the traffic volume increases are anticipated to occur during daytime hours, when barn owls are largely inactive (Taylor 1994). The incremental increase in collision risk for barn owl is not considered a risk to population survival for a number of reasons. The proposed mitigation (flight-height diverters) is considered to be effective in addressing the incremental mortality risk; it is being used successfully on the nearby Highway 17. This mitigation may also reduce the existing impact (**Section 4.8.4 Mitigation Measures**). Barn owl populations have relatively high breeding rates, and in the absence of high effects, can maintain population numbers.

Barn owl numbers appear to be relatively stable in the study area (Hemmera 2014), however mortality on existing highways and the loss of nesting structures as barns are demolished or replaced are drivers that place Lower Mainland barn owl populations at some risk. Barn owls are close to the northern edge of their range in southwest Delta, and the location is one of the highest concentrations for the species in Canada.

The magnitude of the residual effect is considered negligible, but of long-term duration, as it is expected to occur for the life of the Project. The residual effect is characterized as reversible because mitigation may serve to reduce the existing effects. Implementation of mitigation measures (e.g., flight-height diverters to minimize collision risk, habitat management in the right-of-way to minimize attractiveness of roadside verges for foraging owls) is expected to reduce the level of effect. A summary of the ratings for barn owl mortality has been provided in **Table 4.8-14**.

Table 4.8-14 Criteria ratings for barn owl mortality residual effect

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Potential additional mortality is a negative effect |
| Magnitude | Negligible | Potential additional mortality effects are difficult to quantify; but in an at-risk population, one incidence of mortality per annum could be considered a measureable change. In barn owl populations such as in the LAA which have relatively high breeding success, such mortality is not a risk to populations. |
| Extent | Specific | Effect limited to one portion of the Project alignment and LAA |
| Duration | Long-term | Additional mortality effects are for the life of the Project |
| Frequency | Uncommon | Mortality effects are likely intermittent (but difficult to quantify). |
| Reversibility | Reversible | While mortality effects are not reversible, populations can recover, or be maintained, under some mortality pressure. Mitigation may reduce current mortality observed in the LAA. |

4.8.5.2 Likelihood

The likelihood of a residual effect occurring is influenced by existing conditions, Project activities, potential effects, and the implementation of mitigation measures. Information on these factors is used to determine the likelihood of there being an adverse residual effect. The likelihood of a residual effect on terrestrial wildlife occurring is characterized as:

- Low – Chance of the residual effect to occur is less than 25%.
- Moderate – Chance of the residual effect to occur is between 25% and 75%.
- High – Chance of the residual effect to occur is greater than 75%.

Table 4.8-15 summarizes the likelihood ratings of a residual effect on terrestrial wildlife occurring and provides the rationale for the rating.

Table 4.8-15 Likelihood rating of a residual effect on terrestrial wildlife

| Residual Effect | Likelihood Rating | Rationale for Rating |
|---|-------------------|---|
| Barn swallow (upland bird) habitat loss | Low | Mitigation is considered effective and proven |
| Barn owl (upland bird) mortality | Low | Mitigation is considered effective and proven, and will address the small incremental change due to the Project |

4.8.5.3 Proponent’s Determination of Significance

Significance Definition

Species and species groups comprising upland bird, riverine bird, and small mammal (including river otter) subcomponents do not have legislated or regulated thresholds to define significance. Instead, VC-specific factors were used to define significance (B.C. EAO 2013). For each effect, habitat loss, habitat alteration, and mortality (**Table 4.8-2**) were used to measure the effects characteristics and establish significance. A significant effect is considered to be one that results in population(s) at individual sites not being self-sustaining after Project implementation.

Specifically:

- An effect is considered significant if it is characterized as adverse, of high magnitude, and not reversible, in addition to any of the following: frequent/continuous, medium/long-term, and regional extent.
- An effect is considered not significant if characterization does not meet the above criteria.

Significance Determination

This section presents the determination of significance of residual effects of the Project on terrestrial wildlife in terms of barn swallow habitat loss and barn owl mortality, considering the likelihood of a significant adverse effect (**Table 4.8-16**).

Barn Swallow Habitat Loss

The potential habitat loss effect on barn swallow is adverse. The magnitude of the effect is moderate, because the Deas Slough Bridge represents one of the few areas within the LAA that suitable for barn swallow breeding. However, the effect is reversible as the new bridge and approaches will provide alternative habitat. The new structures are anticipated to provide more area suitable for establishment of nests than is lost with the removal of the Deas Slough Bridge, and that habitat will be available for establishment of nests before the loss occurs. In this context, this residual effect is considered not significant.

Barn Owl Mortality

The incremental change in barn owl mortality due to vehicle collisions as a result of the Project is not expected to affect barn owl populations. Barn owls have relatively high breeding success and implementation of mitigation measures, specifically the combination of habitat reduction and management of the remaining habitat to reduce barn owl prey in the right-of-way and construction of flight-height diverters, is expected to minimize some of the current and any incremental future effects. Although the effect is characterized as adverse, it is expected to be of negligible magnitude, uncommon frequency, and specific in extent. With the successful implementation of mitigation measures, effects may be reversible. This residual effect is considered not significant.

Table 4.8-16 Determination of significance of residual effects for terrestrial wildlife

| Residual Effect | Significance (significant/not significant) | Likelihood (low/moderate/high) |
|--|---|---------------------------------------|
| Barn swallow (upland birds) habitat loss | Not significant | Low |
| Barn owl (upland birds) mortality | Not significant | Low |

On the basis that implementation of mitigation will minimize the level of residual effects (i.e., habitat is expected to be available for establishment of barn swallow nests before removal of the Deas Slough Bridge, flight-height diverters will be constructed to minimize barn owl mortality as a result of vehicle collision, and sub-optimal habitat close to Highway 99 that currently attracts barn owl will be reduced) the residual effects of the Project on terrestrial wildlife are considered to be not significant. The populations of these species are expected to be self-sustaining in the LAA and in the portions of the Project alignment where they currently occur after Project implementation; as such the likelihood of a significant effect is low and the residual effects are considered not significant.

4.8.5.4 Confidence and Risk

The prediction of confidence was based on expert judgment and includes characteristics that determine the level of uncertainty associated with both the significance and likelihood determinations. The level of confidence is based on scientific information, professional judgment of the discipline expert, effectiveness of mitigation, and assumptions made. The level of confidence in the effects predictions for barn owl and barn swallow, associated with both the significance determination (not significant) and the likelihood (low), is moderate to high, because:

- There are good data to understand the potential effects. The quality and reliability of the data that supported the assessment was rated moderate (**Section 4.8.2.4**). Standard sampling methods, or reliable methods published in government-approved or peer-reviewed documents were used. As well, the availability of data for the area surrounding the LAA (including in the RAA) is reasonable, in large part from the Ministry's studies on the nearby Highway 17/SFPR.
- Efficacy of mitigation based on past and ongoing experience with the management of these species. The experience in identifying and managing effects on barn owl from the nearby SFPR gives high confidence in the likelihood of effects for that species, and the means by which they should be managed. Recent attention to the management of barn swallow in the Lower Mainland gives better confidence on the predicted level of effects and the mitigation needs for the species.

Given the moderate to high confidence level in the effects prediction, the anticipated non-significant residual effects, and the proposed monitoring and follow-up programs, risk is determined to be low and risk analysis is not required (see **Section 3.9 Confidence and Risk**).

4.8.6 Cumulative Effects and their Significance

Residual effects on barn swallow and barn owl as a result of the project were considered in combination with the known or projected residual effects on these species from past present or reasonably foreseeable projects (**Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**). The purpose is to determine the potential for interaction of residual effects in space and time, and if there is an interaction the significance of those combined effects (i.e., cumulative effects) and necessary mitigation.

For barn swallow the potential for other projects (**Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**) to result in residual effects to structures on which their nests are located is considered unlikely. Two of the projects identified the presence of barn swallow (i.e., Vancouver Airport Fuel Delivery, and Roberts Bank Terminal 2). There were no residual effects on this species, or the VC in which barn swallow is a component, identified for both projects. Both projects are solely or mostly located outside of the RAA (information obtained from the EAO ePIC document repository database and James Rourke, R.P.Bio. pers. comm.). Accordingly these projects are not considered further in this cumulative effects assessment because there is no interaction with the residual effects of the project under consideration. Other of the projects reviewed did not mention barn swallow as a VC, or as a component of a VC (i.e., Tilbury LNG Expansion, Fraser Surrey Docks Direct Coal Transfer, Westpac Tilbury Marine, Lehigh South Richmond Terminal Project, Kinder Morgan Trans Mountain Pipeline Expansion, and BC Hydro Massey Circuit Relocation (information obtained from EAO ePIC, Port of Vancouver and National Energy Board document repository

databases). These projects are not considered further in this cumulative effects assessment as there are no stated residual effects on the species under consideration, and therefore no interaction. For the remainder of the projects under consideration the proponents did not publish information describing their effects on barn swallow. To address these unknowns a review of the nature and extent of their projects with respect to barn swallow biology and nesting was conducted. Based on that review these remaining projects under consideration are not considered to have residual effects on barn swallow and therefore to not interact because they (i) lack the presence of structures suitable for breeding in their project areas (i.e., Fraser River Dredging and Port of Vancouver Habitat Enhancement), or (ii) the projects are too early in their design phases to adequately understand the potential for residual effects (i.e., Pattullo Bridge Replacement and Ladner Harbour Revitalisation). The Pattullo Bridge may not be removed as part of the works, and hence there may be no reduction in any available nesting habitat for barn swallow. These projects are also outside of the RAA.

As no interacting residual effects on barn swallow were determined for the projects under review (**Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**) this assessment finds no cumulative effects.

For barn owl the potential for other projects (**Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**) to result in residual effects from collisions is considered minimal. Two of the projects identified the presence of barn owl (i.e., Vancouver Airport Fuel Delivery, and Roberts Bank Terminal 2). There were no residual effects on this species, or the VC in which barn owl is a component, identified for both projects (information obtained from the EAO ePIC document repository database and James Rourke, R.P.Bio. pers. comm.). Accordingly these projects are not considered further in this cumulative effects assessment because there is no interaction with the residual effects of the project under consideration. Most of the other projects reviewed did not mention barn owl as a VC, or as a component of a VC (i.e., Tilbury LNG Expansion, Fraser Surrey Docks Direct Coal Transfer, Westpac Tilbury Marine, Lehigh South Richmond Terminal Project, Kinder Morgan Trans Mountain Pipeline Expansion, and BC Hydro Massey Circuit Relocation (information obtained from EAO ePIC, Port of Vancouver and National Energy Board document repository databases). These projects will not be considered further in this cumulative effects assessment as there are no stated residual effects on the species under consideration, and therefore no interaction. For the remainder of the projects the proponents did not publish information describing their effects on barn owl. To address these unknowns a review of the nature and extent of their projects, with respect to barn owl biology and collision effect potential, was conducted. Based on that review, these remaining projects are not considered to have

residual effects on barn owl and therefore to not interact because they do not include collision effects (i.e., Fraser River Dredging, Port of Vancouver Habitat Enhancement, and Ladner Harbour Revitalisation). The Pattullo Bridge Replacement involves vehicles that could collide with barn owl, and therefore may have an interaction. However, there are no known interactions with barn owl on the Pattullo Bridge, and the location and type of the replacement structure is unknown. There are three location options being considered, and one option includes a tunnel that has no potential for interaction with barn owl. The uncertainties with this project are too great for it to be considered further. An existing project that interacts with barn owl, the South Fraser Perimeter Road (SFPR, Highway 17) was recently constructed and opened. It crosses the Project Alignment just west of Burns Bog. Barn owl was identified as a valued ecosystem component during the environmental assessment review of the SFPR, and an adaptive management plan to design mitigation and monitor the efficacy of that mitigation was developed prior to approval. During and since construction, monitoring of barn owl populations along the SFPR and of effects on barn owl from the SFPR has been conducted. That monitoring indicates populations of barn owl have been maintained and that collision effects on barn owl, for example areas of higher-than-expected mortality, are being addressed through additional mitigation. The ongoing barn owl mitigation monitoring program on the SFPR project is effectively addressing the residual effects of the SFPR on barn owl. There is an interaction between the SFPR and the Project, but the active management of those effects currently being conducted on SFPR, and proposed for the Project (**Section 14.2 Summary of Mitigation Measures**) are considered to be an effective means of avoiding cumulative effects on barn owl in south west Delta.

4.8.7 Follow-up Strategy

Monitoring will be conducted during and after Project construction to ensure mitigation measures identified in **Section 4.8.4** are implemented and expected outcomes in terms of avoiding or minimizing effects on terrestrial wildlife, specifically barn swallow and barn owl, are achieved. Post-construction monitoring will focus on monitoring of barn swallow nest establishment, establishment of flight-height barriers / diverters (e.g., hedgerows) as barn owl mitigation) and the removal of barn owl foraging areas close to the highway. Post-construction monitoring will be conducted to confirm continued use of the two latrine sites within the LAA by river otter.

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APPENDIX A

Overview of Potential Project Interactions with Terrestrial Wildlife

Table 1 Overview of Potential Project Interactions with Terrestrial Wildlife

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|--|
| Pre-Construction / Site Preparation | | | |
| Pre-construction / site preparation | No Interaction | <ul style="list-style-type: none"> • Surveying • Acquiring land for the Project | <p>Nature of interaction: No interaction anticipated</p> <p>Comment: Activities are not anticipated to cause changes in habitat quality, or result in habitat loss or impact terrestrial wildlife</p> |
| | No Effect | <ul style="list-style-type: none"> • Preloading for embankment and highway construction • Conducting additional site investigations (i.e., a geotechnical drilling program) | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment | <p>Nature of interaction: Activities with potential to affect terrestrial wildlife</p> <p>Comment: Potential effects include:</p> <ul style="list-style-type: none"> • Habitat loss and direct mortality of terrestrial wildlife during vegetation clearing and grubbing, stripping, and soil excavation • Habitat alteration due to sensory disturbance from noise, dust, and presence and movement of construction crews and equipment |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Construction | | | |
| New bridge including approaches and ramp connections | No Interaction | <ul style="list-style-type: none"> • Hoisting pre-assembled deck segments from barges in the river or land-based transport system | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: Activities with potential to affect terrestrial wildlife</p> <p>Comment: Potential effects include:</p> <ul style="list-style-type: none"> • Habitat loss due to highway widening, permanent installation of upland piers, and restoration of Green Slough • Habitat alteration due to changes in surface water quality from dewatering and temporary diversion of upland ditches, and sensory disturbance related to noise, dust, presence and movement of construction crews and equipment • Accidental spills of deleterious substances (see Section 8.0 Accidents and Malfunctions) |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|---|
| Highway 99 improvements, including interchange upgrades | No Interaction | N/A | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: Activities with potential to affect terrestrial wildlife</p> <p>Comment: Potential effects include:</p> <ul style="list-style-type: none"> • Habitat alteration due to changes in surface water quality from sedimentation, dewatering and temporary diversion of upland ditches, and sensory disturbance related to noise, dust presence and movement of construction crews and equipment • Direct mortality of small mammals during soil/gravel placing and compaction • Accidental spills of deleterious substances (see Section 8.0 Accidents and Malfunctions) |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|--|
| Tunnel decommissioning | No Interaction | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | N/A | N/A |
| Decommissioning of Deas Slough Bridge | No Interaction | N/A | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | <p>Nature of interaction: Activities with potential to affect terrestrial wildlife</p> <p>Comment: Potential effects include</p> <ul style="list-style-type: none"> • Direct mortality of upland birds (e.g., destruction or failure of an active nest) • Habitat alteration due to sensory disturbance related to noise, presence and movement of construction crews and equipment • Accidental spills of deleterious substances (see Section 8.0 Accidents and Malfunctions) |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|---|--|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No Interaction | N/A | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | <p>Nature of interaction: Activities with potential to affect terrestrial wildlife</p> <p>Comment: Potential effects include:</p> <ul style="list-style-type: none"> • Habitat alteration due to sensory disturbance related to incremental growth in traffic and associated ambient noise levels • Loss of small mammal and upland bird habitat due to periodic maintenance of roadside and upland ditch vegetation • Vehicle collisions with avian wildlife |

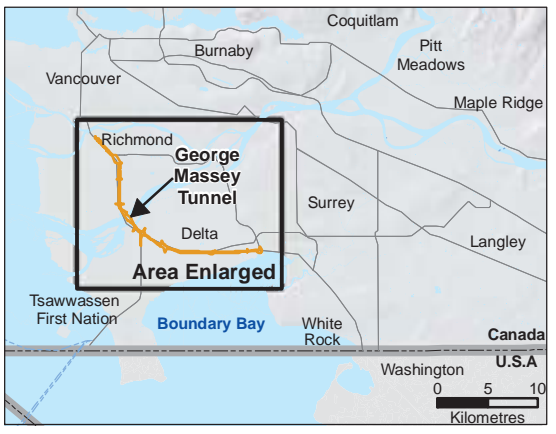
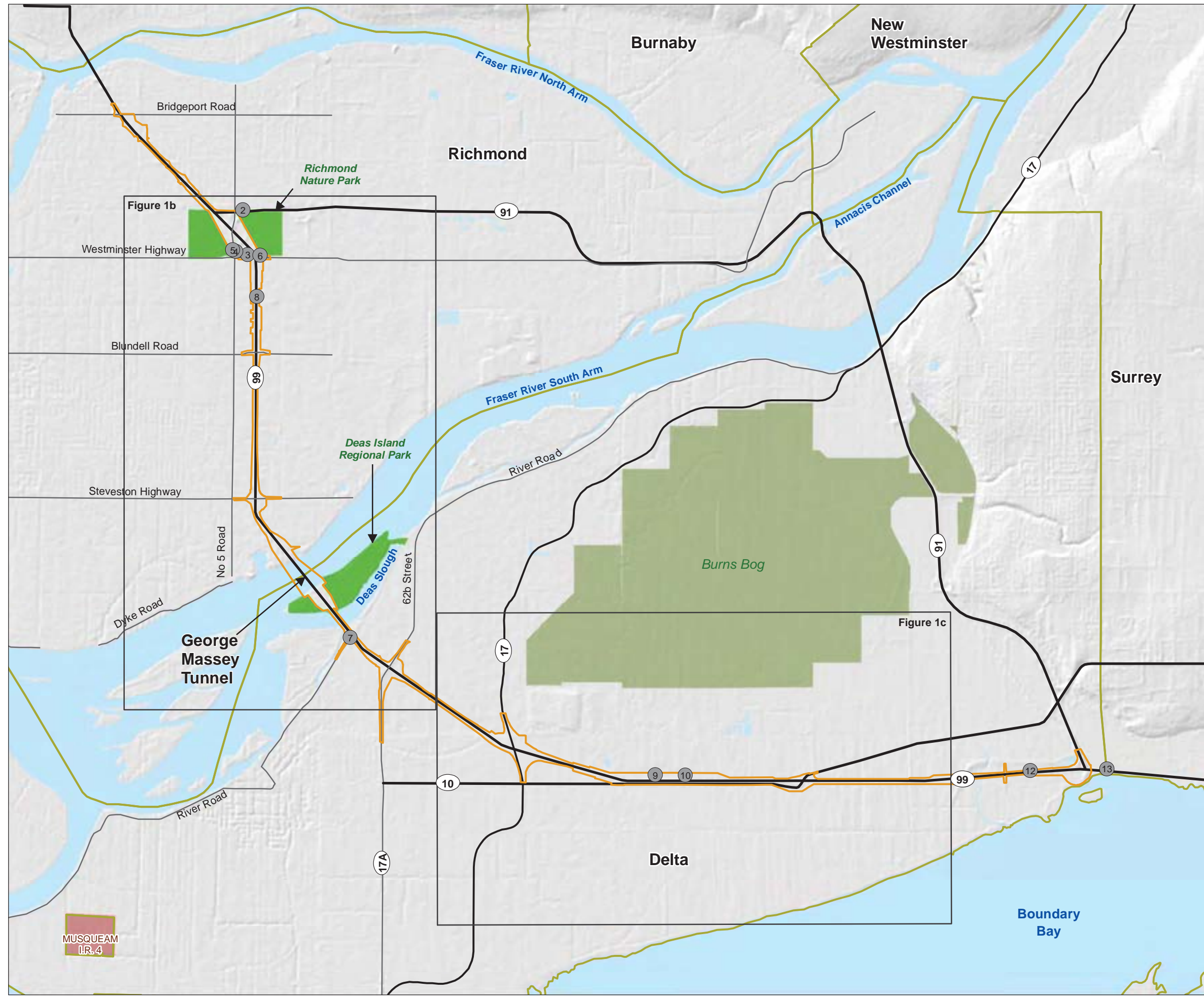
| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-----------------------------|------------------------|---|--|
| New bridge | No Interaction | <ul style="list-style-type: none"> • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: No interaction anticipated</p> <p>Comment: Activities are not anticipated to cause changes in habitat quality, or result in habitat loss or mortality of terrestrial wildlife</p> |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Operating the new bridge | <p>Nature of interaction: Activities with potential to affect terrestrial wildlife</p> <p>Comment: Potential effects include:</p> <ul style="list-style-type: none"> • Direct mortality of upland birds and riverine birds and bats as a result of collisions with the new bridge • Habitat alteration due to sensory disturbance related to incremental growth in traffic and associated ambient noise levels, and changes in the ambient light environment |

"N/A" indicates that no Project works and/or activities are applicable to the category

APPENDIX B

Wildlife Figures

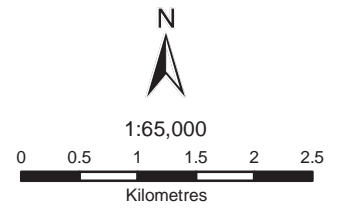
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- Legend**
- Pacific Water Shrew eDNA Sample Location
 - ▬ Project Alignment
 - ▭ First Nation Reserve
 - ▭ Municipal Boundaries
 - ▭ Burns Bog Ecological Conservancy Area
 - ▭ Waterbody
 - ▬ Canada - U.S. Border
 - ▬ Highway
 - ▬ Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

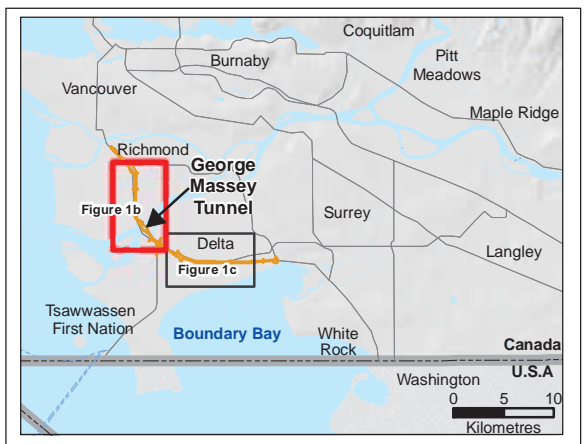
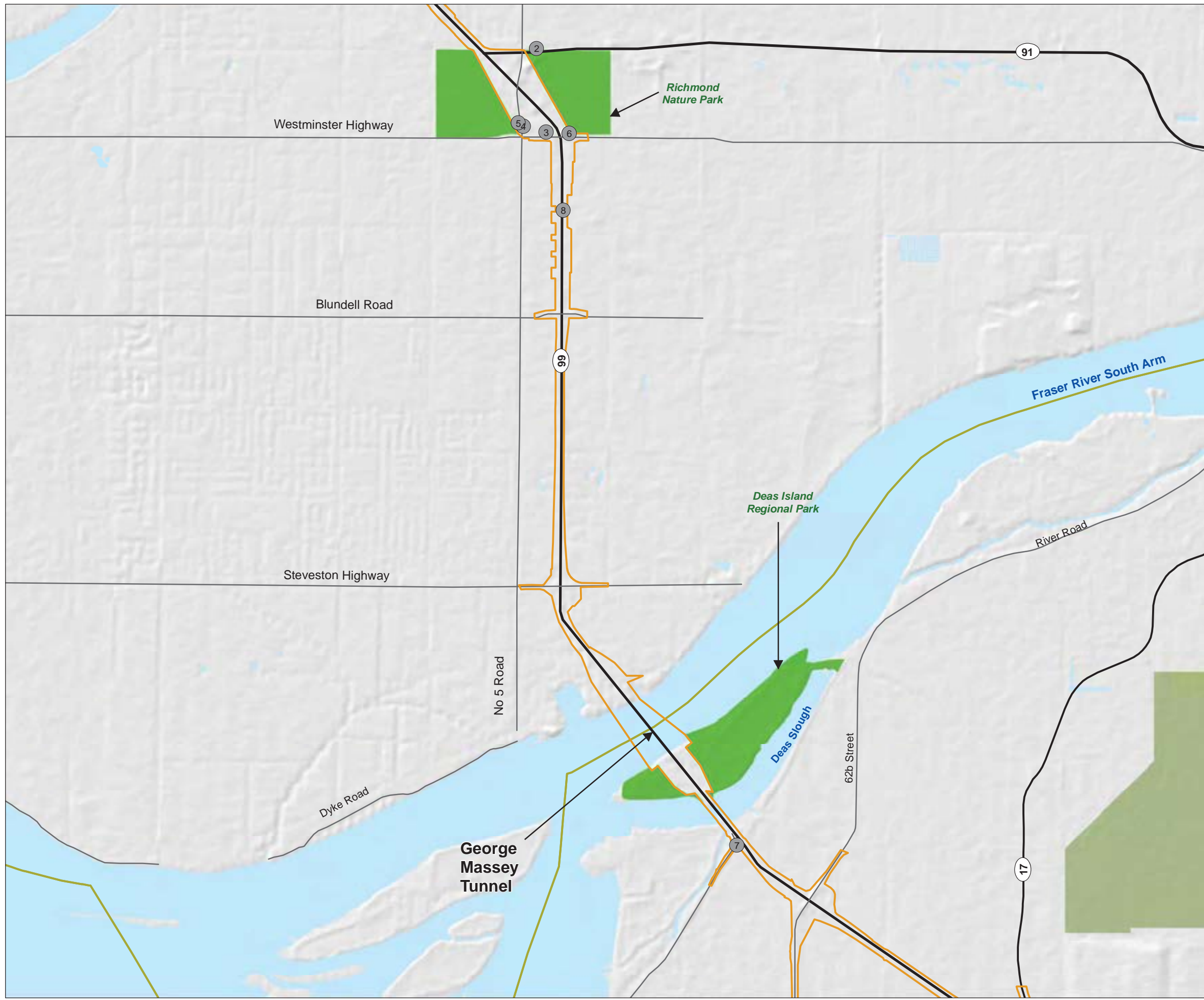


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

PACIFIC WATER SHREW ENVIRONMENTAL
DNA SAMPLING LOCATIONS OVERVIEW

| | |
|-----------|------------|
| Figure 1a | 13/05/2016 |
|-----------|------------|

Path: C:\217-299\285\077\03\mxd\Wildlife\Small_Mammals\EA\Fig1b-c_285_077_03_EA_PWS-eDNA-Sheets_160114_FINAL.mxd

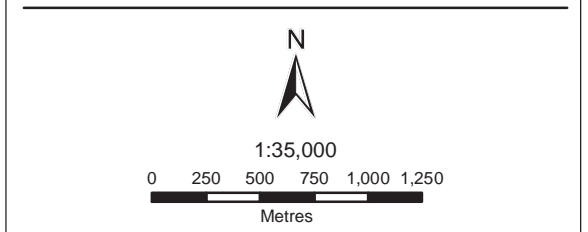


Legend

- Pacific Water Shrew eDNA Sample Location
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

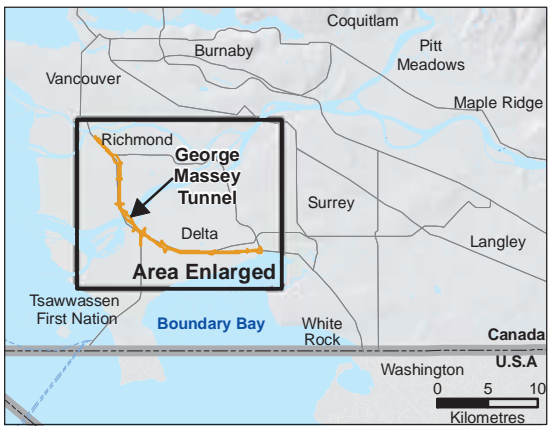
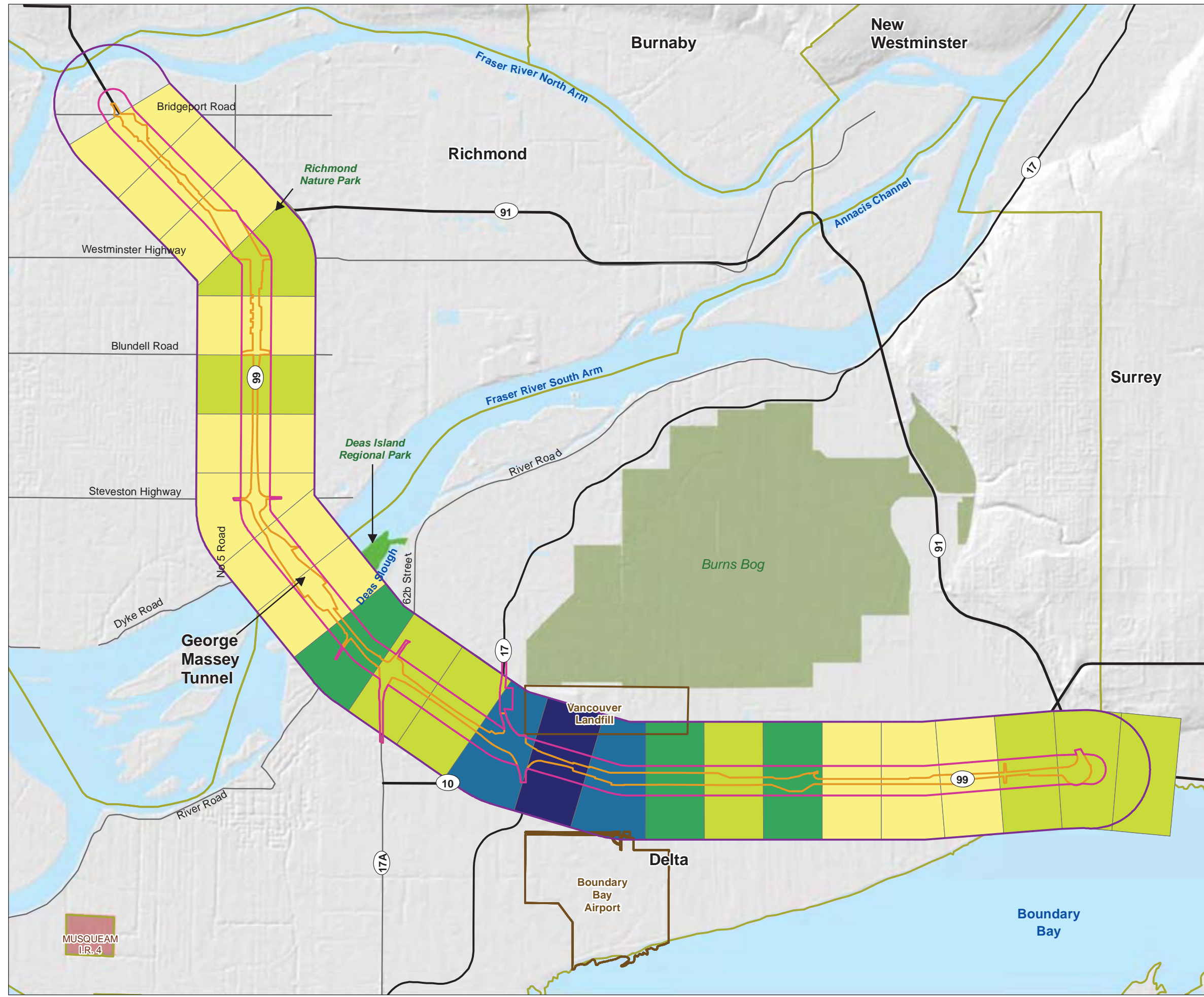
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| PACIFIC WATER SHREW ENVIRONMENTAL DNA SAMPLING LOCATIONS | |
| Figure 1b | 13/05/2016 |
| | |

Path: C:\1217-299\285\077\03\mxd\WildlifeRaptors\EA\Fig2a_285_077_03_EA_Raptors-Spring_160114_FINAL.mxd



Legend

1km Sample Intervals - Number of Bird Sightings

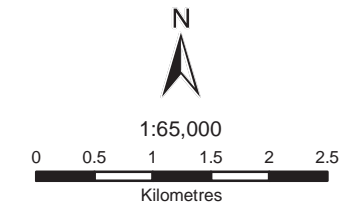
- 1 - 3
- 3 - 9
- 9 - 20
- 20 - 51
- 51 - 485
- No Records

Terrestrial Wildlife Local Assessment Area
 Terrestrial Wildlife Regional Assessment Area
 Project Alignment
 First Nation Reserve
 Municipal Boundaries
 Burns Bog Ecological Conservancy Area
 Waterbody
 Canada - U.S. Border
 Highway
 Arterial/Collector Road

¹ The sample interval length is 1km along the centreline of Highway 99. The buffer distance of each sample interval length is 1km perpendicular to the direction of the road. (The total width is 2km)

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

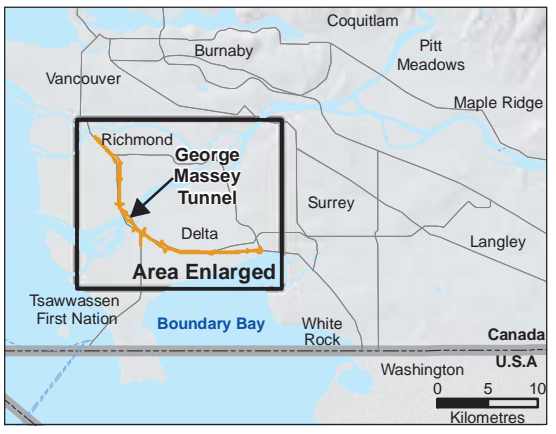
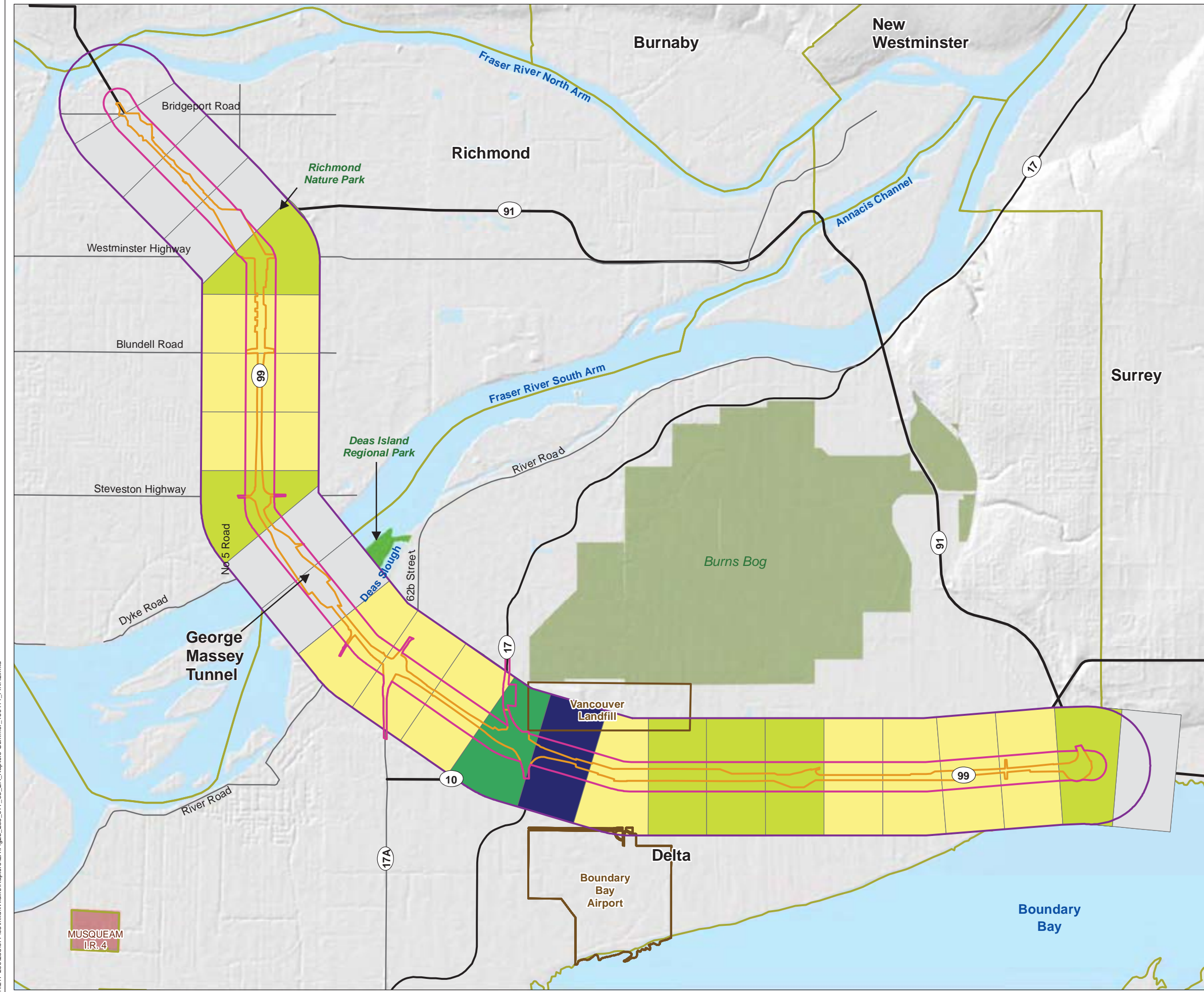


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**CONSPICUOUS RAPTOR ABUNDANCE
AND DISTRIBUTION (SPRING 2014)**

Figure 2a 13/05/2016

Path: O:\1217-299\285\077\03\mxd\Wildlife\Raptors\EAN\fig2b_285_077_03_EA_Raptors-Summer_160114_FINAL.mxd



Legend

1km Sample Intervals - Number of Bird Sightings

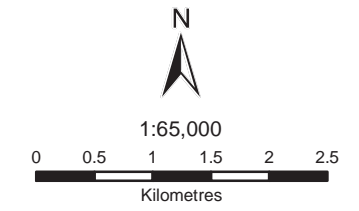
- 1 - 3
- 3 - 9
- 9 - 20
- 20 - 51
- 51 - 485
- No Records

Terrestrial Wildlife Local Assessment Area
 Terrestrial Wildlife Regional Assessment Area
 Project Alignment
 First Nation Reserve
 Municipal Boundaries
 Burns Bog Ecological Conservancy Area
 Waterbody
 Canada - U.S. Border
 Highway
 Arterial/Collector Road

¹ The sample interval length is 1km along the centreline of Highway 99. The buffer distance of each sample interval length is 1km perpendicular to the direction of the road. (The total width is 2km)

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



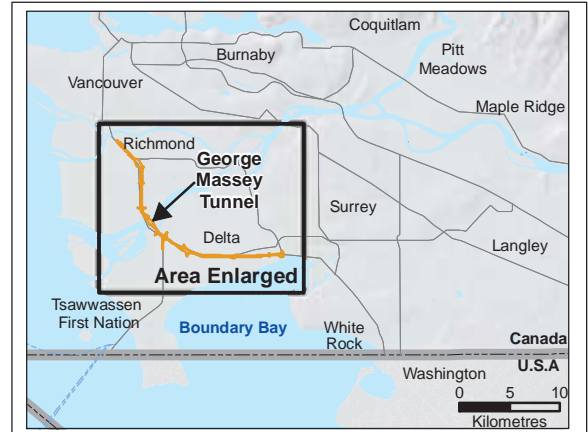
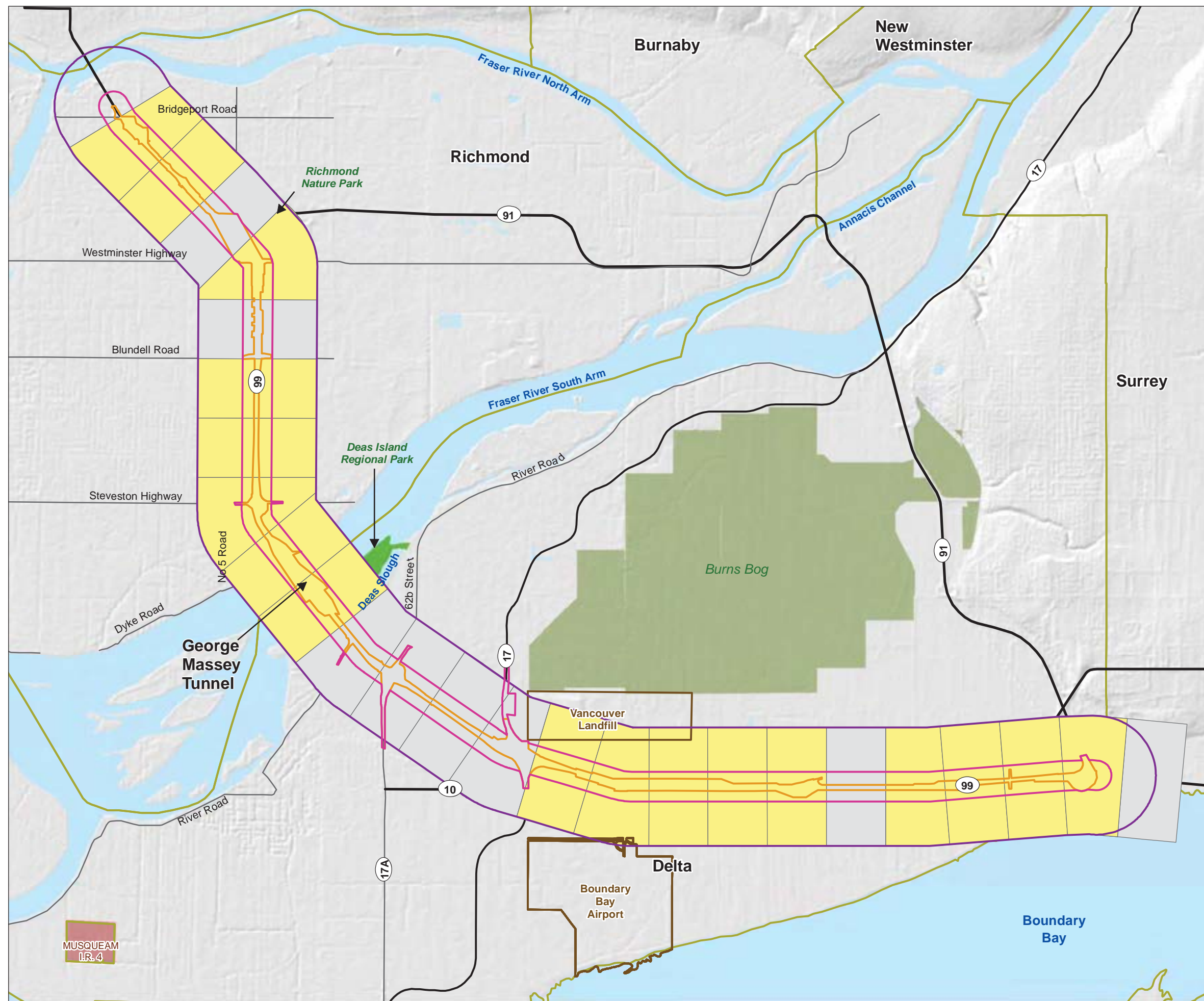
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

CONSPICUOUS RAPTOR ABUNDANCE AND DISTRIBUTION (SUMMER 2014)

Figure 2b | 13/05/2016

George Massey Tunnel Replacement Project | BC 1005 PLAN | B.C. on the Move

Path: C:\1217-299285\077\03\mxd\Wildlife\Raptors\EA\Fig2c_285_077_03_EA_Raptors-Fall_160114_FINAL.mxd



Legend

1km Sample Intervals - Number of Bird Sightings

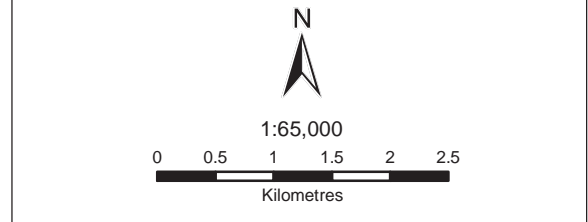
- 1 - 3
- 3 - 9
- 9 - 20
- 20 - 51
- 51 - 485
- No Records

Terrestrial Wildlife Local Assessment Area
 Terrestrial Wildlife Regional Assessment Area
 Project Alignment
 First Nation Reserve
 Municipal Boundaries
 Burns Bog Ecological Conservancy Area
 Waterbody
 Canada - U.S. Border
 Highway
 Arterial/Collector Road

¹ The sample interval length is 1km along the centreline of Highway 99. The buffer distance of each sample interval length is 1km perpendicular to the direction of the road. (The total width is 2km)

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



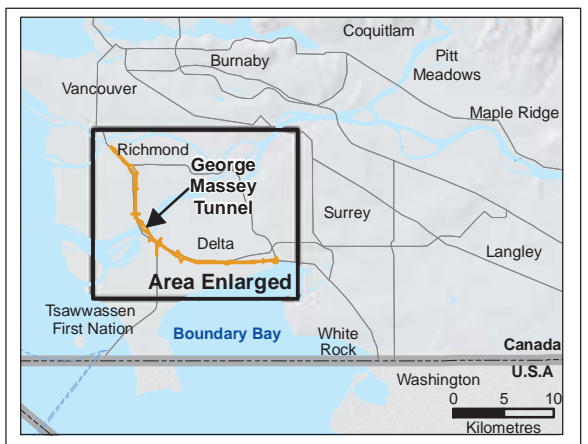
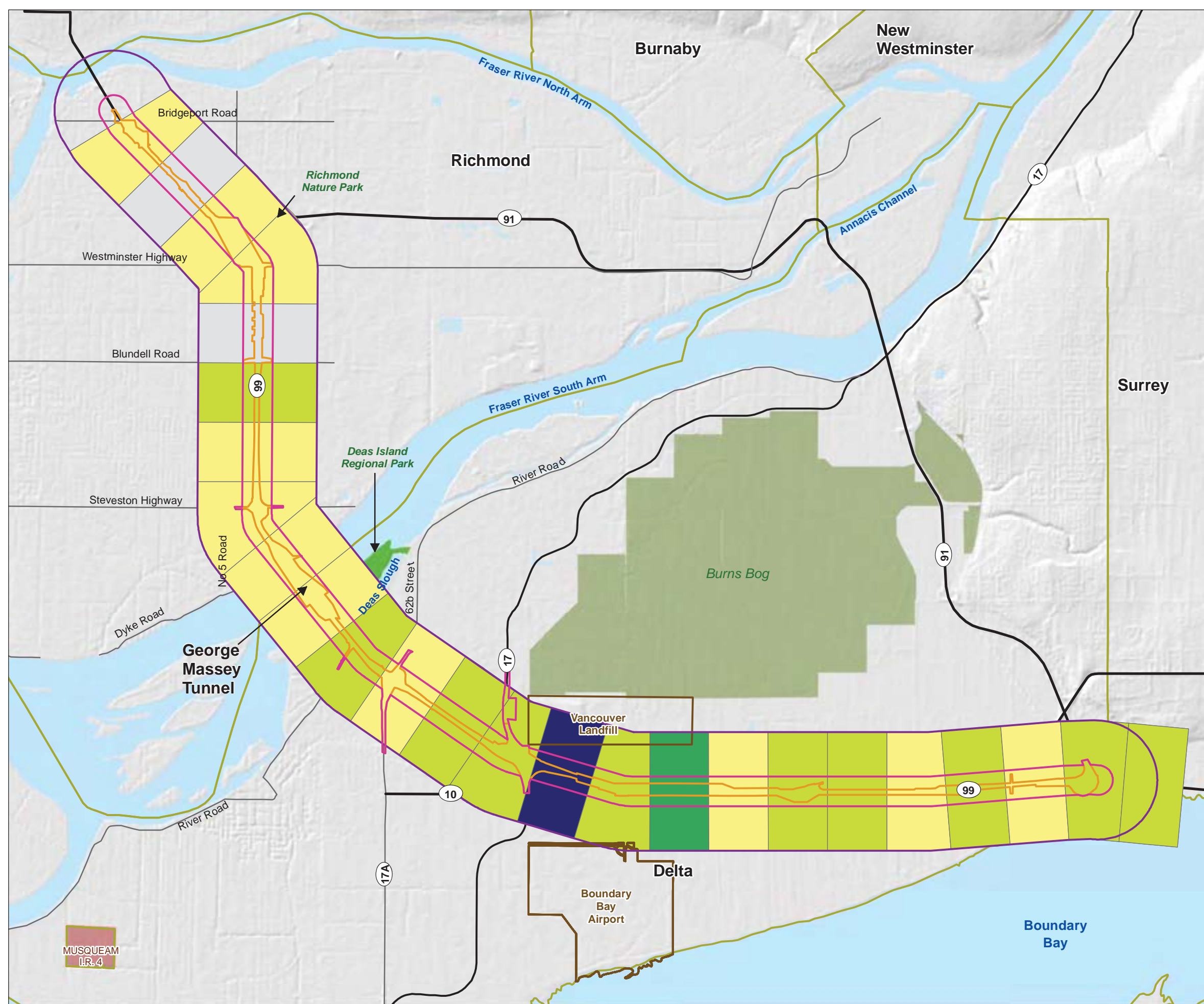
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

CONSPICUOUS RAPTOR ABUNDANCE AND DISTRIBUTION (FALL 2014)

Figure 2c | 13/05/2016

George Massey Tunnel Replacement Project | BC 1005 PLAN | B.C. on the Move

Path: C:\1217-299\285\077\03\mxd\Wildlife\Raptors\EA\Fig2d_285_077_03_EA_Raptors-Winter_160114_FINAL.mxd



Legend

1km Sample Intervals - Number of Bird Sightings

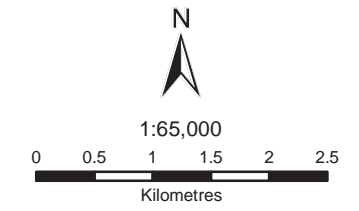
- 1 - 3
- 3 - 9
- 9 - 20
- 20 - 51
- 51 - 485
- No Records

Terrestrial Wildlife Local Assessment Area
 Terrestrial Wildlife Regional Assessment Area
 Project Alignment
 First Nation Reserve
 Municipal Boundaries
 Burns Bog Ecological Conservancy Area
 Waterbody
 Canada - U.S. Border
 Highway
 Arterial/Collector Road

¹ The sample interval length is 1km along the centreline of Highway 99. The buffer distance of each sample interval length is 1km perpendicular to the direction of the road. (The total width is 2km)

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



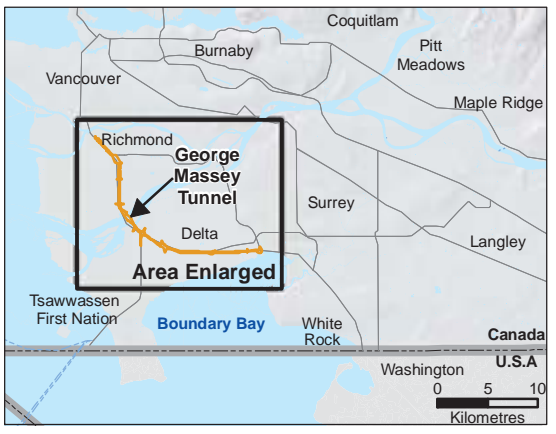
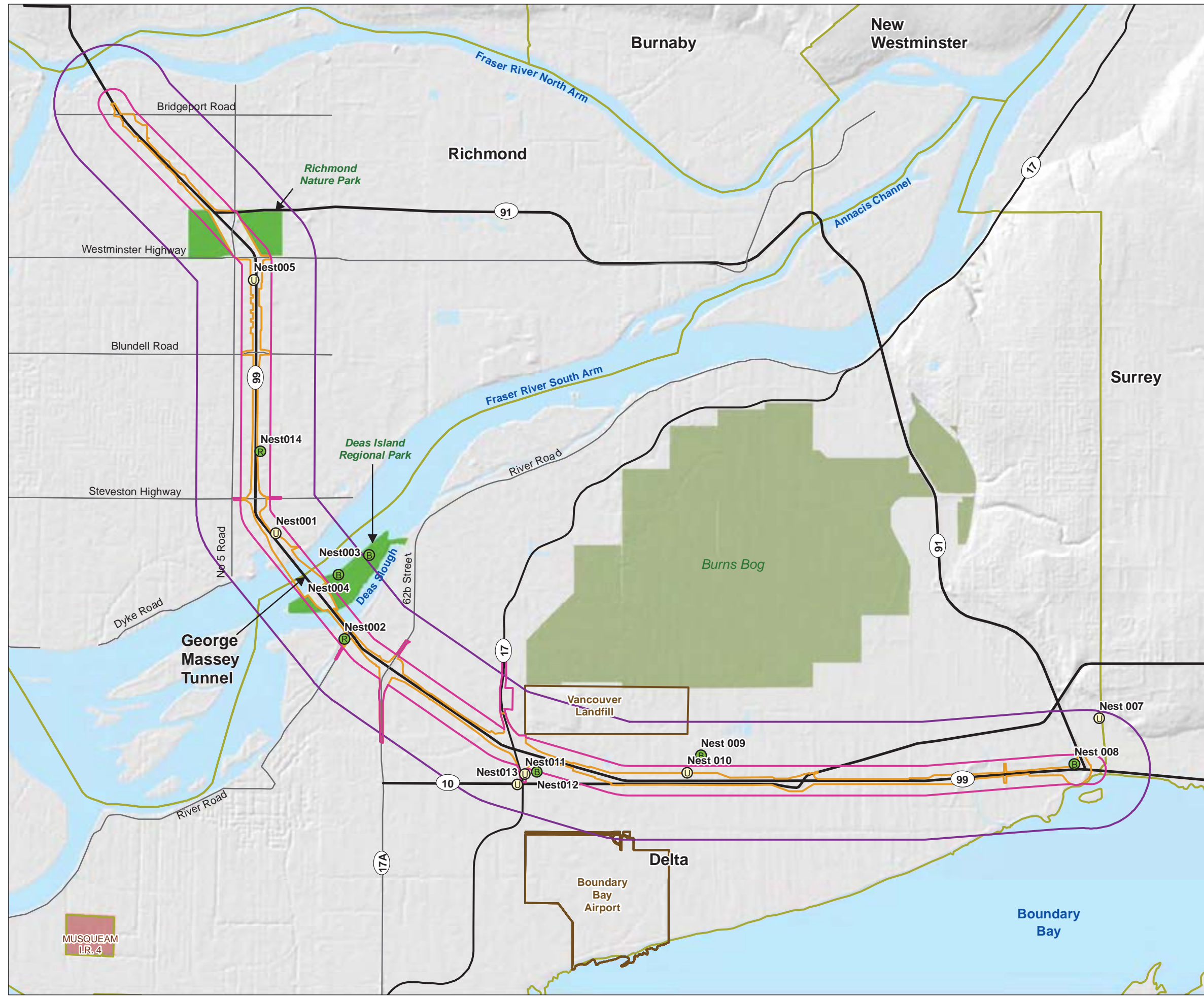
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

CONSPICUOUS RAPTOR ABUNDANCE AND DISTRIBUTION (WINTER 2014)

Figure 2d | 13/05/2016

George Massey Tunnel Replacement Project | BC 1005 PLAN | B.C. on the Move

Path: O:\217-289\286\077\03\mxd\Wildlife\Raptors\EA\Fig3_286_077_03_EA_StuckNest_16014_FINAL.mxd



Legend

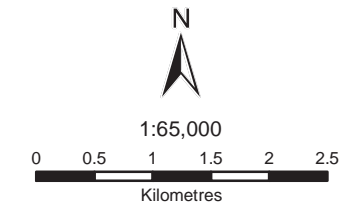
Nest Species and Condition

- ⓑ Bald Eagle, Active
- Ⓡ Red-tailed Hawk, Active
- Ⓢ Unidentified Raptor Nest, Unknown Activity

Terrestrial Wildlife Local Assessment Area
 Terrestrial Wildlife Regional Assessment Area
 Project Alignment
 First Nation Reserve
 Municipal Boundaries
 Burns Bog Ecological Conservancy Area
 Waterbody
 Canada - U.S. Border
 Highway
 Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

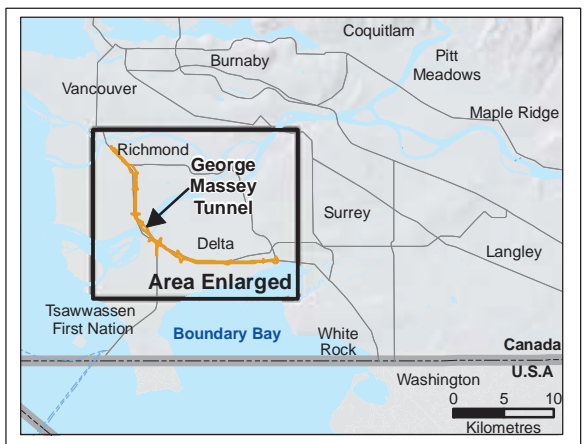
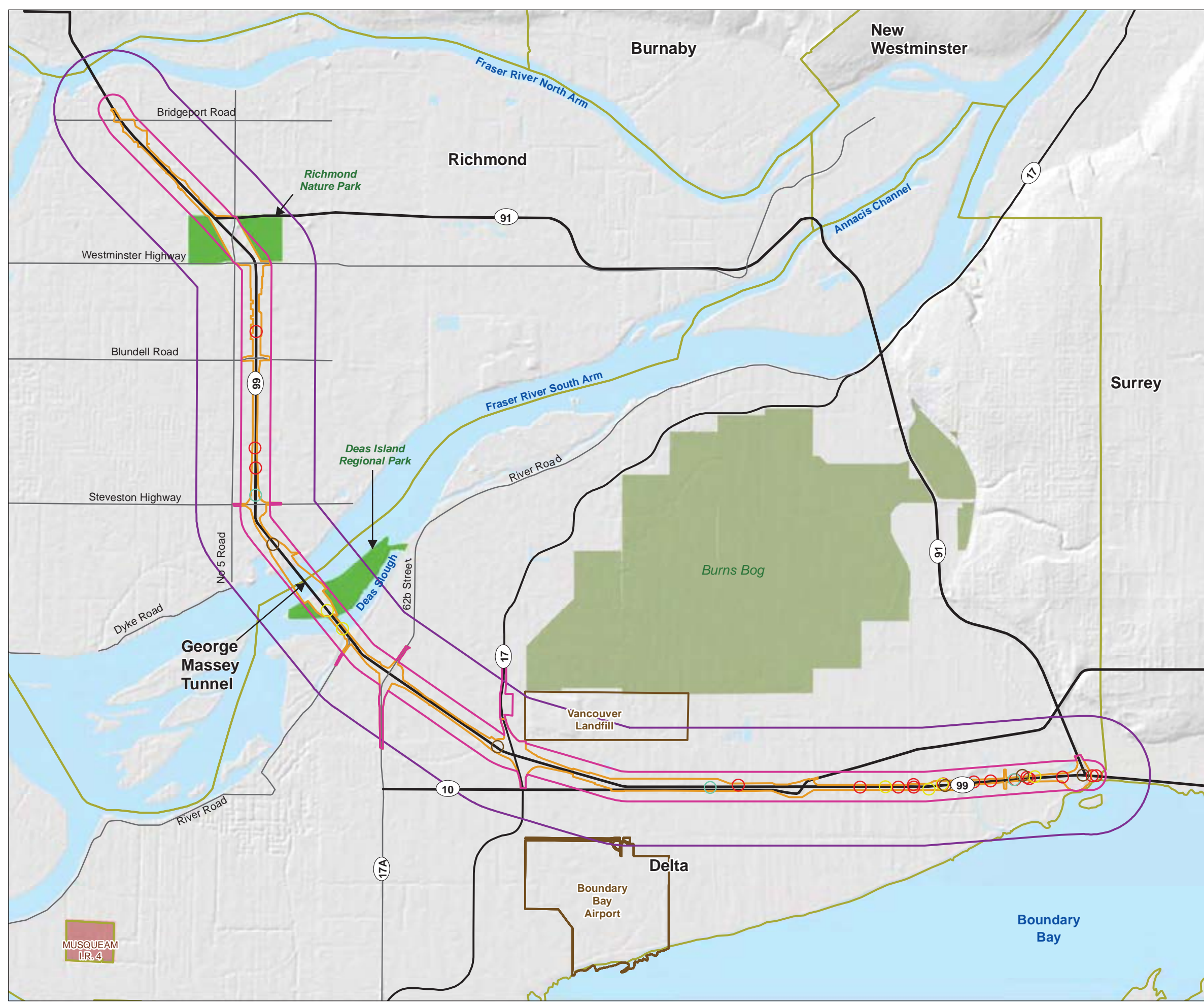


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**CONSPICUOUS RAPTOR
NEST LOCATIONS**

| | |
|----------|------------|
| Figure 3 | 13/05/2016 |
|----------|------------|

Path: C:\1217-299\285\077\03\mxd\WildlifeRaptorsEA\Fig4_285_077_03_EA_BlueHeron_160114_FINAL.mxd

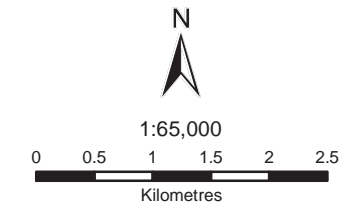


Legend

- Spring 2014 (6 total sightings)
- Summer 2014 (4 total sightings)
- Fall 2014 (5 total sightings)
- Winter 2014 (15 total sightings)
- Terrestrial Wildlife Local Assessment Area
- Terrestrial Wildlife Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

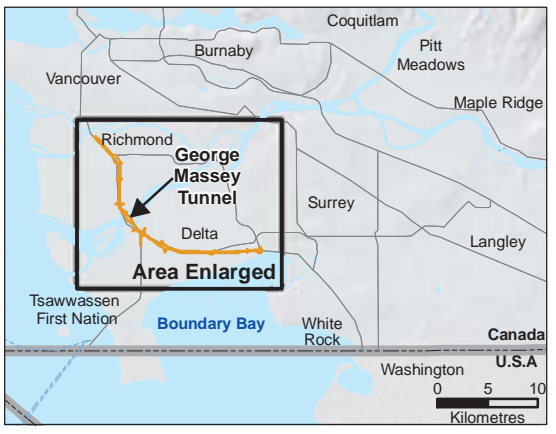
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**GREAT BLUE HERON
ABUNDANCE AND DISTRIBUTION**

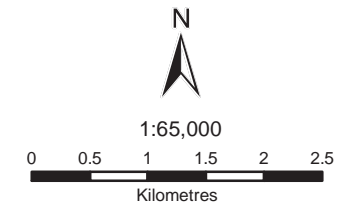
| | |
|----------|------------|
| Figure 4 | 13/05/2016 |
|----------|------------|



- Legend**
- Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

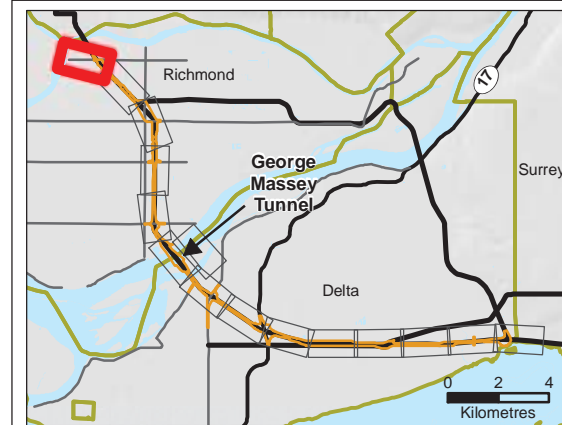
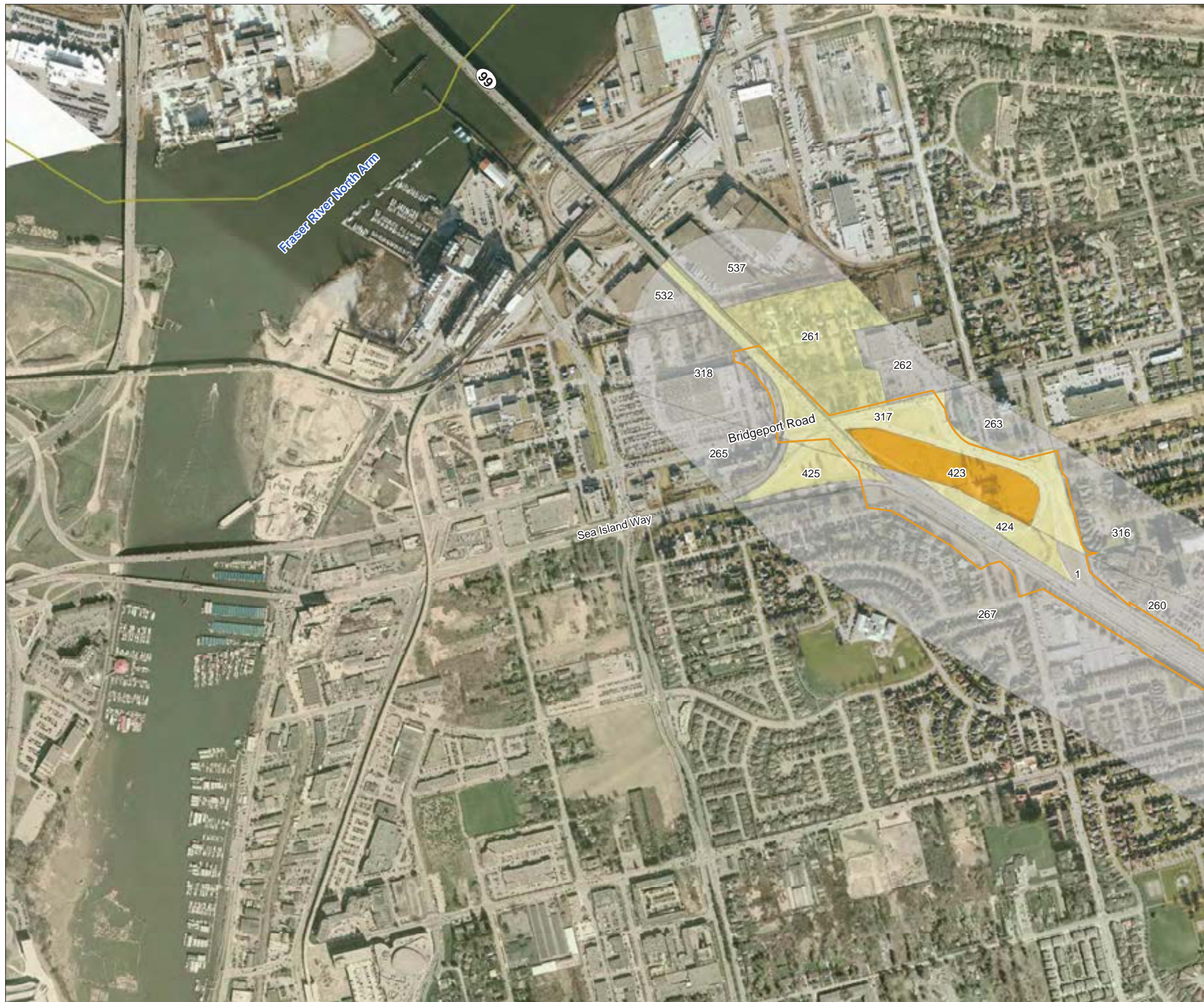
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT OVERVIEW | |
| Figure 5a | 12/05/2016 |
| | |

Path: O:\217-289\285\077\03\mxd\Wid\IEAF\g5a_285_077_03_EA_BOWL-Overview_160504_FINAL.mxd



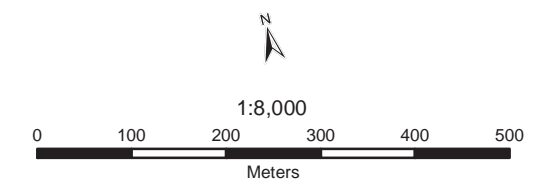
Legend

Barn Owl Foraging Ratings

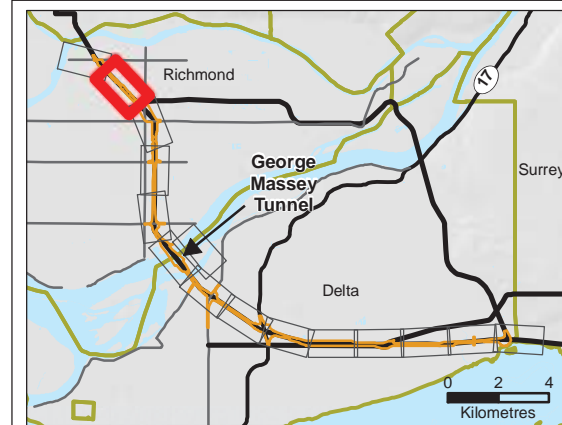
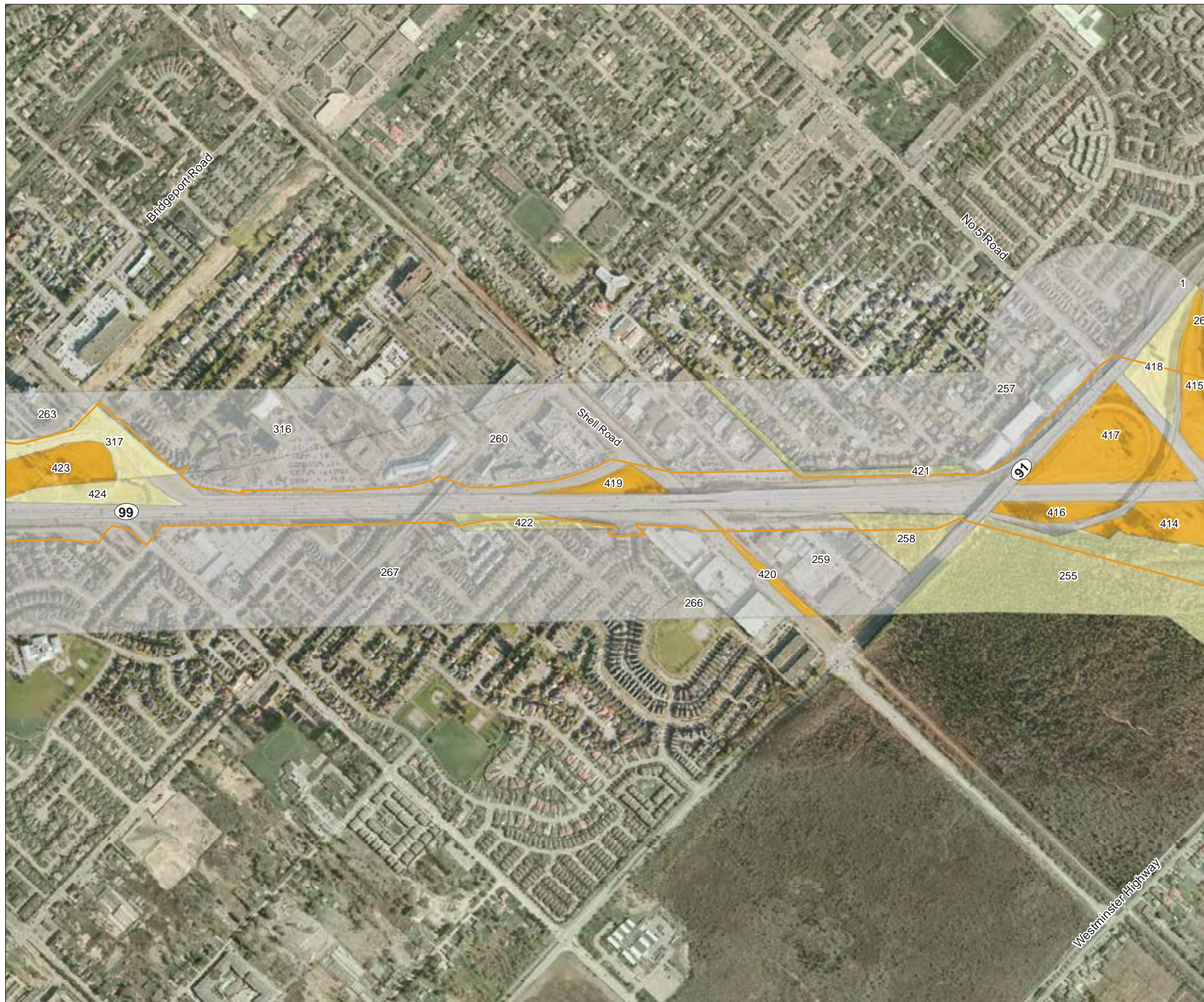
- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5b | 12/05/2016 |
| | |



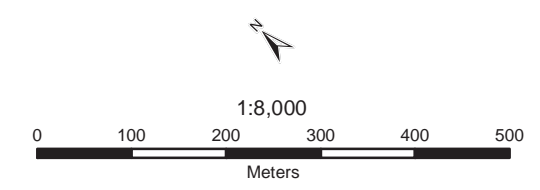
Legend

Barn Owl Foraging Ratings

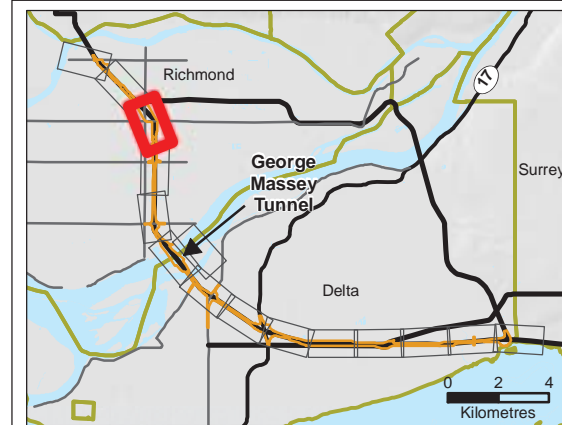
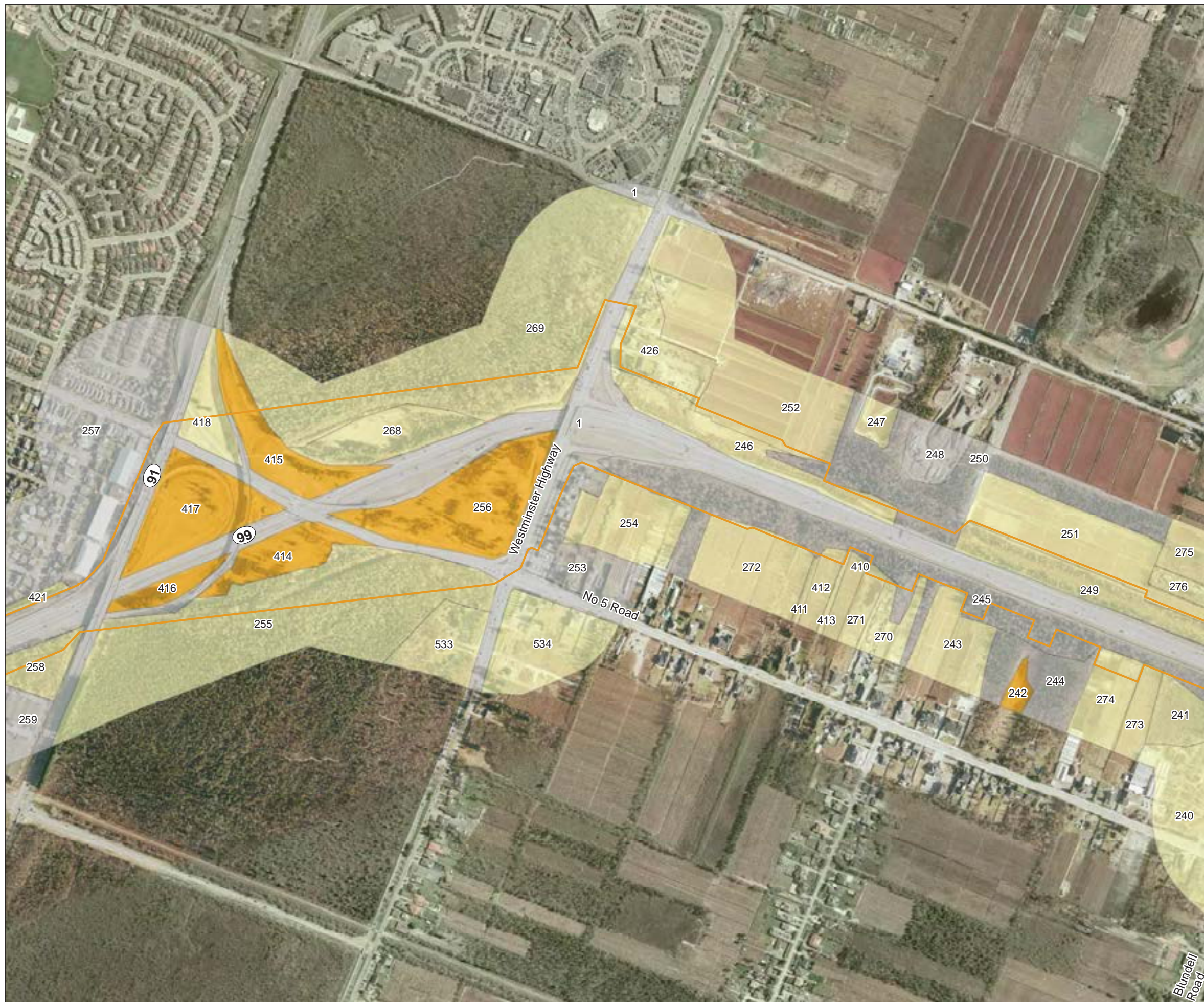
- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5c | 12/05/2016 |
| | |



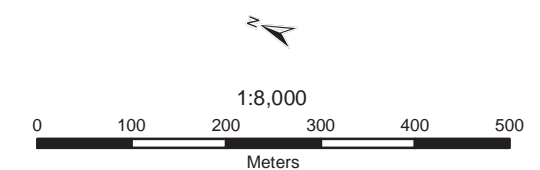
Legend

Barn Owl Foraging Ratings

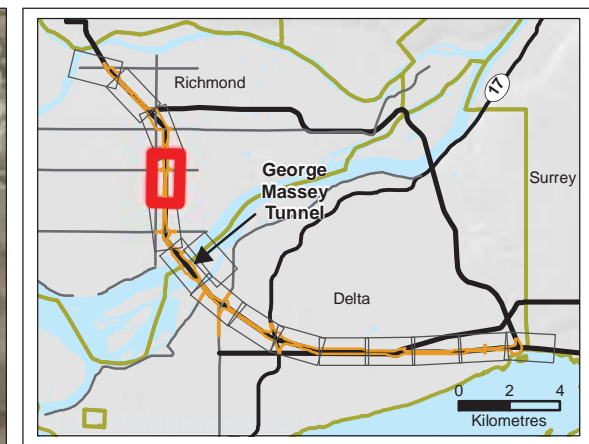
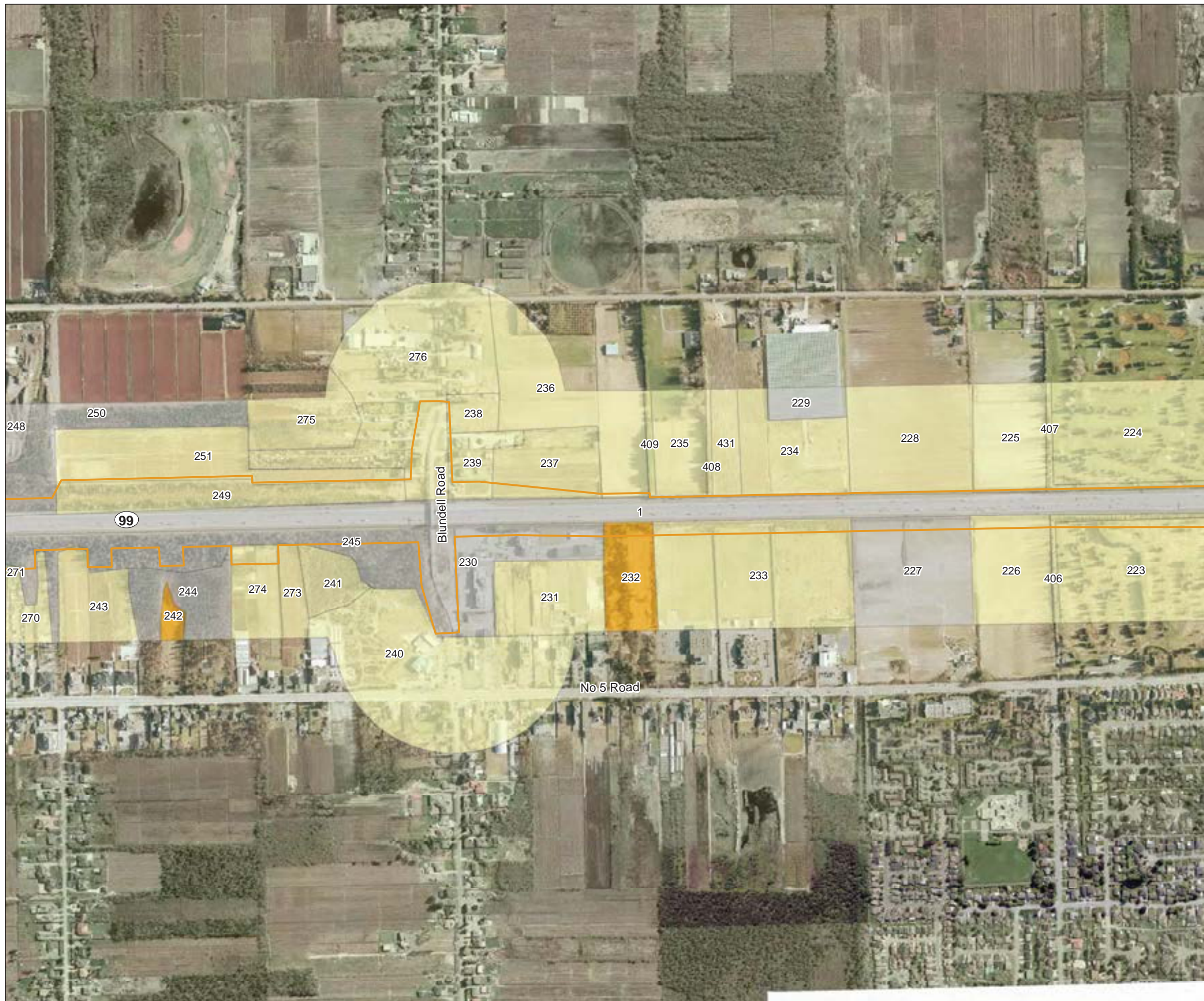
- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5d | 12/05/2016 |
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Legend

Barn Owl Foraging Ratings

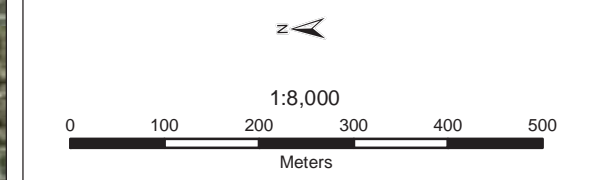
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

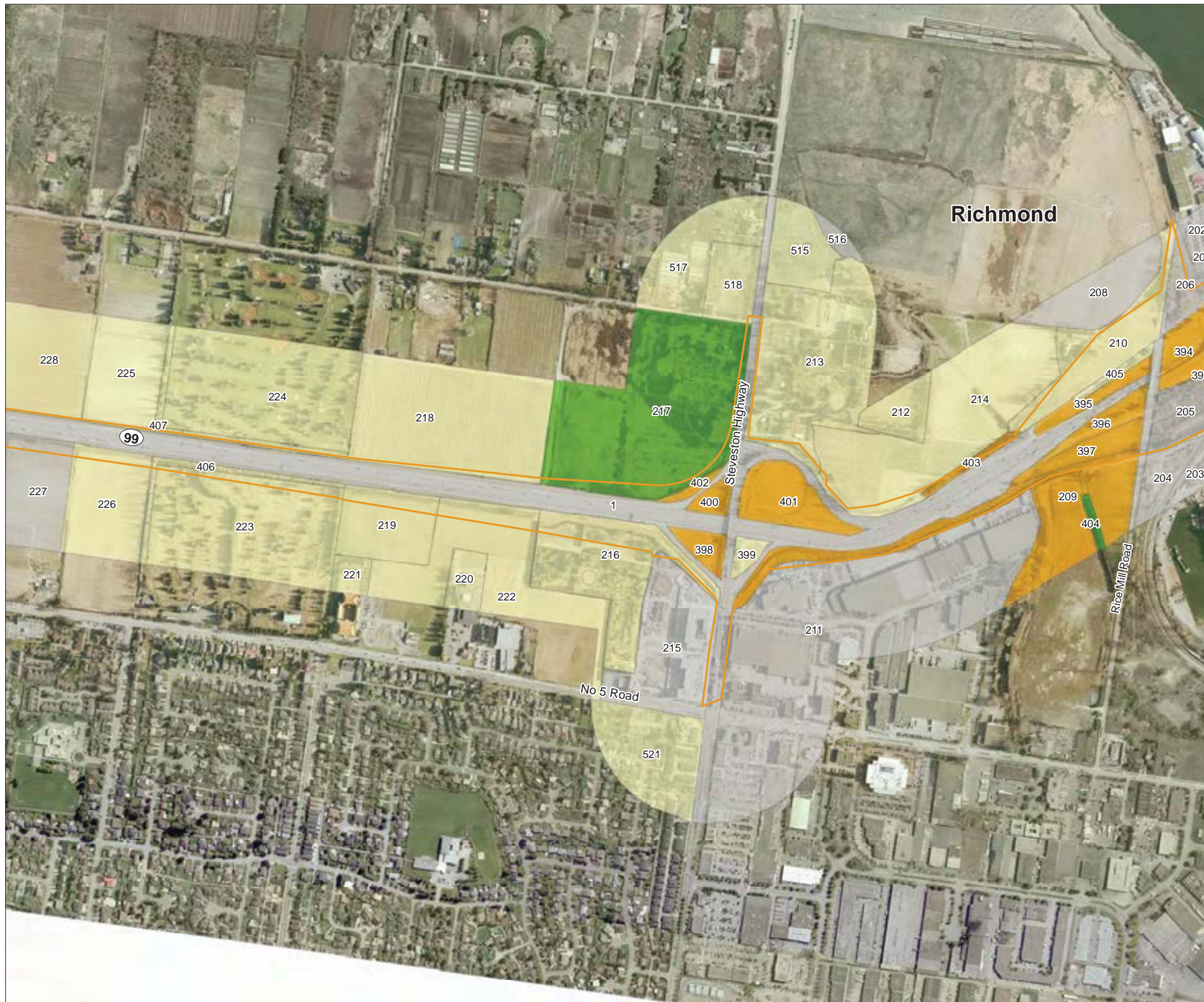
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**BARN OWL FORAGING HABITAT
SUITABILITY ASSESSMENT**

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| Figure 5e | 12/05/2016 |
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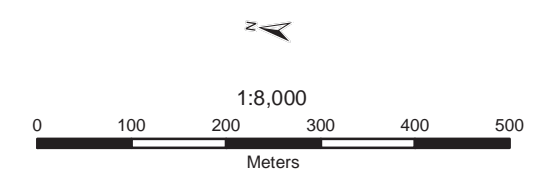
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Barn Owl Foraging Ratings

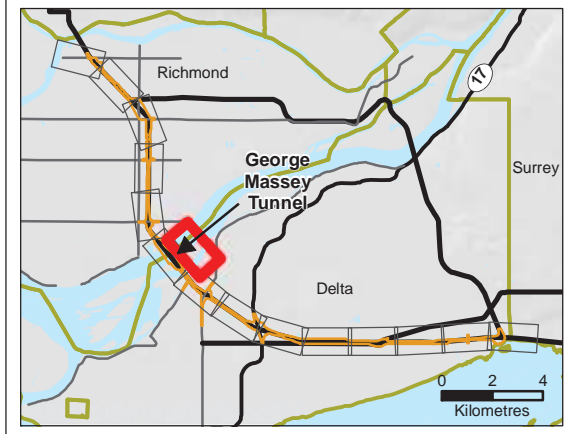
- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5f | 12/05/2016 |
| | |



Legend

Barn Owl Foraging Ratings

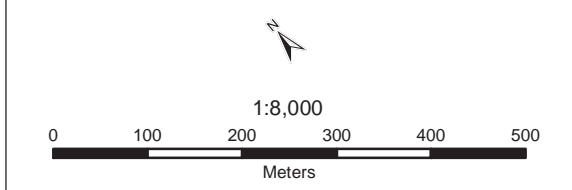
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

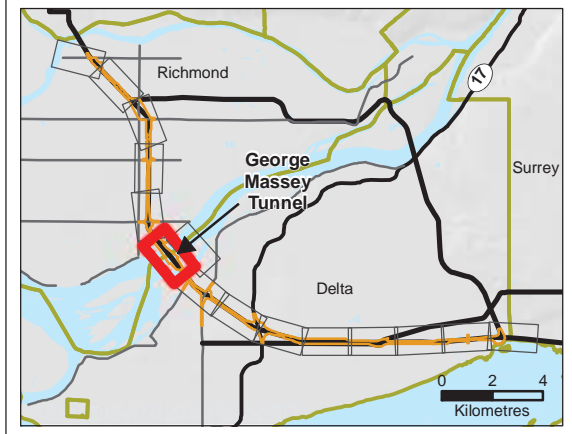


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**BARN OWL FORAGING HABITAT
SUITABILITY ASSESSMENT**

Figure 5g 12/05/2016

George Massey Tunnel Replacement Project BC 2005 PLAN B.C. on the Move



Legend

Barn Owl Foraging Ratings

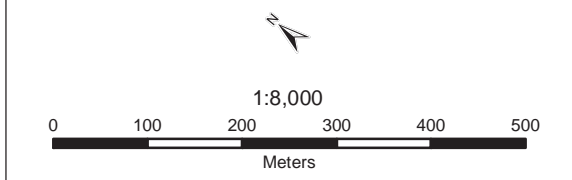
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

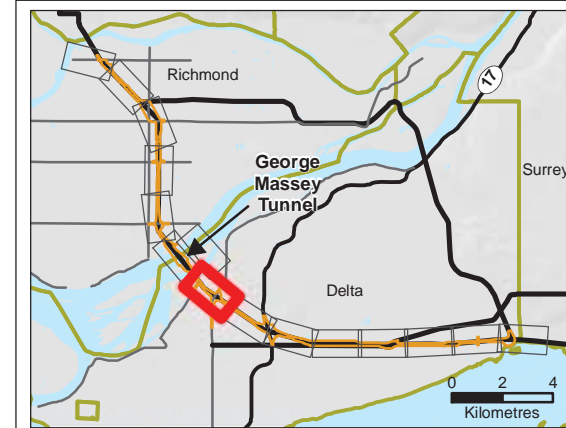
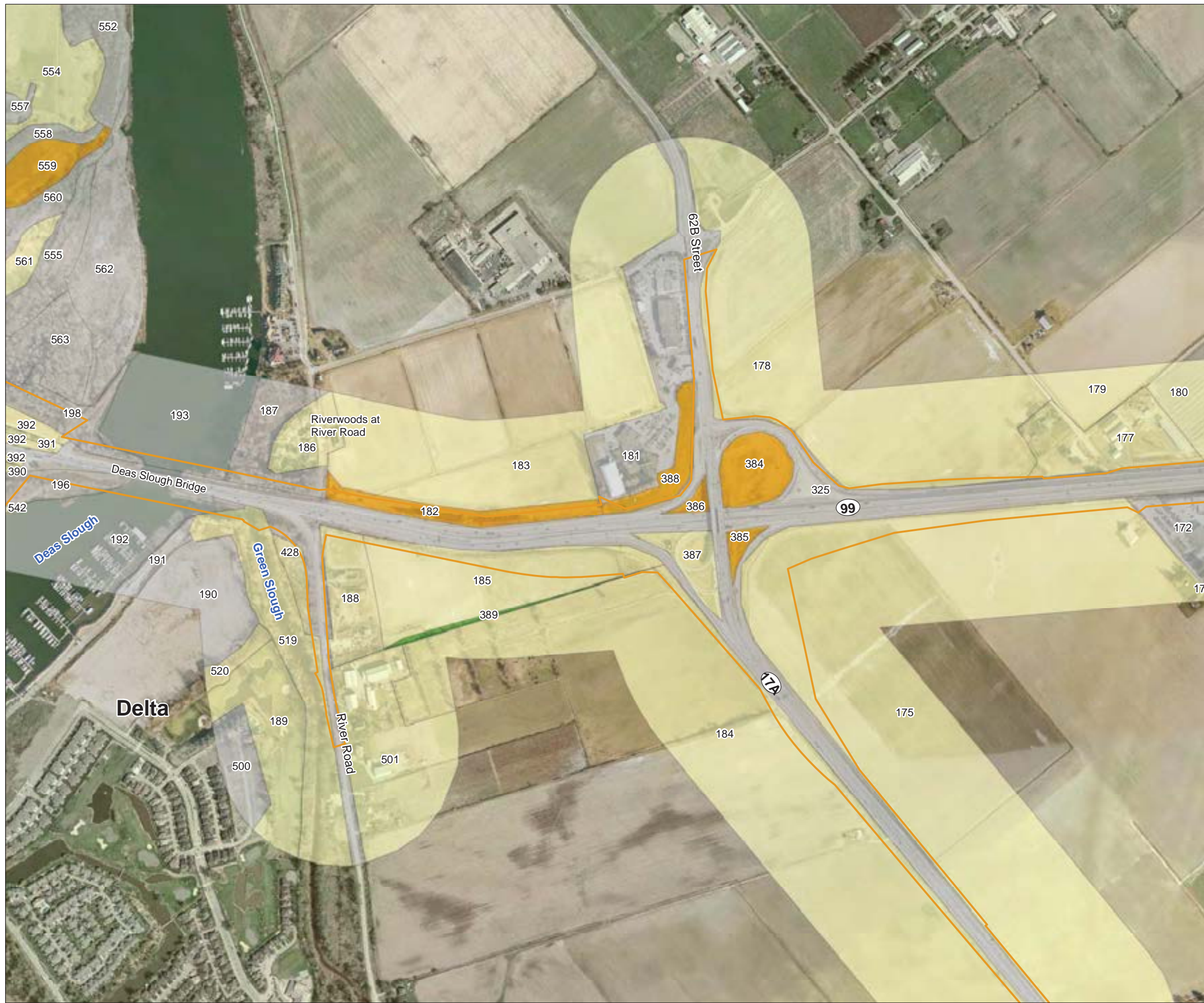
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**BARN OWL FORAGING HABITAT
SUITABILITY ASSESSMENT**

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| Figure 5h | 12/05/2016 |
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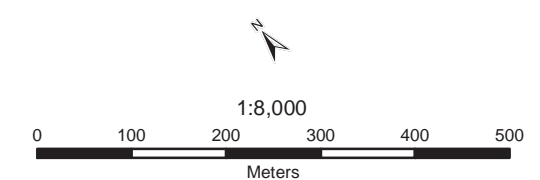
Legend

Barn Owl Foraging Ratings

- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5i | 12/05/2016 |
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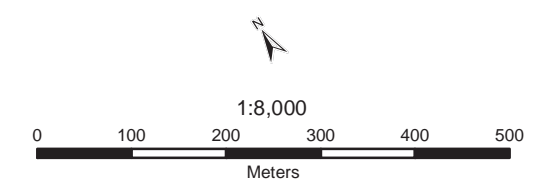
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Barn Owl Foraging Ratings

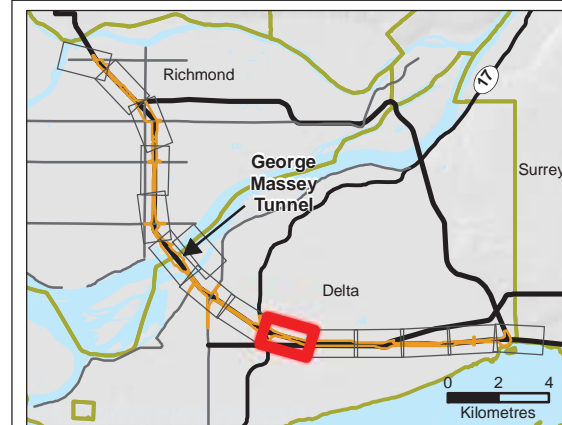
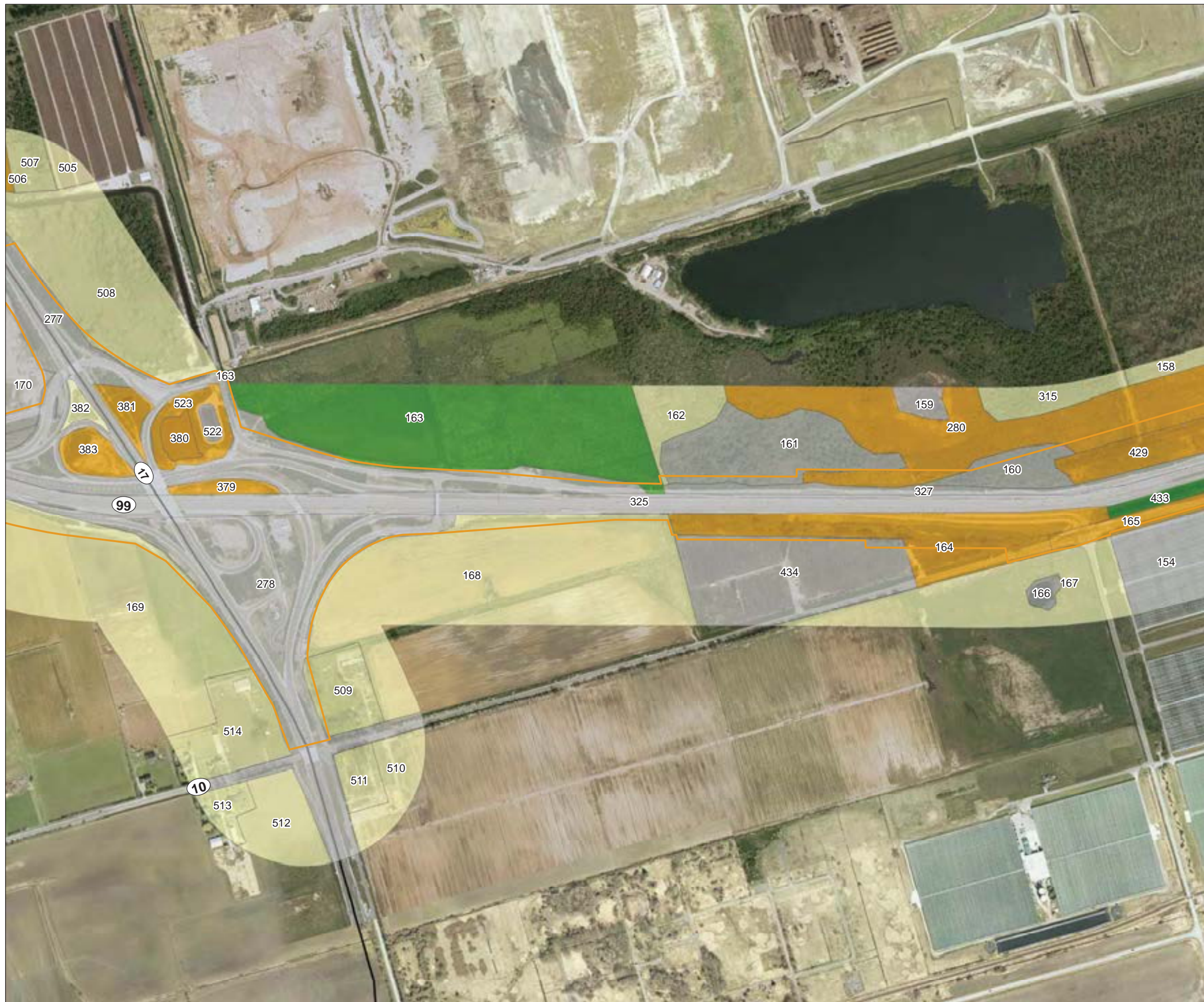
- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5j | 12/05/2016 |
| | |

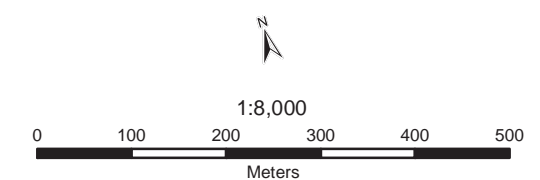


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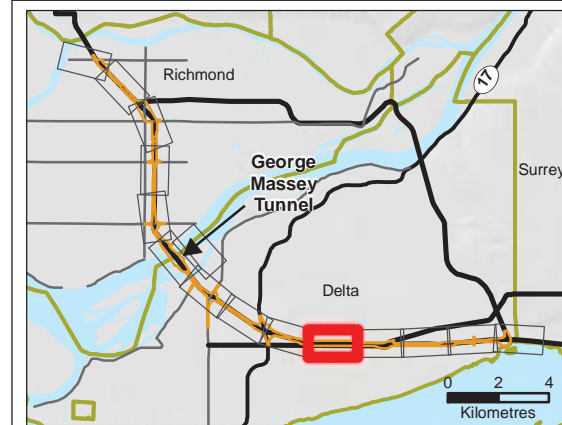
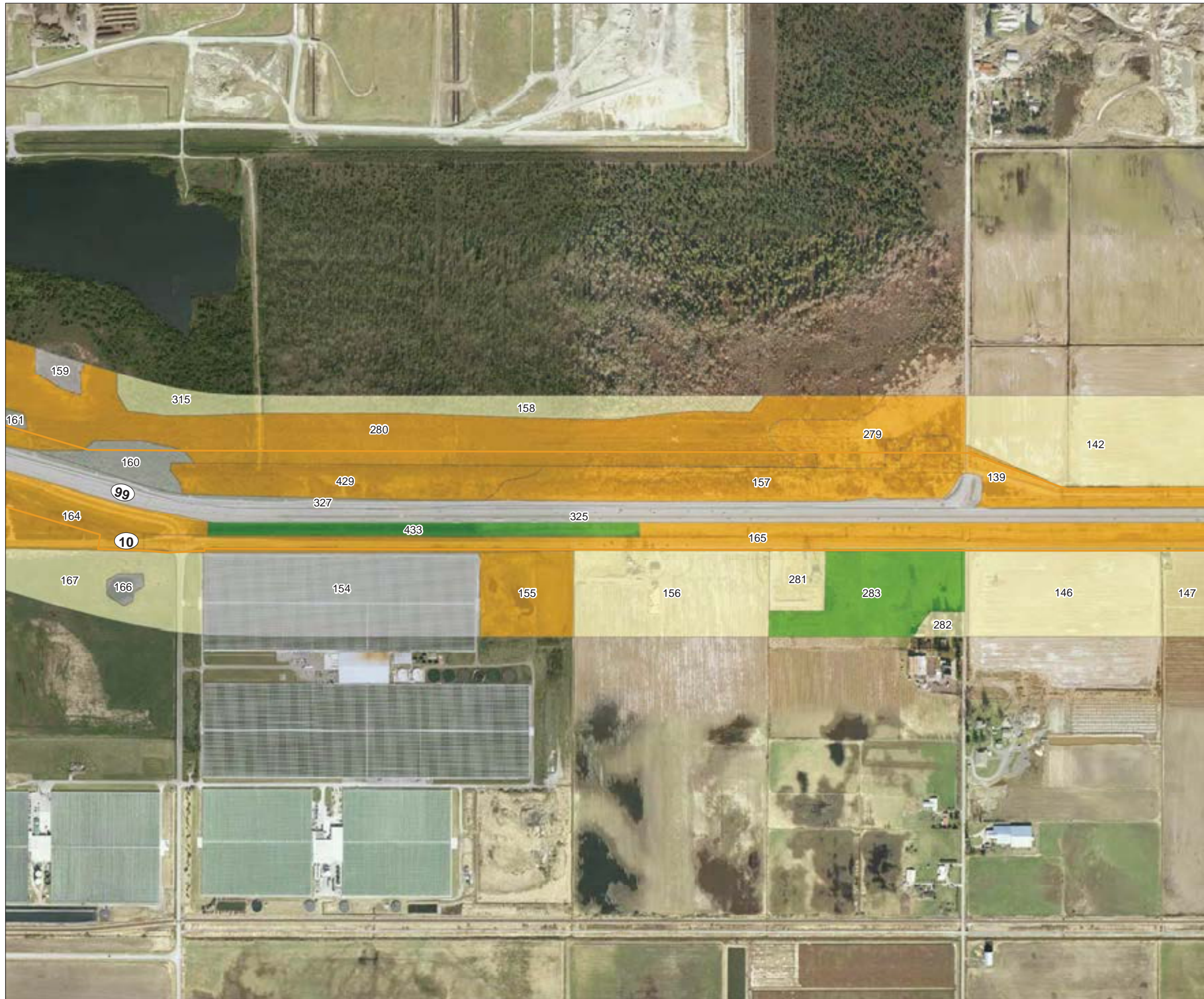
- Barn Owl Foraging Ratings**
- High
 - Moderate
 - Low
 - Nil
- 10 TEM polygon number
- Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5k | 12/05/2016 |
| | |



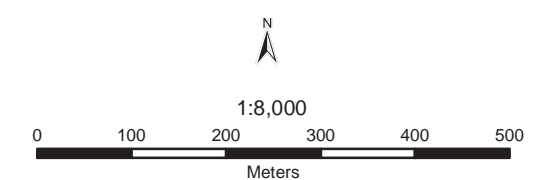
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Barn Owl Foraging Ratings

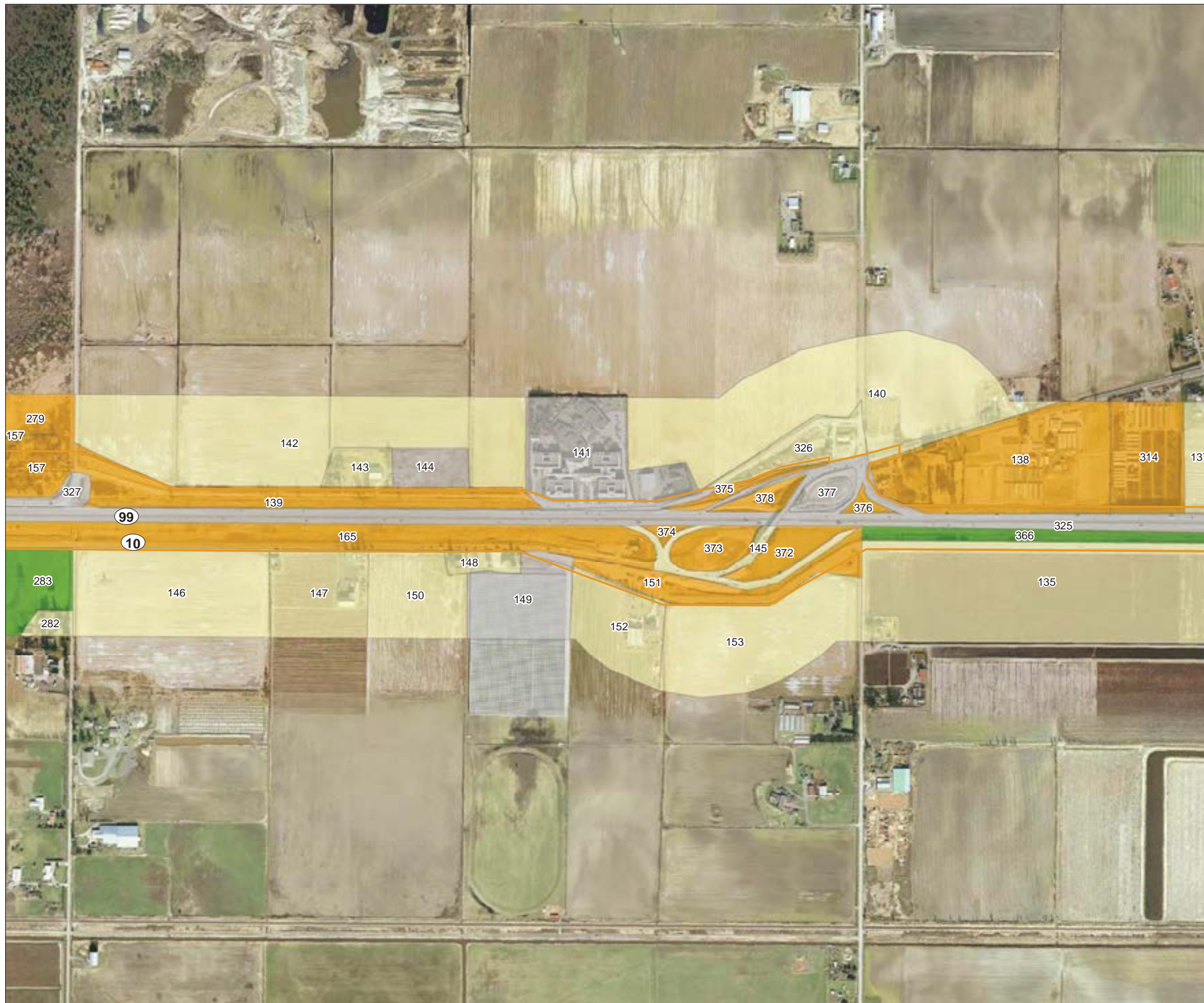
- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5I | 12/05/2016 |
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Legend

Barn Owl Foraging Ratings

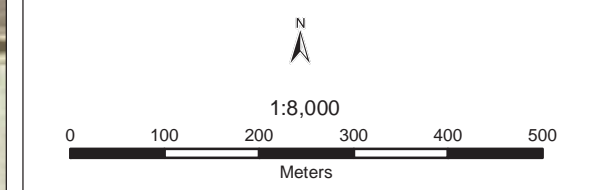
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**BARN OWL FORAGING HABITAT
SUITABILITY ASSESSMENT**

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| Figure 5m | 12/05/2016 |
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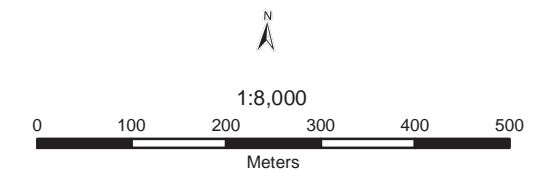
Legend

Barn Owl Foraging Ratings

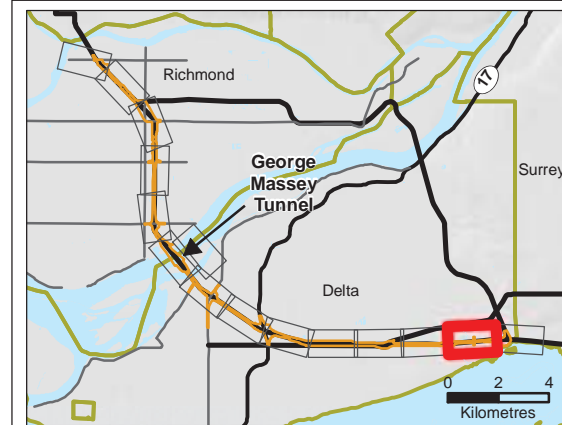
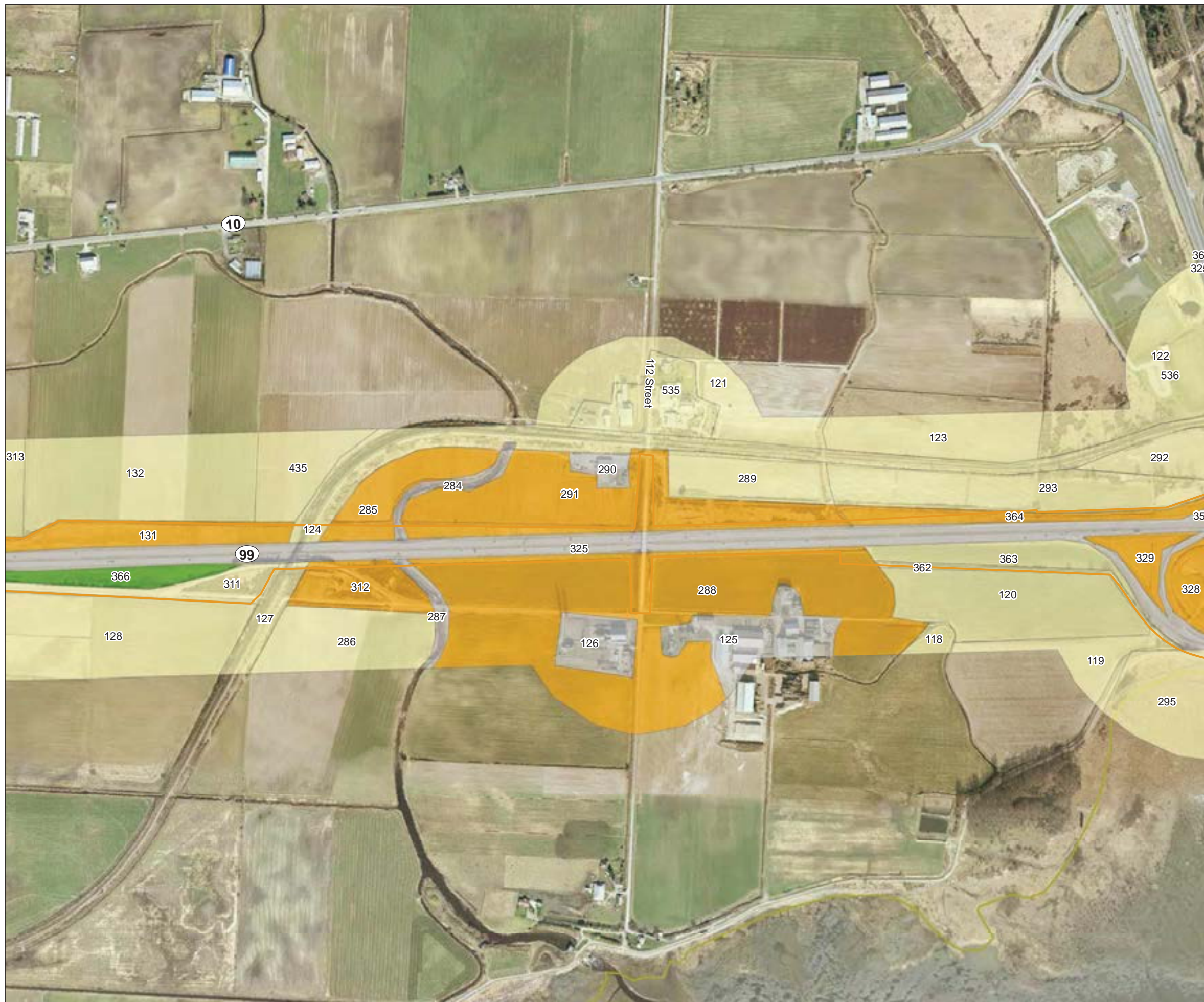
- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5n | 12/05/2016 |
| | |

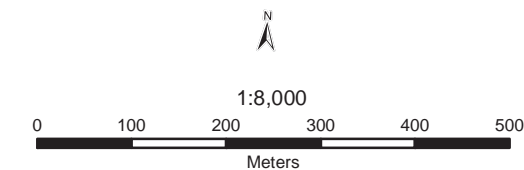


Legend

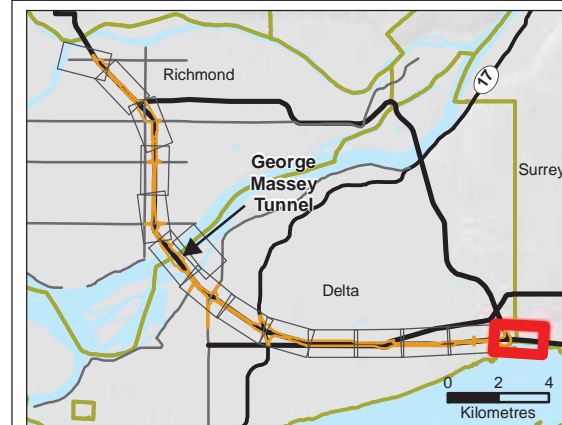
- Barn Owl Foraging Ratings**
- High
 - Moderate
 - Low
 - Nil
- 10 TEM polygon number
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5o | 12/05/2016 |
| | |



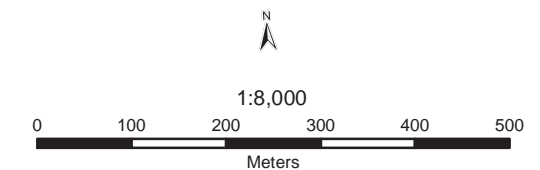
Legend

Barn Owl Foraging Ratings

- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

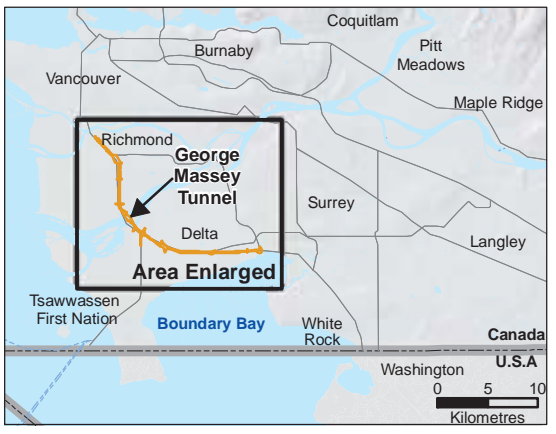
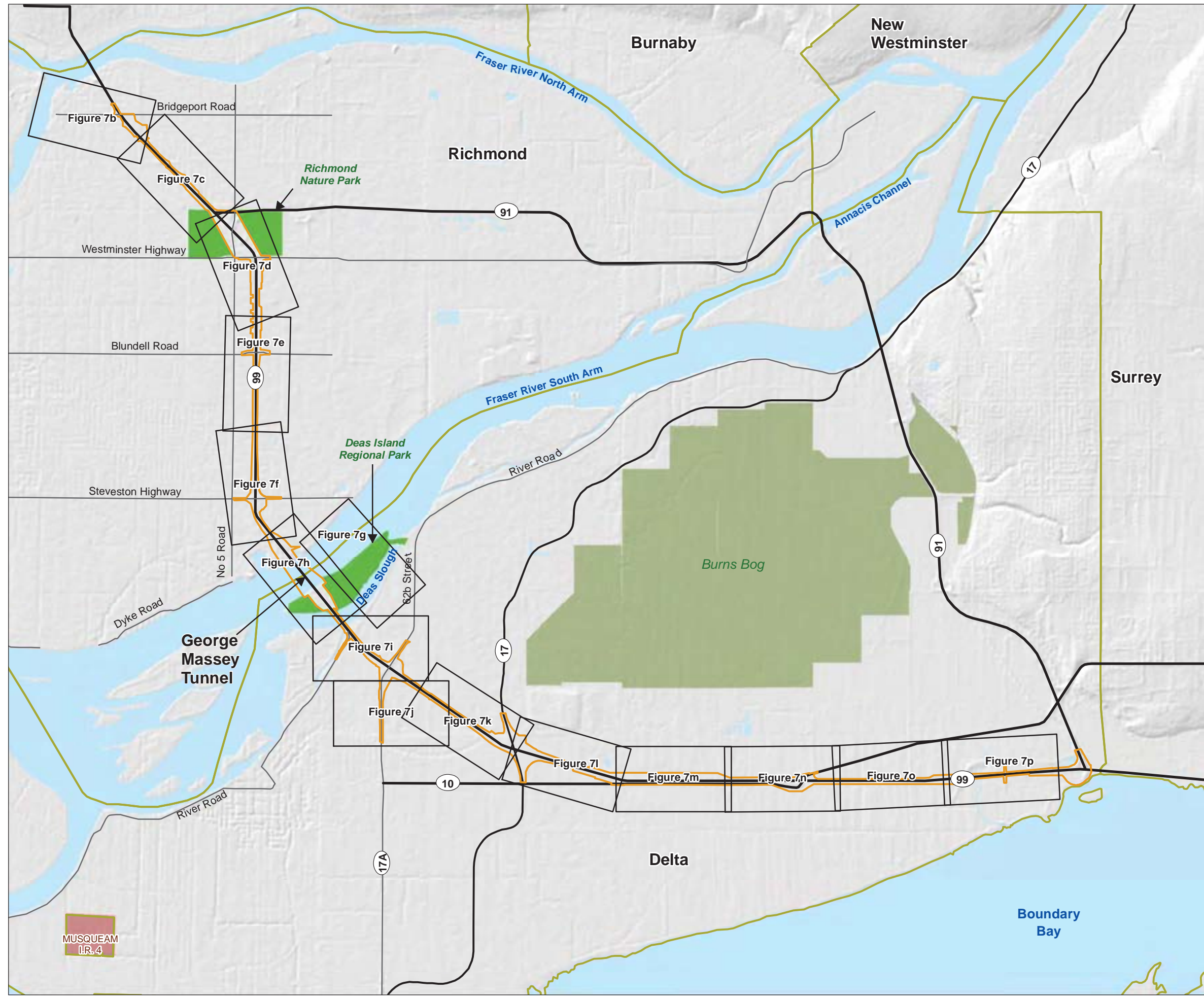
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| BARN OWL FORAGING HABITAT SUITABILITY ASSESSMENT | |
| Figure 5p | 12/05/2016 |
| | |

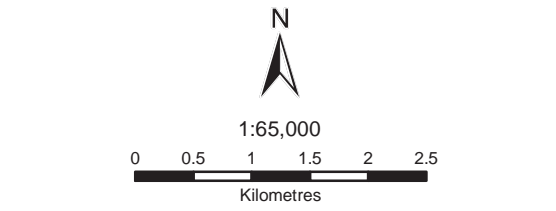
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- Legend**
- Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

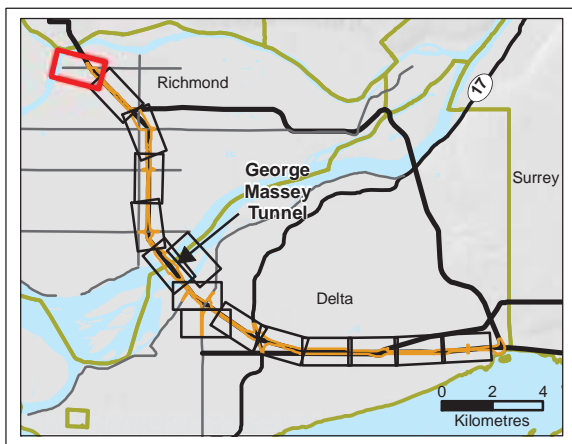
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TROWBRIDGE SHREW HABITAT SUITABILITY ASSESSMENT OVERVIEW | |
| Figure 6a | 12/05/2016 |
| | |

Path: O:\1217-289\285077\03\mxd\Widfile\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

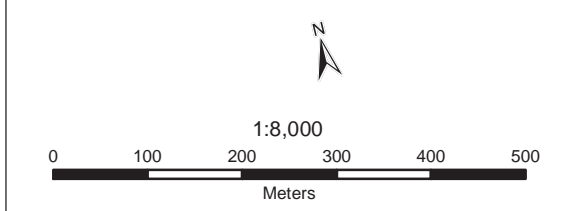
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

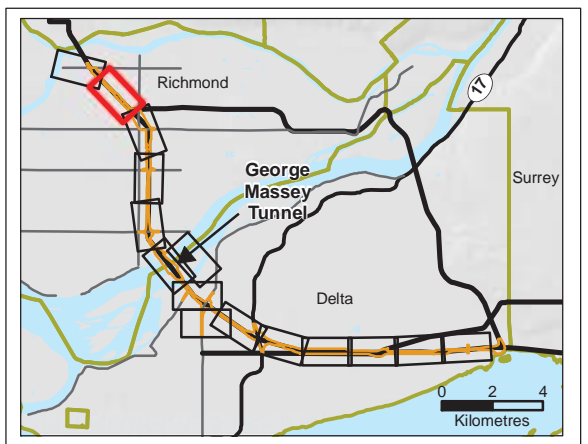
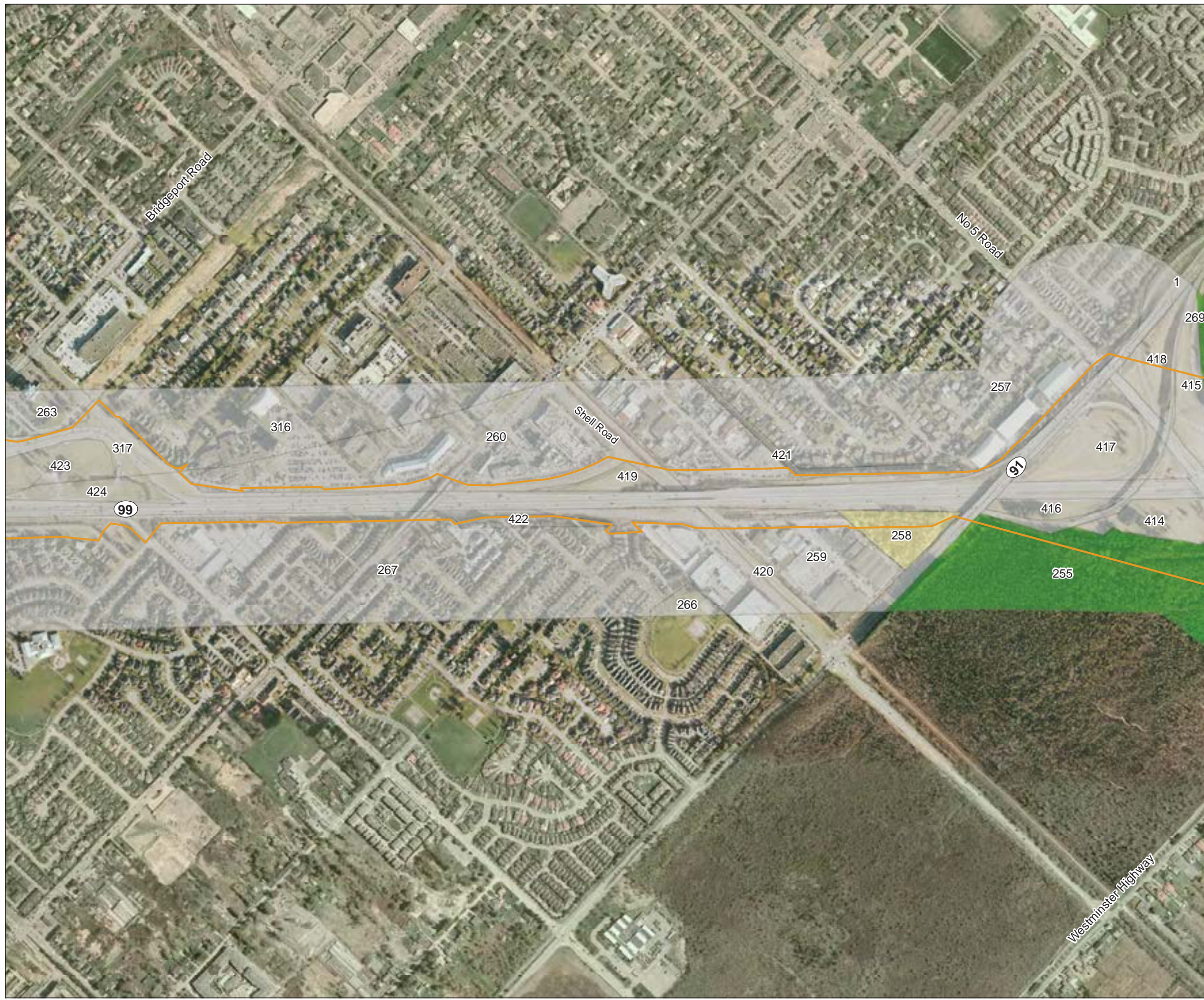


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6b | 12/05/2016 |
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Path: O:\217-289\285077\03\mxd\Widra\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

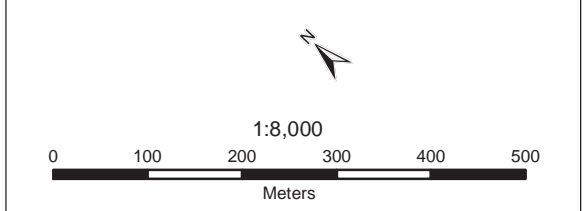
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

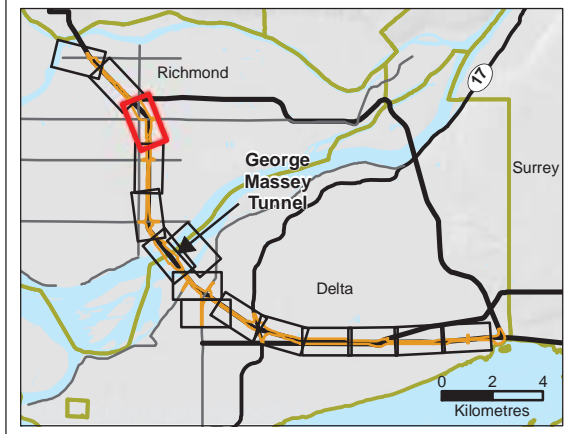
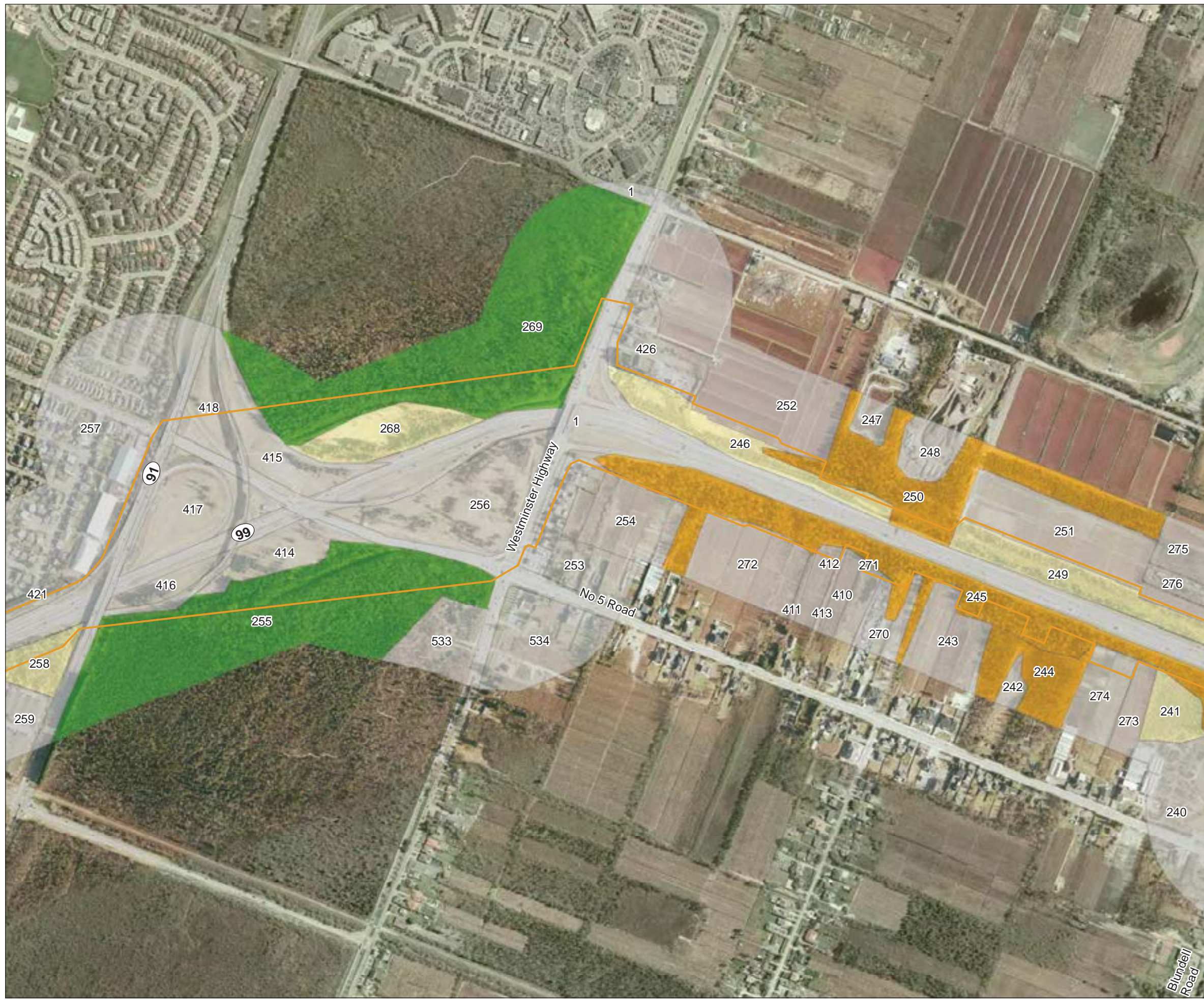


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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|-----------|------------|
| Figure 6c | 12/05/2016 |
|-----------|------------|

Path: O:\1217-289\285077\03\mxd\Widfile\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

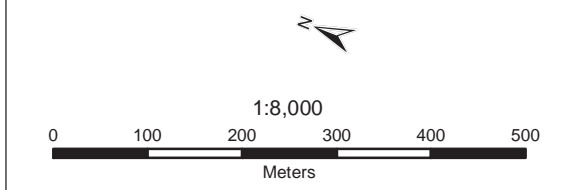
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

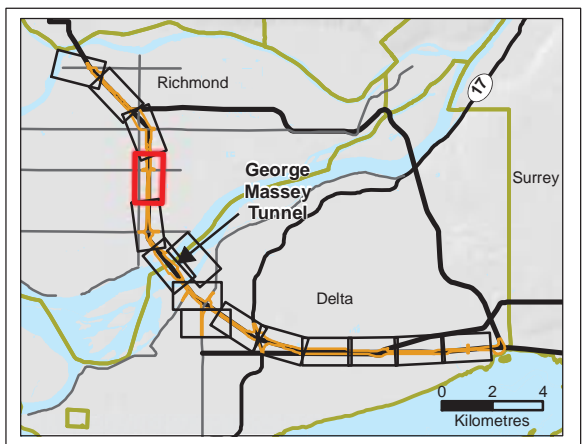
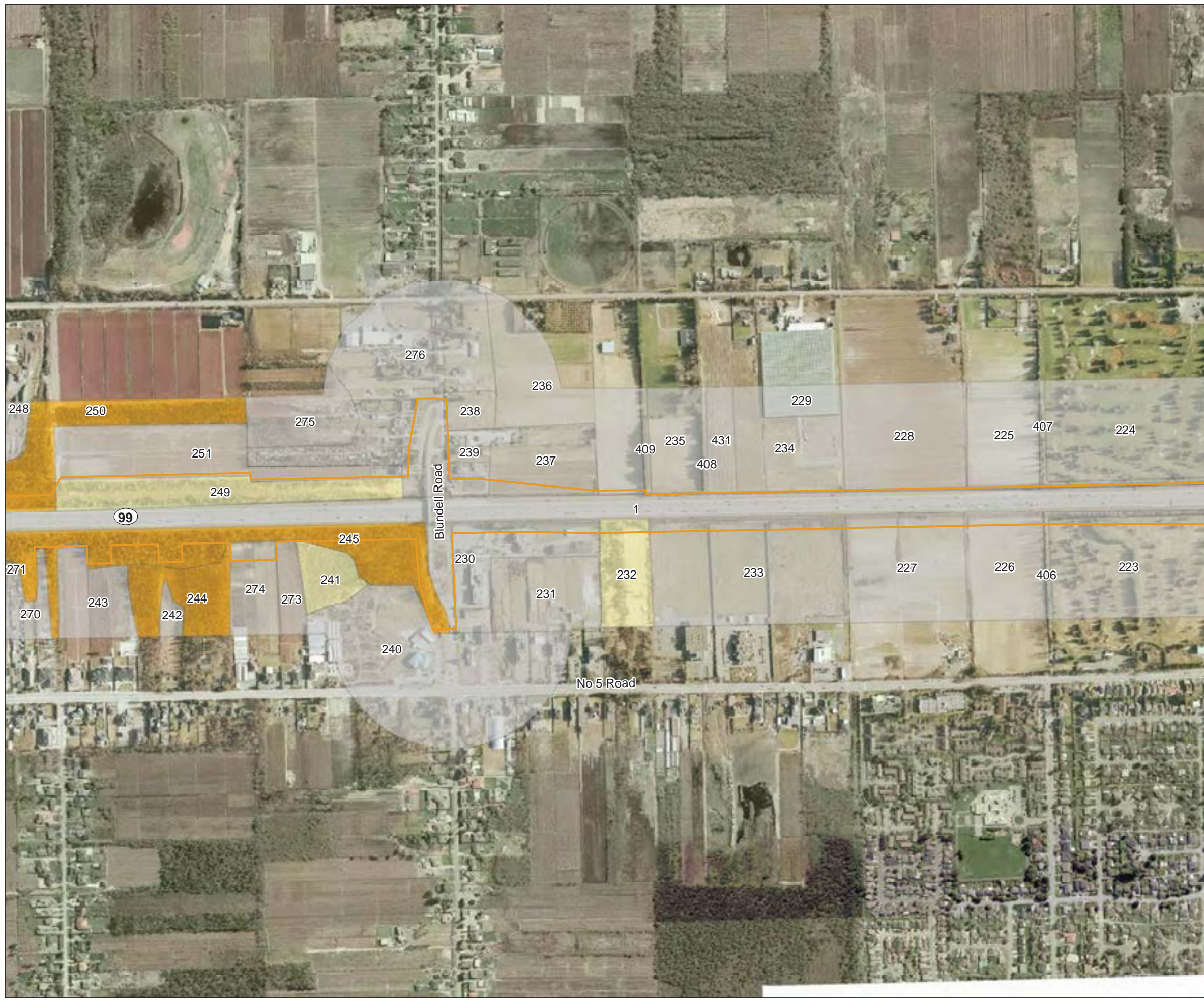


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

| | |
|-----------|------------|
| Figure 6d | 12/05/2016 |
|-----------|------------|

Path: O:\1217-289\285077\03\mxd\W\dlr\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

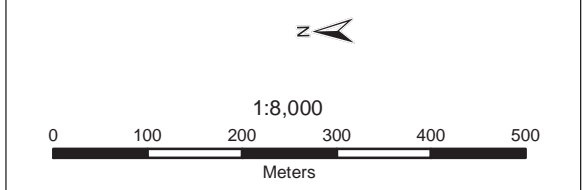
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

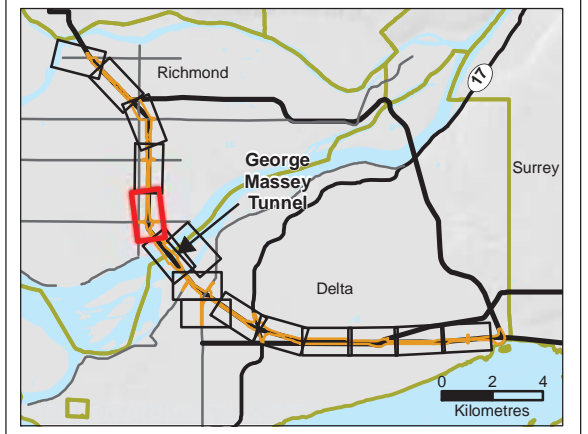
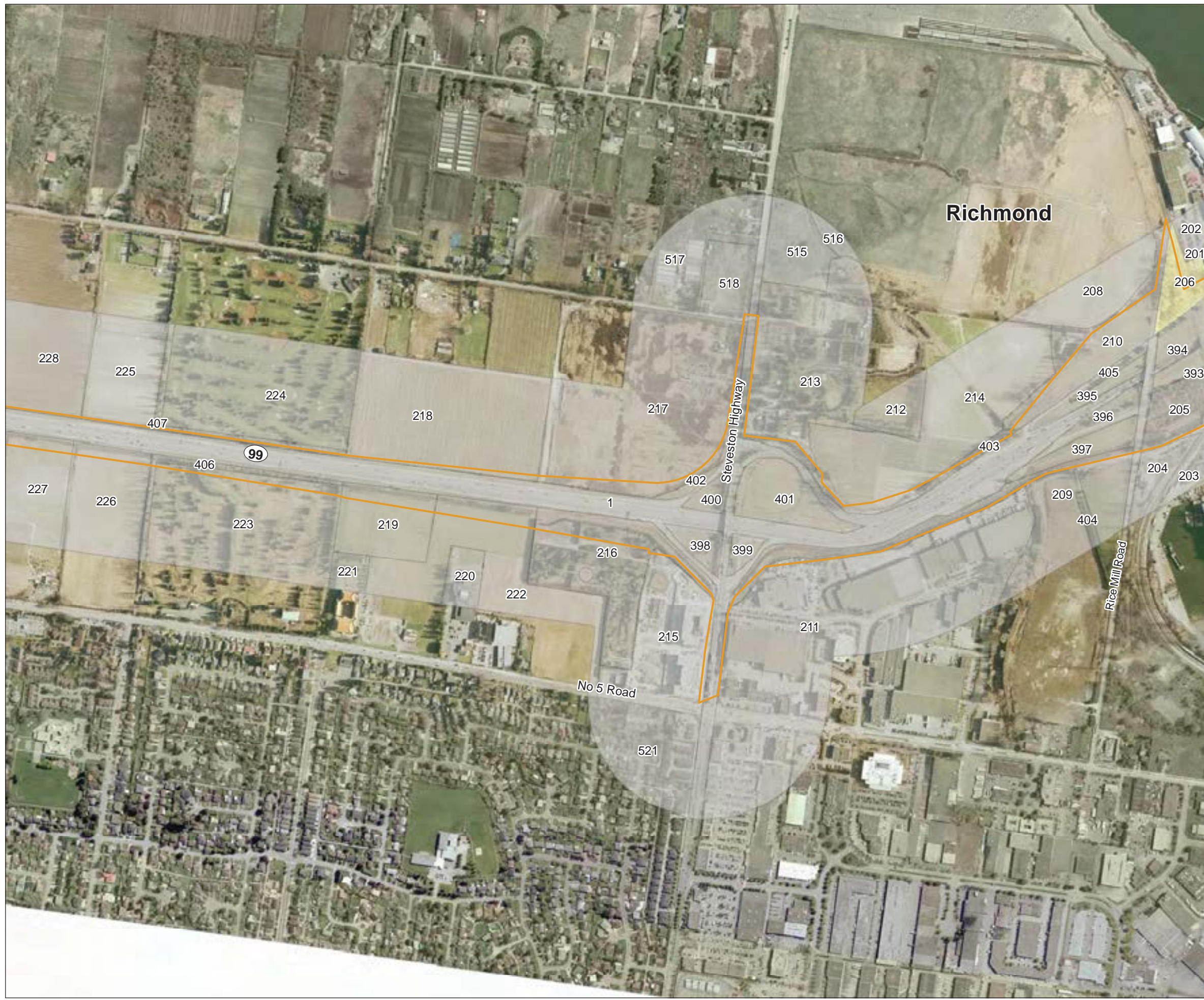


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6e | 12/05/2016 |
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Path: O:\217-289\285077\03\mxd\W\dlia\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

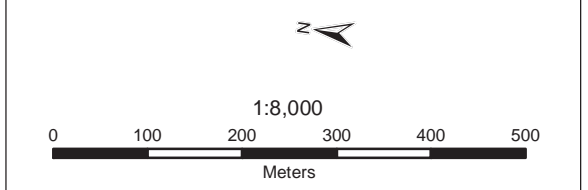
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

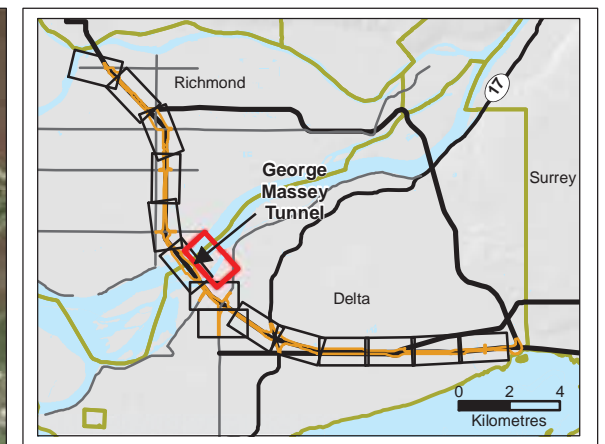


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6f | 12/05/2016 |
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Path: O:\1217-289\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig6g-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

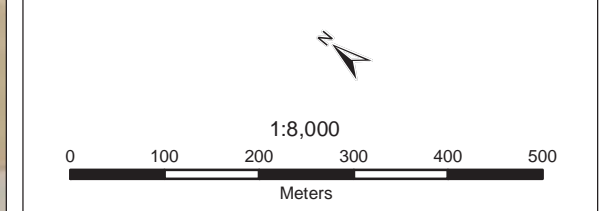
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

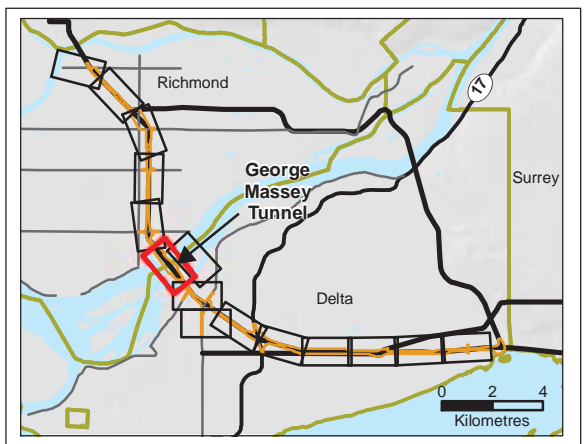


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6g | 12/05/2016 |
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Path: O:\1217-289\285077\03\mxd\Widline\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

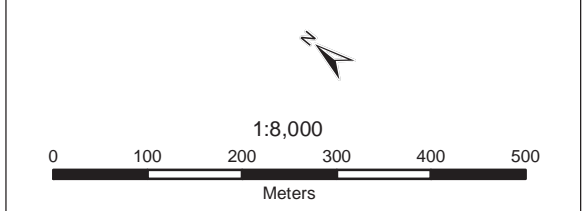
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

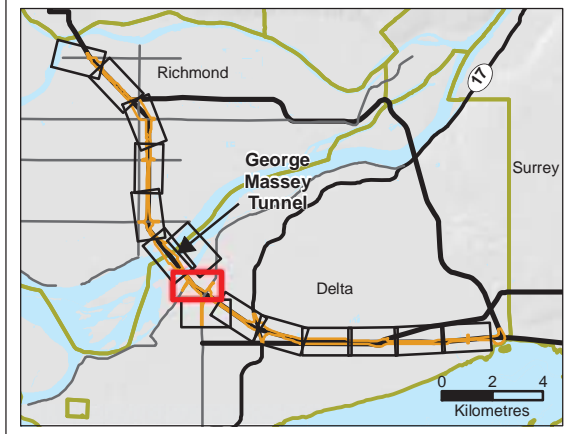


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6h | 12/05/2016 |
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Path: O:\217-289\285077\03\mxd\W\dlfia\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

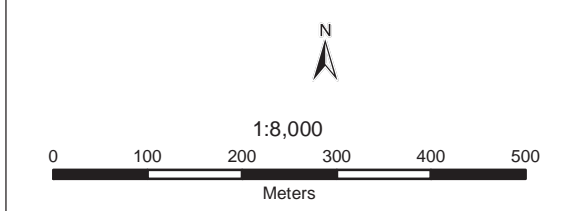
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

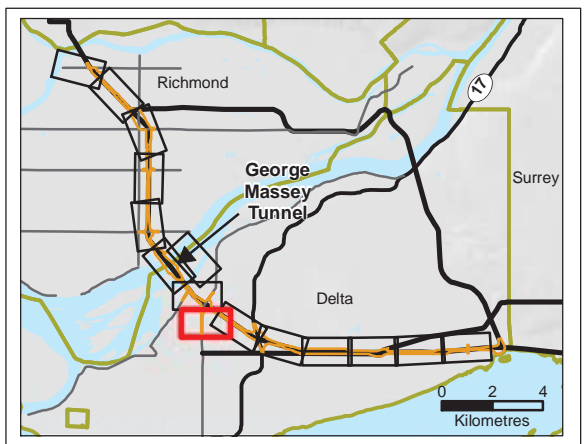


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6i | 12/05/2016 |
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Path: O:\217-289\285077\03\mxd\Widfile\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

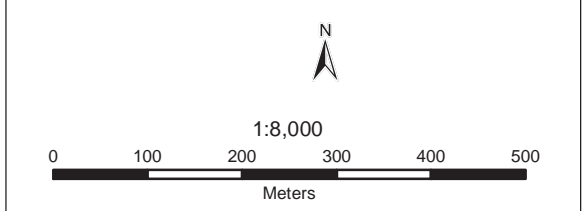
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

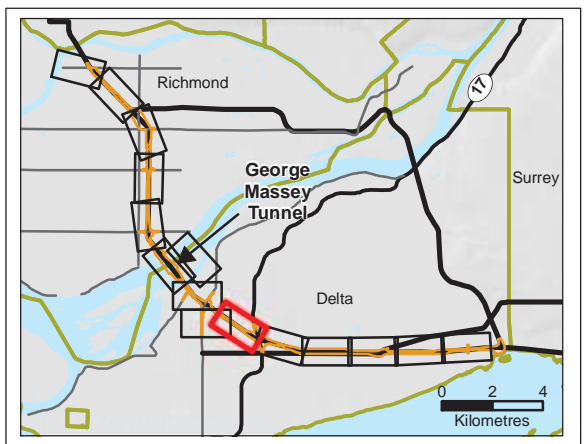


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6j | 12/05/2016 |
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Path: O:\217-289\285077\03\mxd\Widfile\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

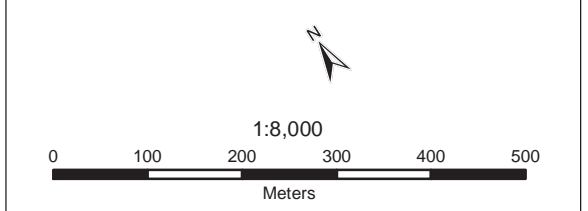
Trowbridge's Shrew Habitat Suitability

- High
- Moderate
- Low
- Nil

- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

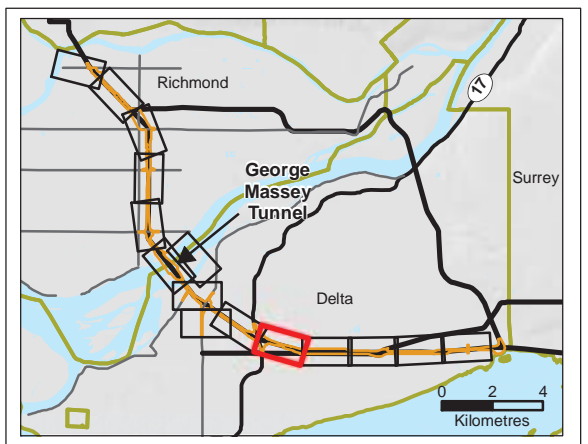


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6k | 12/05/2016 |
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Path: O:\217-289\285077\03\mxd\WidfileSmall_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

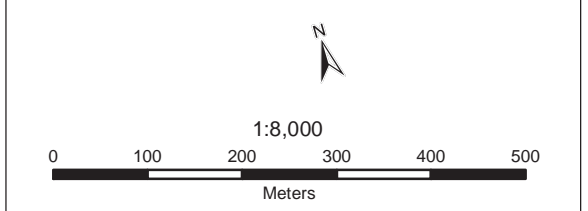
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

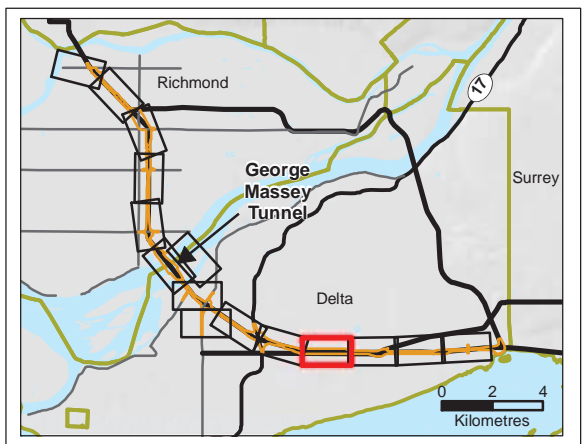


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6I | 12/05/2016 |
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Path: O:\1217-289\285077\03\mxd\Widfile\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

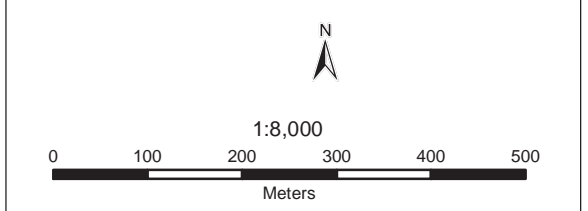
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

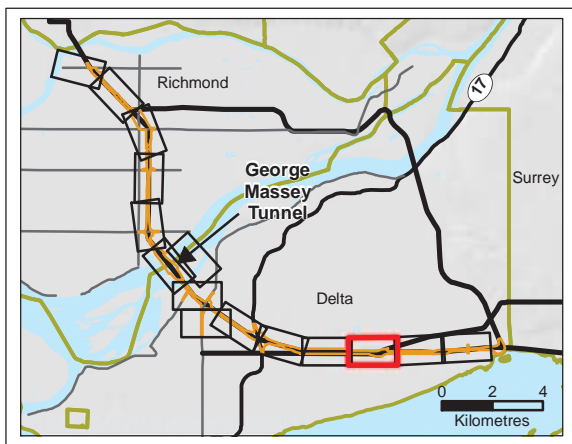


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6m | 12/05/2016 |
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Path: O:\1217-289\285077\03\mxd\Widfile\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

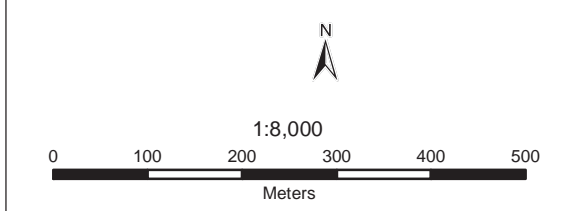
Trowbridge's Shrew Habitat Suitability

- High
- Moderate
- Low
- Nil

- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

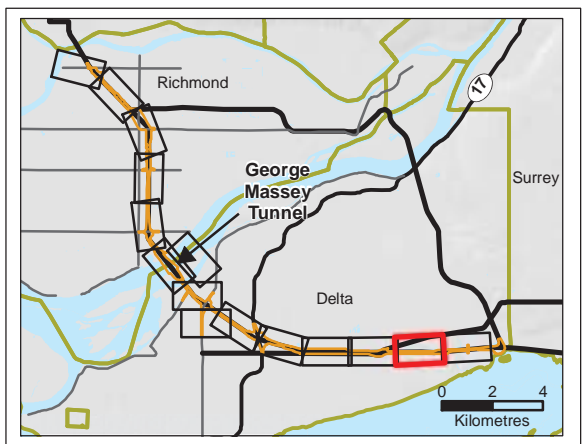


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6n | 12/05/2016 |
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Path: O:\1217-289\285077\03\mxd\Widfile\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

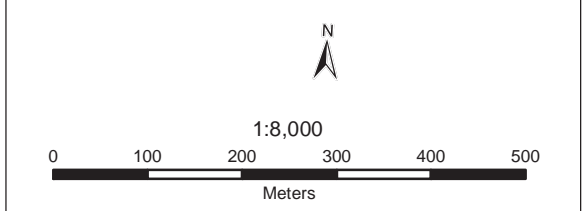
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

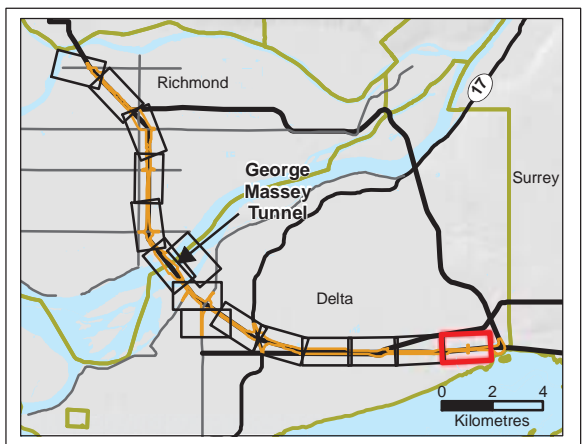


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6a | 12/05/2016 |
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Path: O:\217-289\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig\q-285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

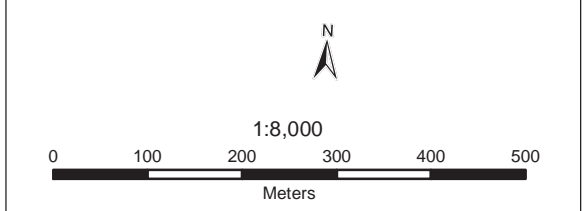
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

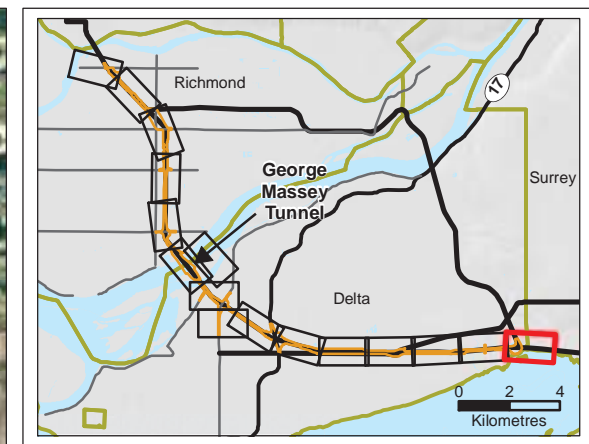


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6p | 12/05/2016 |
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Path: O:\1217-289\285077\03\mxd\Widline\Small_Mammals\EA\Fig6b-q_285_077_03_EA_TrowbridgeShrew-Sheets_160506_FINAL.mxd



Legend

Trowbridge's Shrew Habitat Suitability

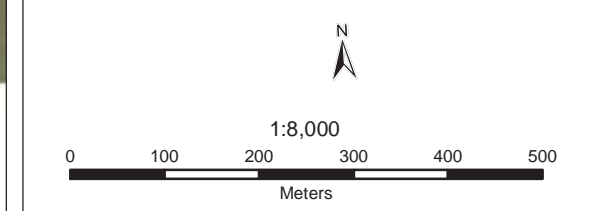
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

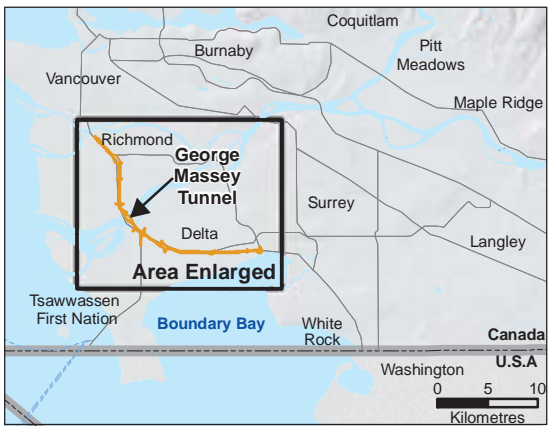
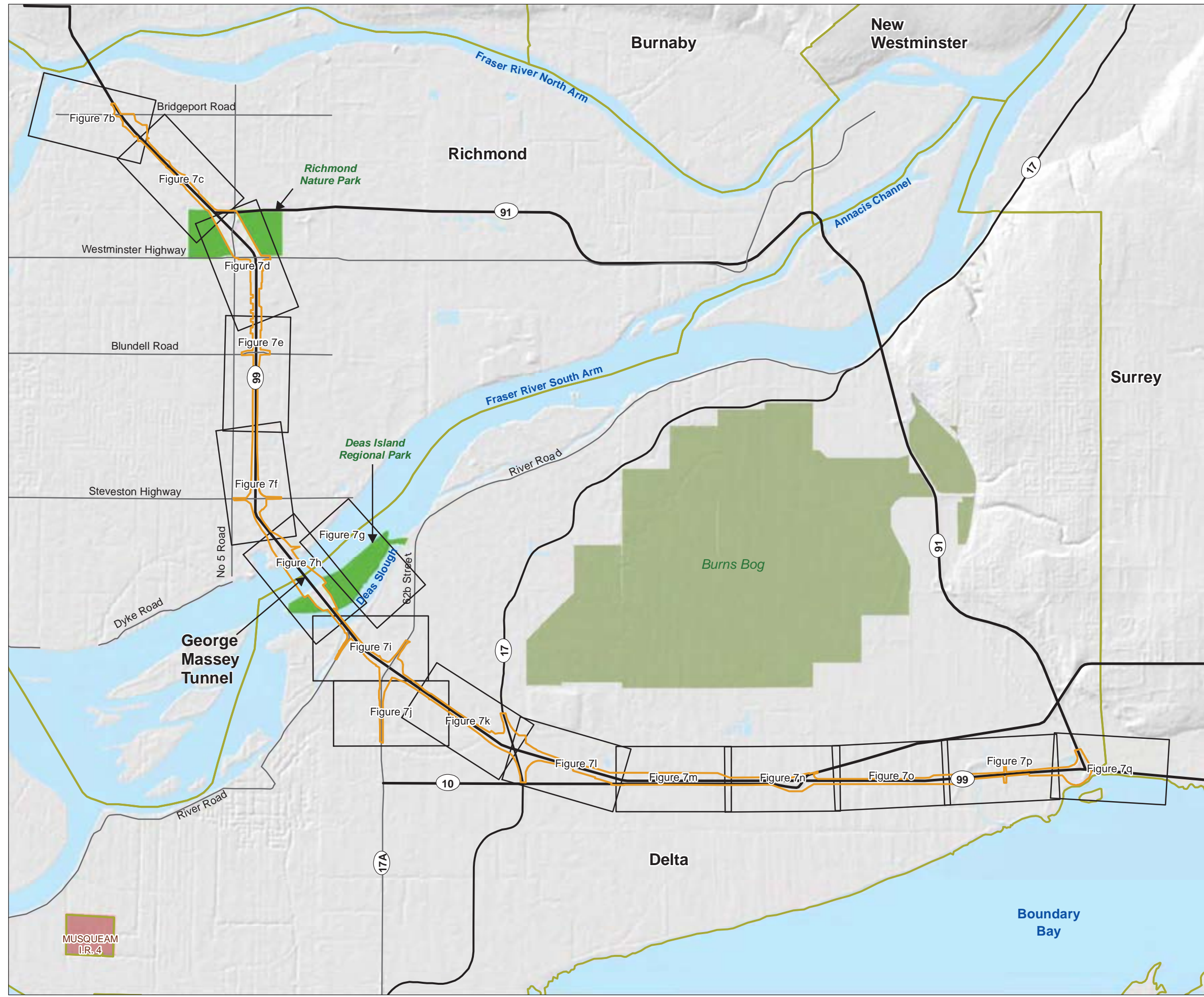


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**TROWBRIDGE'S SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 6q | 12/05/2016 |
|-----------|------------|

Path: O:\1217-289\285\077\03\mxd\Wildlife\Small_Mammals\EA\Fig7a_285_077_03_EA_PWS-Overview_160506_FINAL.mxd

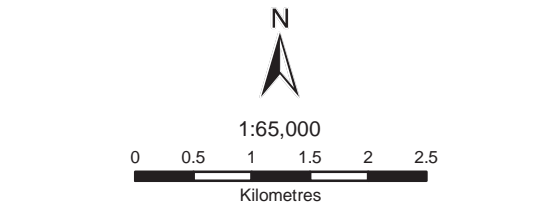


Legend

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

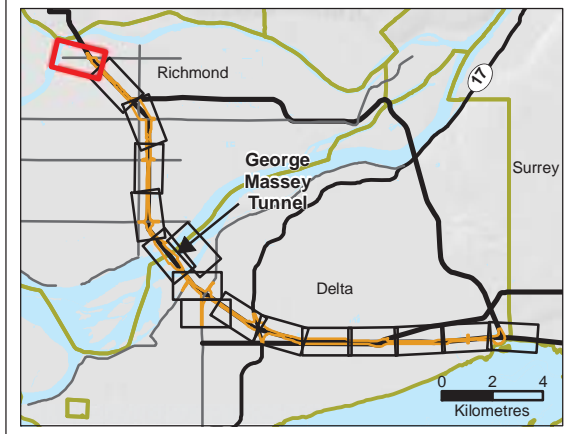
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT OVERVIEW**

| | |
|-----------|------------|
| Figure 7a | 13/05/2016 |
|-----------|------------|



Legend

Pacific Water Shrew Habitat Suitability

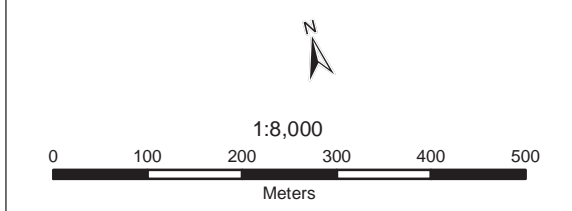
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

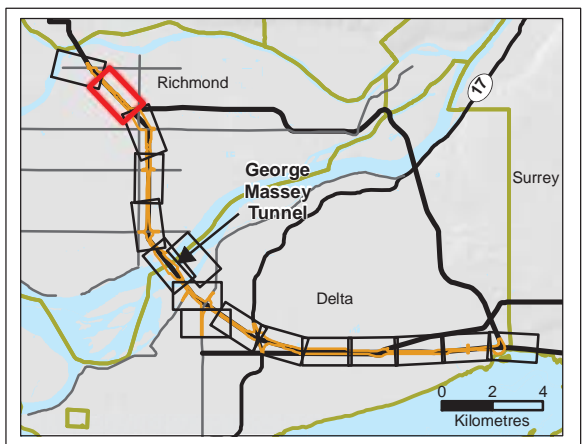
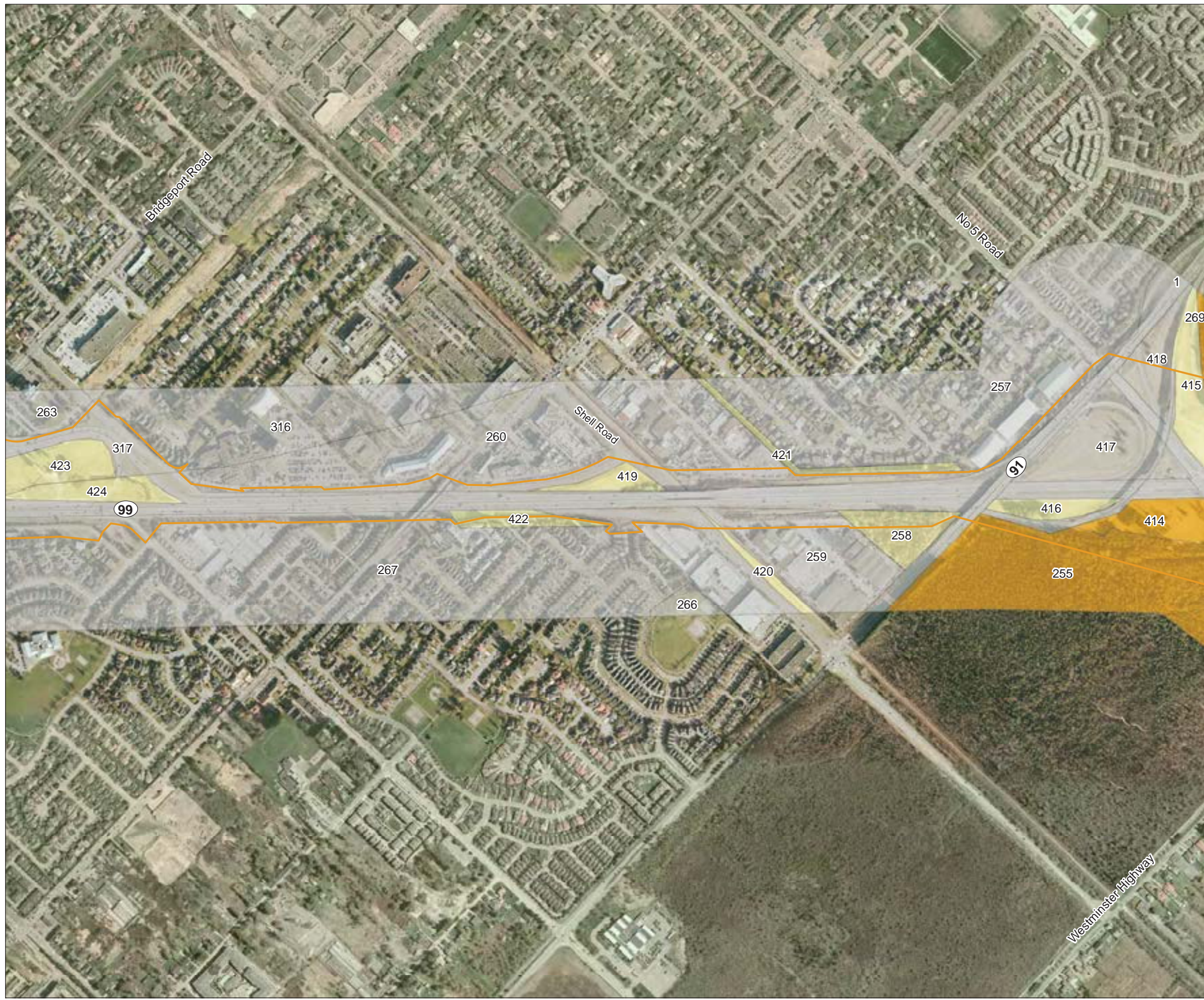


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7b | 12/05/2016 |
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Legend

Pacific Water Shrew Habitat Suitability

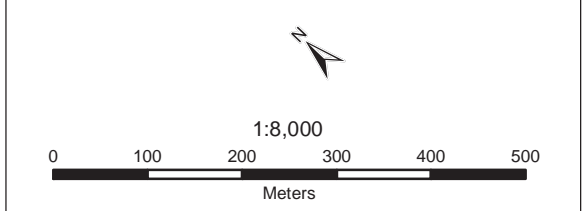
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

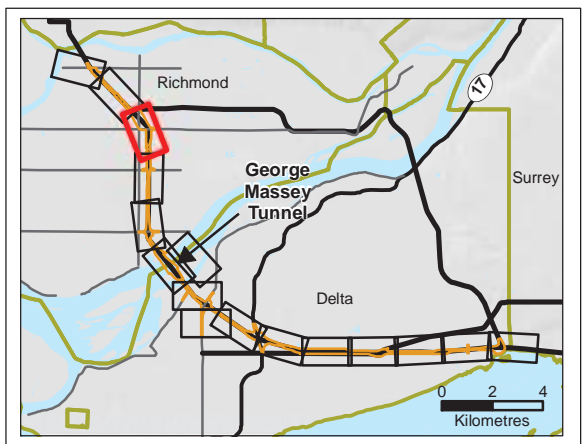
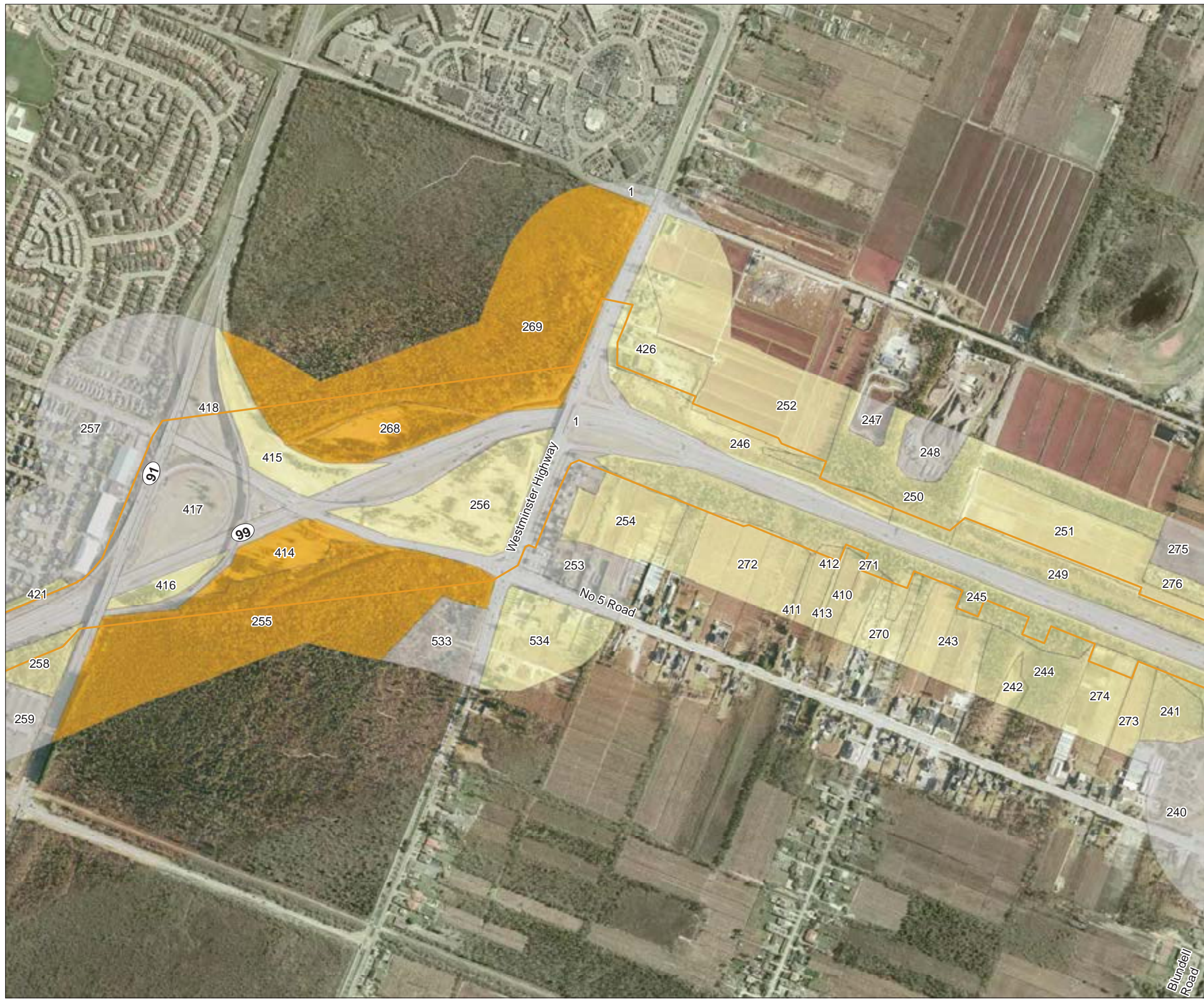


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7c | 12/05/2016 |
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Path: O:\217-289\285077\03.mxd\Widfile\Small_Mammals\EA\Fig7b-q_285_077_03_EA_PWS-Sheets_160506_FINAL.mxd



Legend

Pacific Water Shrew Habitat Suitability

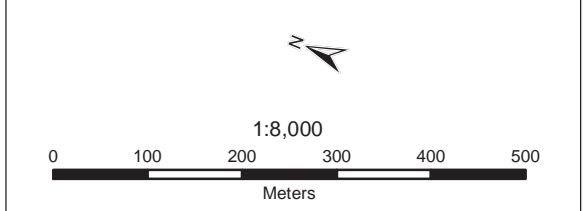
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

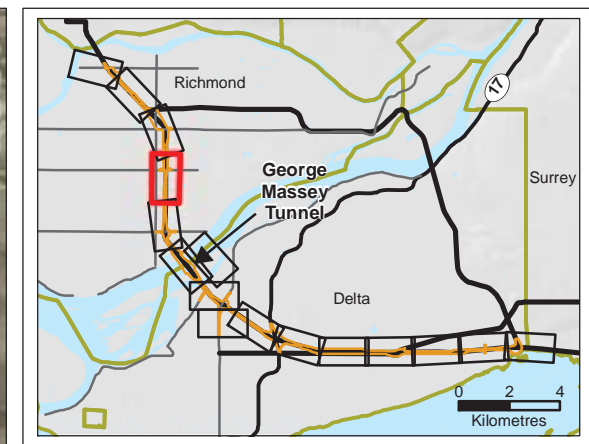
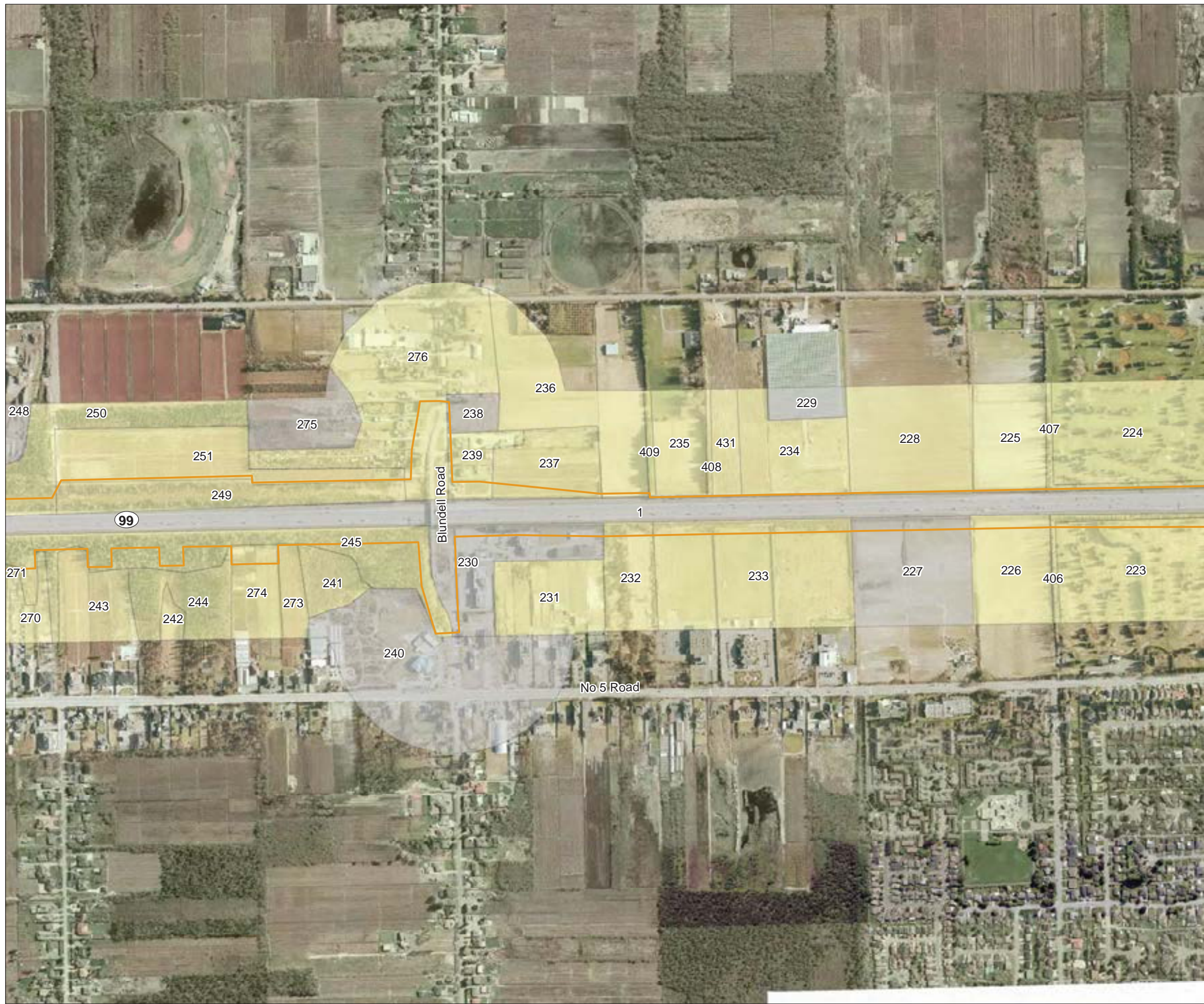
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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|-----------|------------|
| Figure 7d | 12/05/2016 |
|-----------|------------|



Legend

Pacific Water Shrew Habitat Suitability

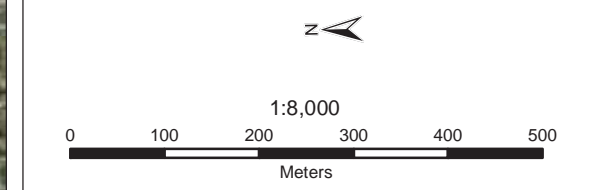
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

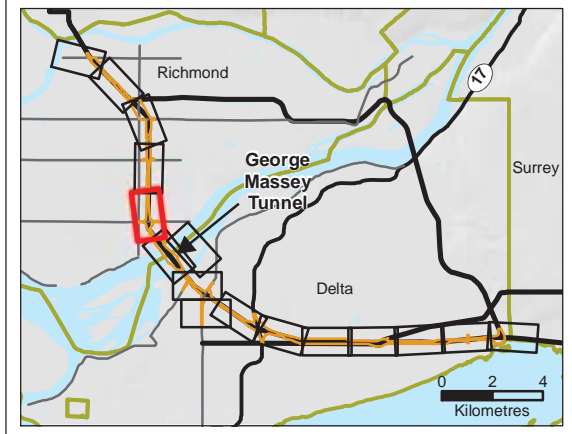
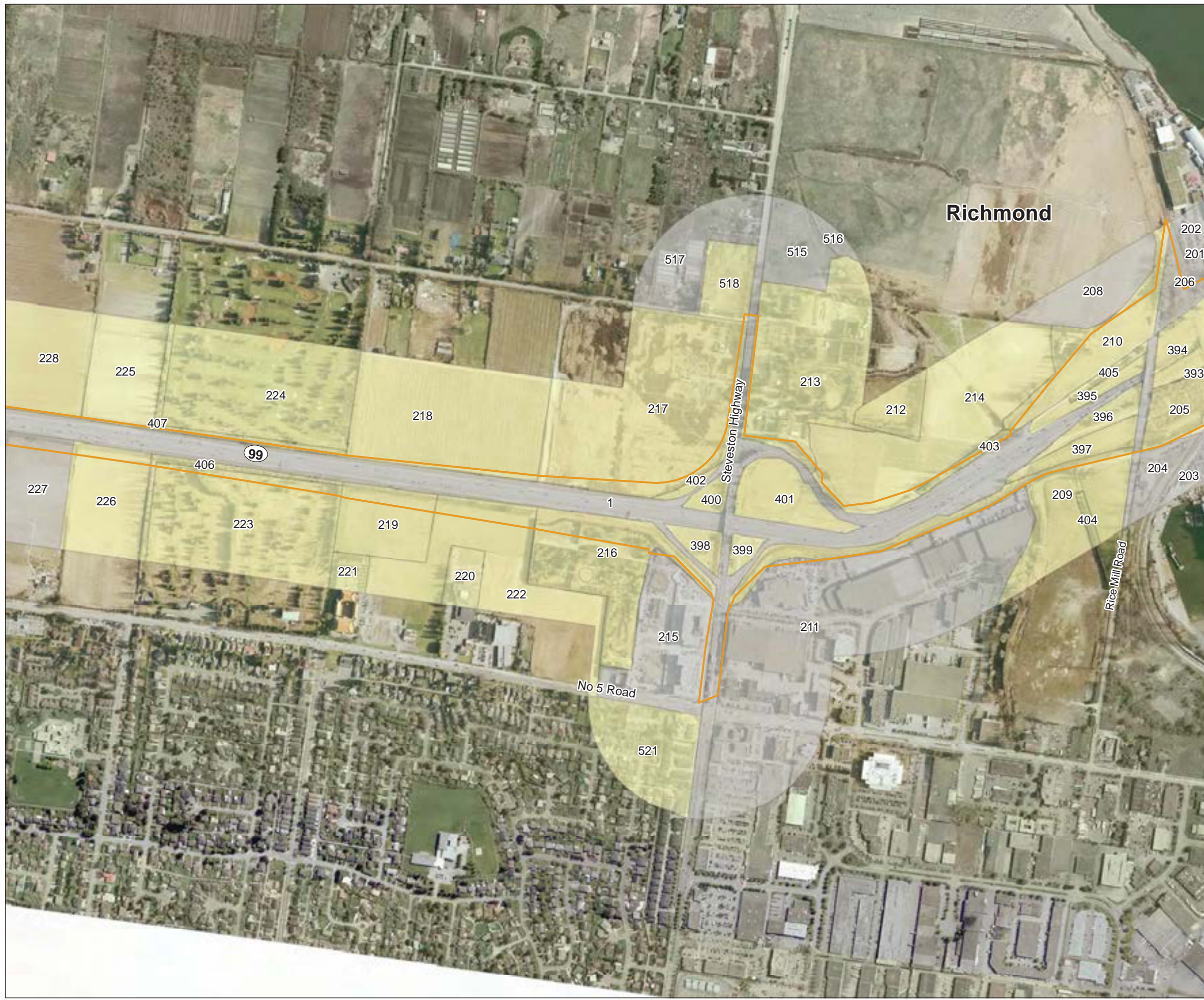
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7e | 12/05/2016 |
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Legend

Pacific Water Shrew Habitat Suitability

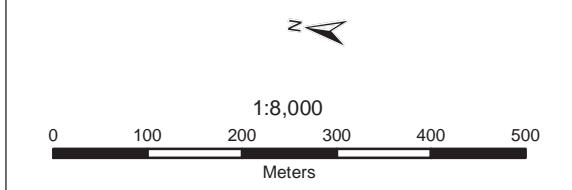
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

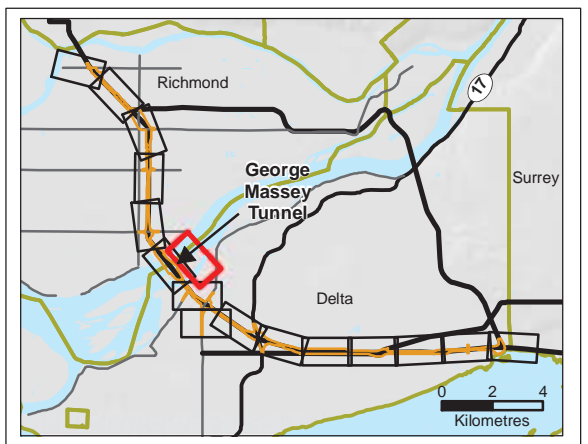


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7f | 12/05/2016 |
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Path: O:\17-289\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig7g-285_077_03_EA_PWS-Sheets_160506_FINAL.mxd



Legend

Pacific Water Shrew Habitat Suitability

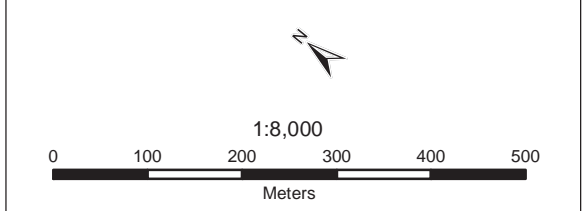
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

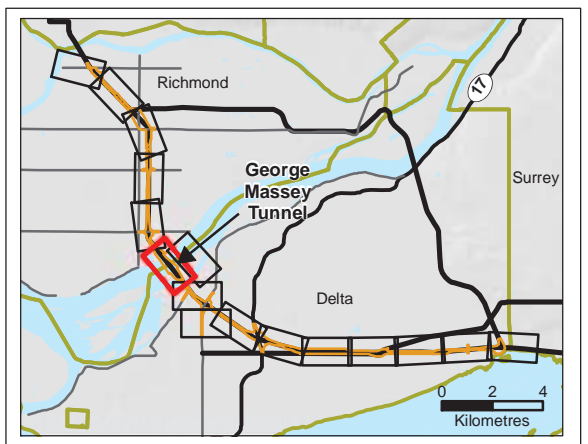


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7g | 12/05/2016 |
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Legend

Pacific Water Shrew Habitat Suitability

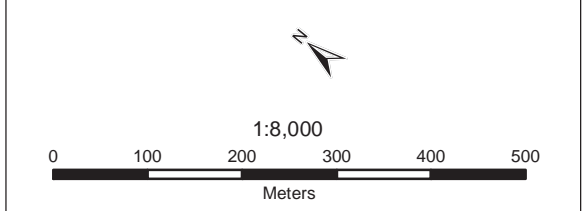
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

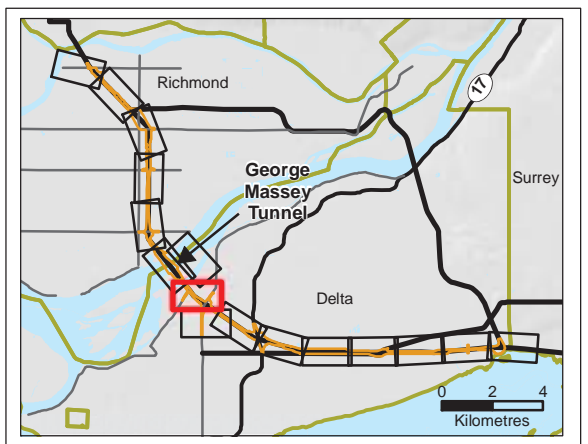
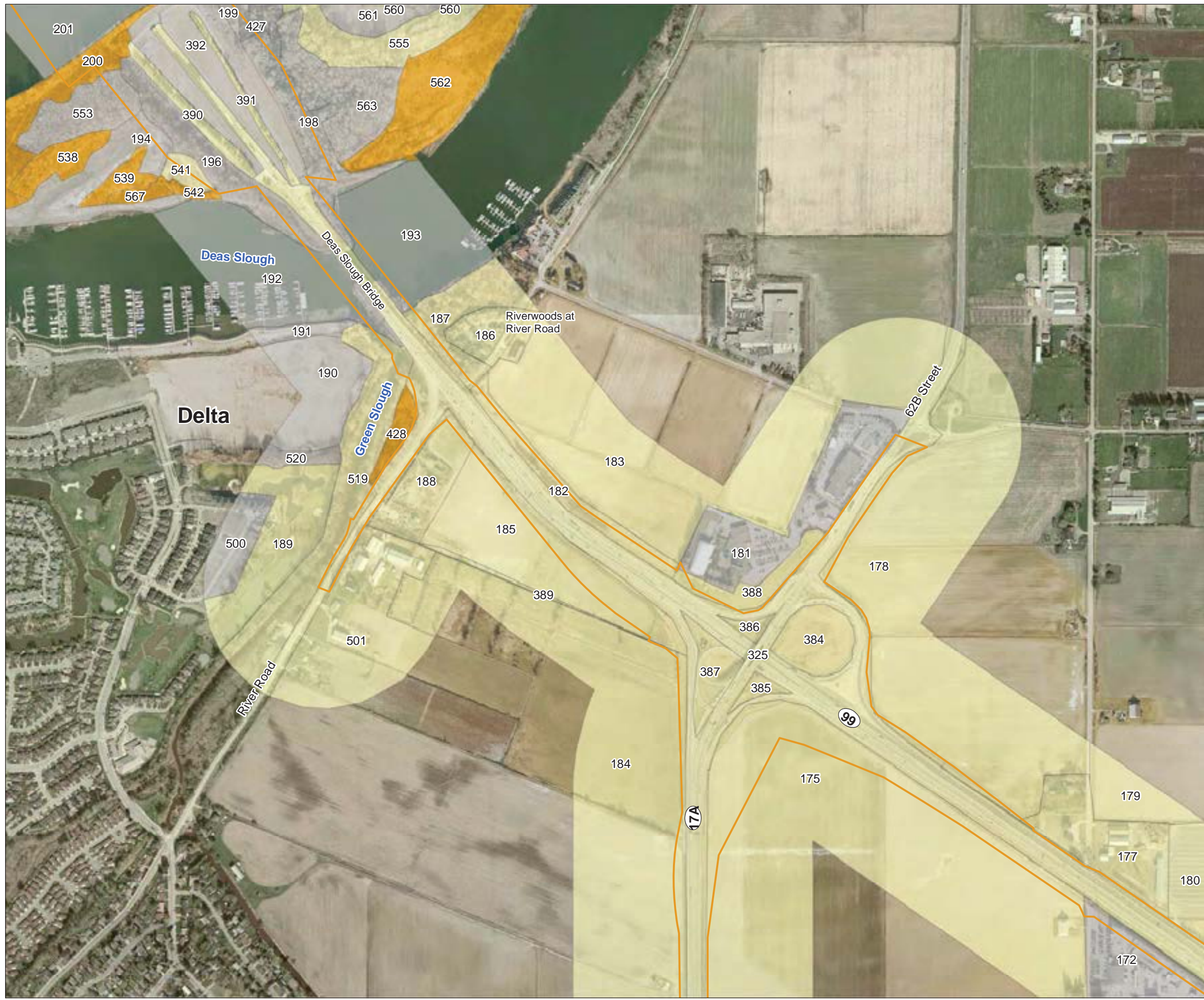


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7h | 12/05/2016 |
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Legend

Pacific Water Shrew Habitat Suitability

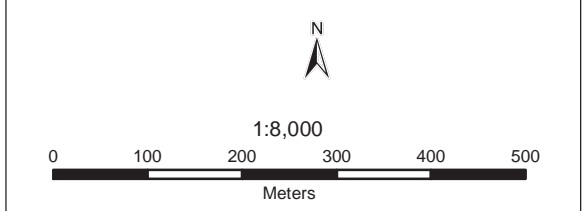
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

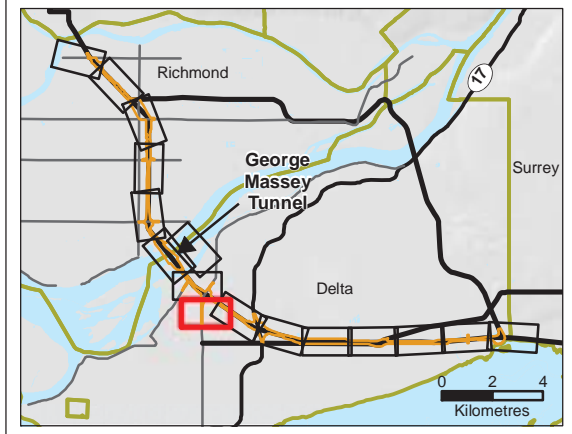


GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

PACIFIC WATER SHREW HABITAT SUITABILITY ASSESSMENT

Figure 7i 12/05/2016

George Massey Tunnel Replacement Project BC JRS PLAN B.C. on the Move



Legend

Pacific Water Shrew Habitat Suitability

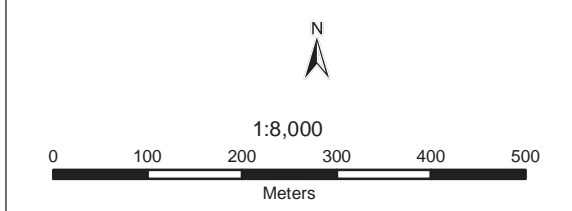
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

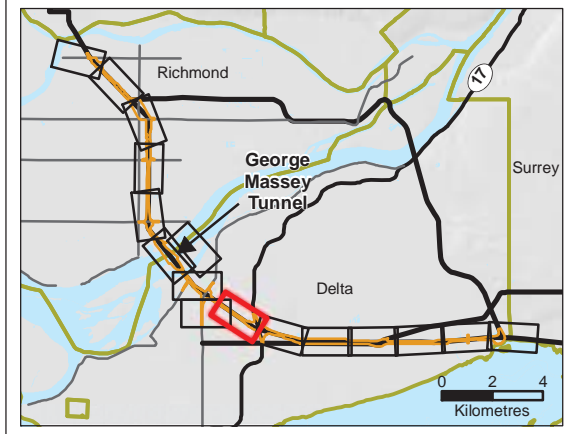


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7j | 12/05/2016 |
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Legend

Pacific Water Shrew Habitat Suitability

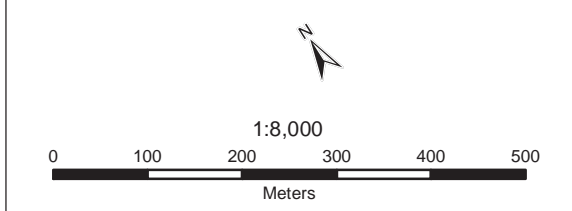
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

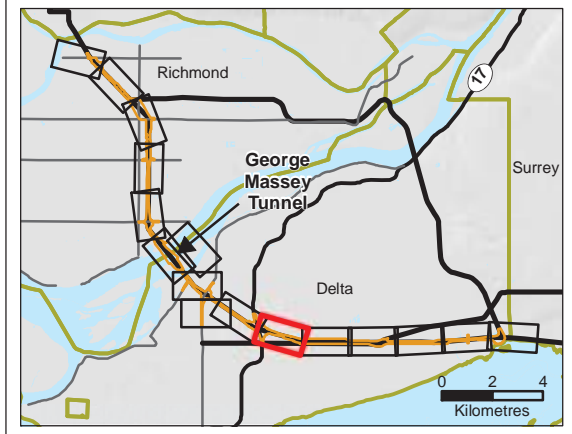


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7k | 12/05/2016 |
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Legend

Pacific Water Shrew Habitat Suitability

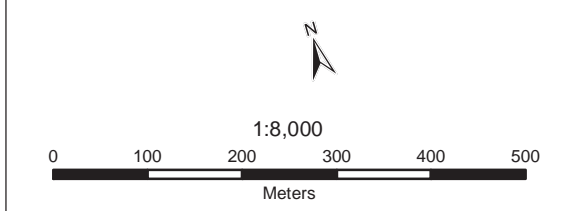
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

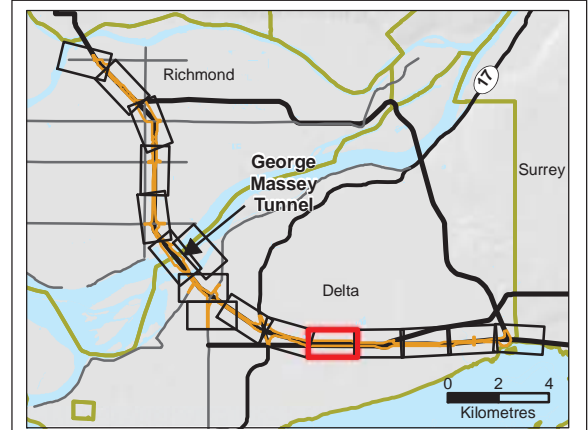
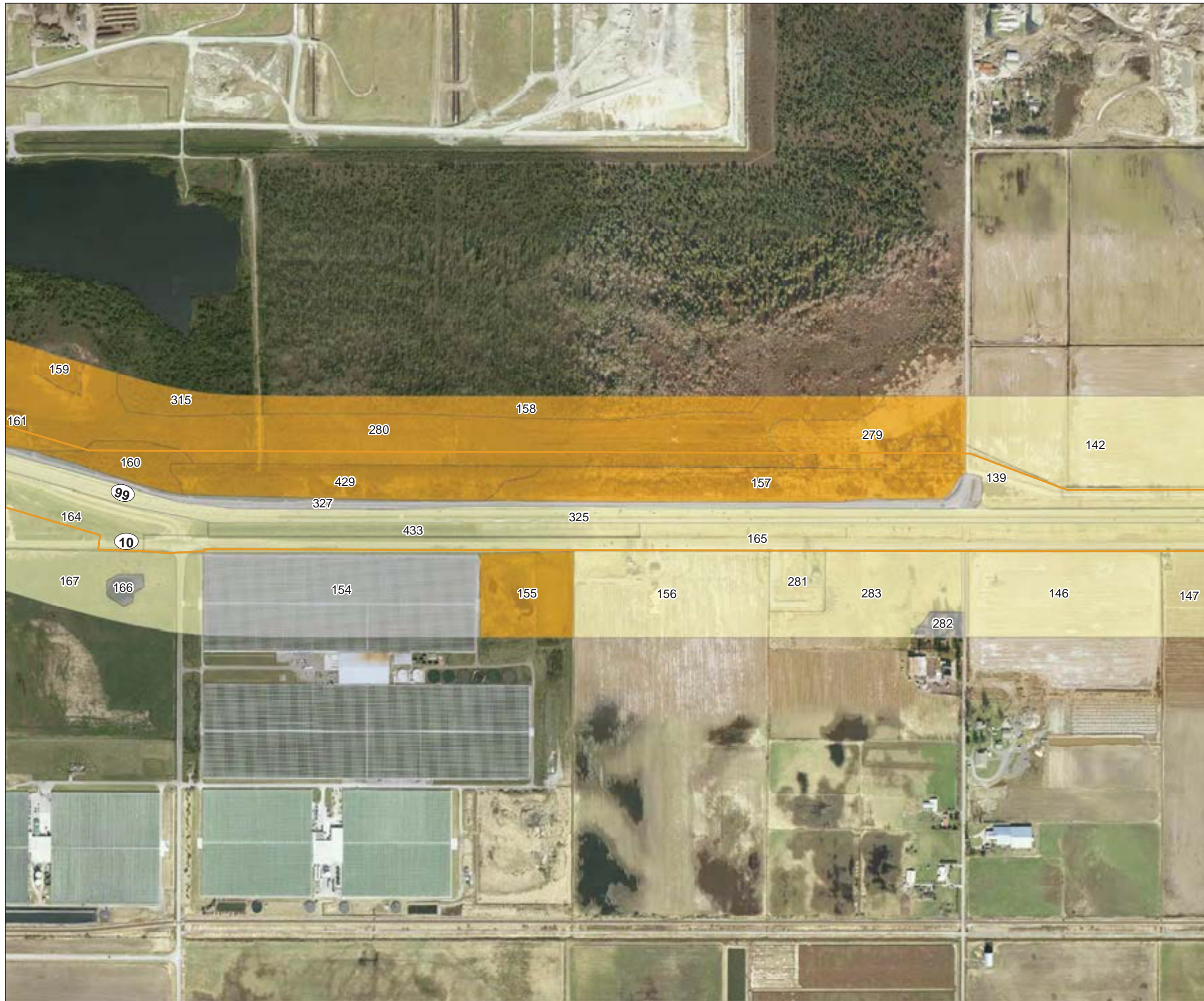
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7I | 12/05/2016 |
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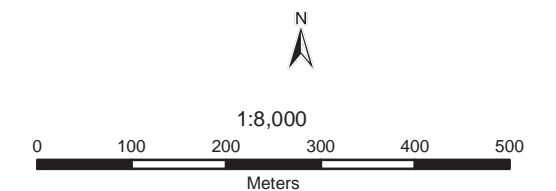
Legend

Pacific Water Shrew Habitat Suitability

- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

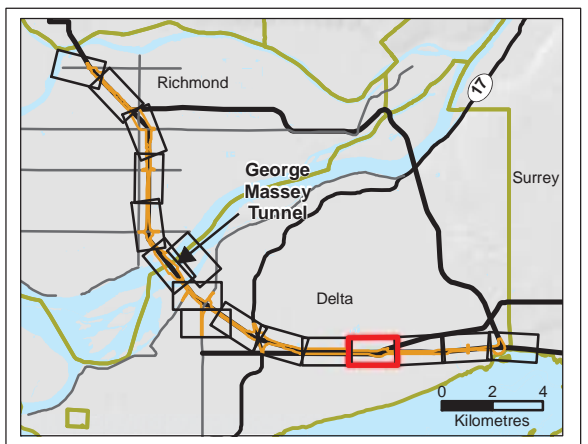
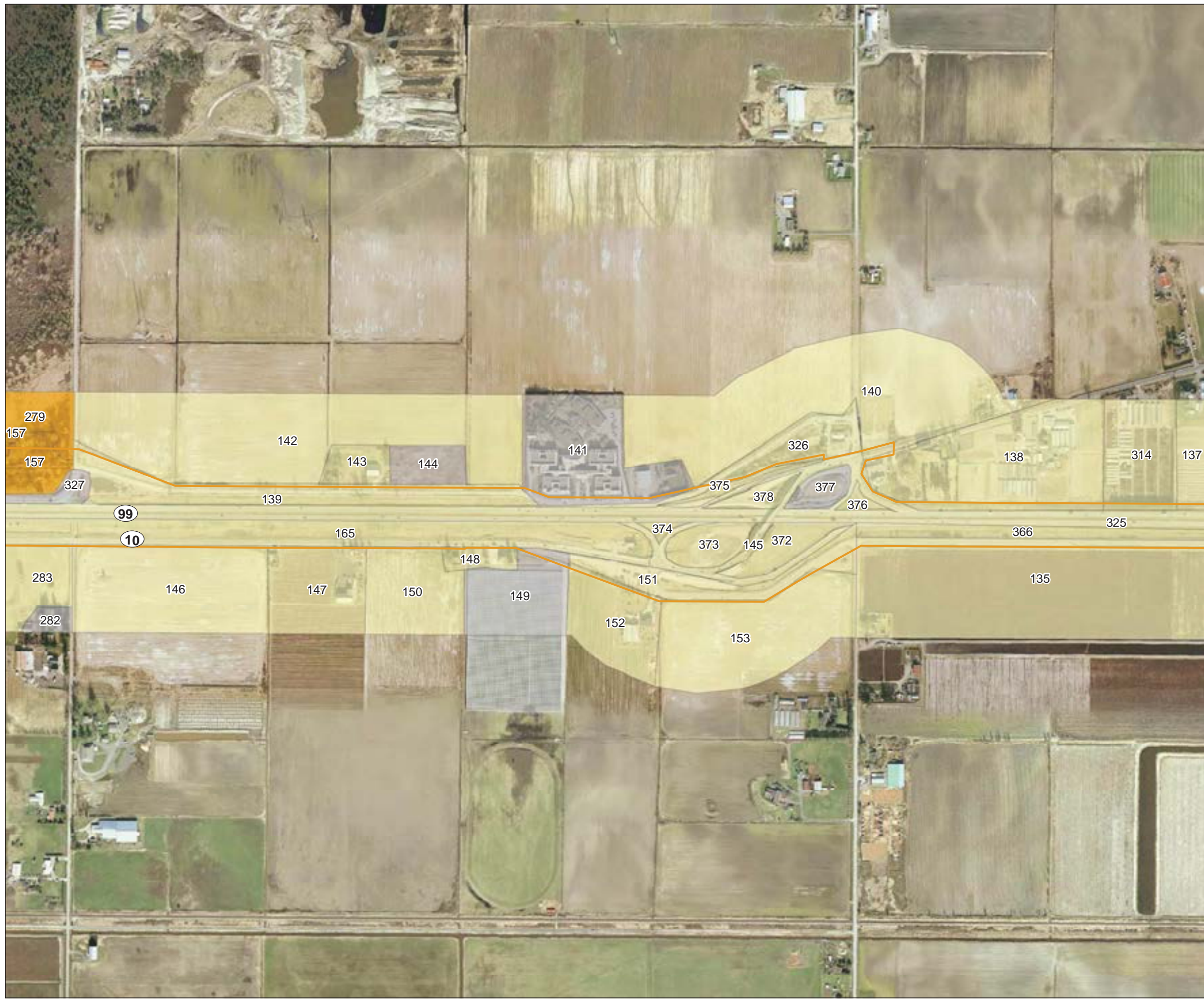
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| PACIFIC WATER SHREW HABITAT SUITABILITY ASSESSMENT | |
| Figure 7m | 12/05/2016 |
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Legend

Pacific Water Shrew Habitat Suitability

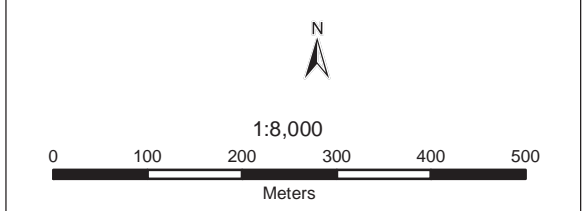
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

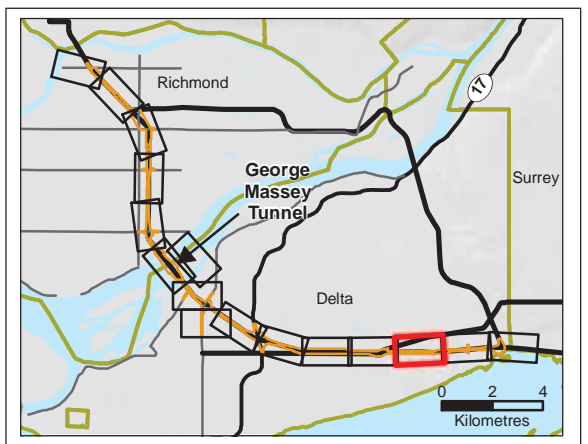


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

Figure 7n 12/05/2016

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Legend

Pacific Water Shrew Habitat Suitability

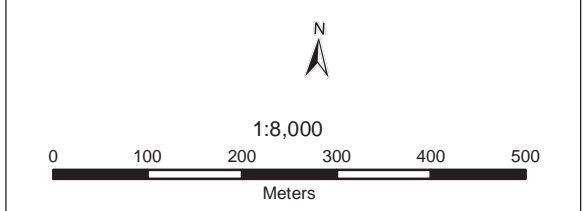
- High
- Moderate
- Low
- Nil

10 TEM polygon number

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

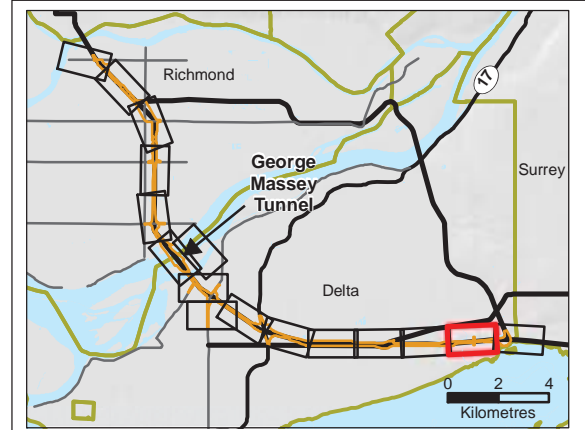


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7o | 12/05/2016 |
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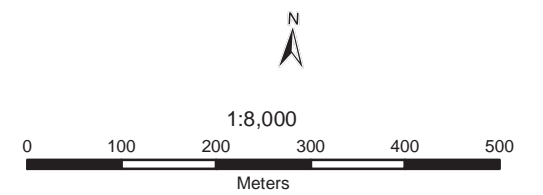
Legend

Pacific Water Shrew Habitat Suitability

- High
- Moderate
- Low
- Nil
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



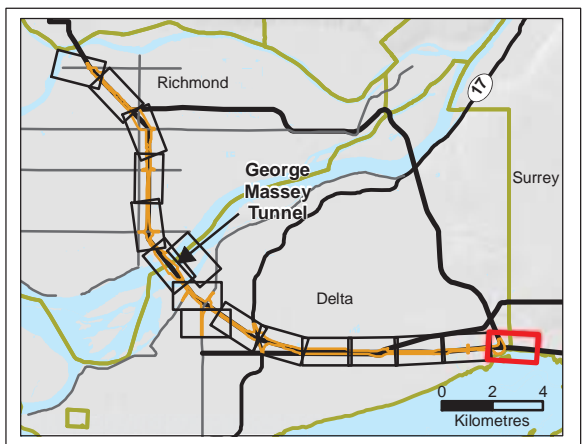
**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

Figure 7p

12/05/2016

Path: O:\217-289\285077\03.mxd\Wildlife\Small_Mammals\EA\Fig7b-q_285_077_03_EA_PWS-Sheets_160506_FINAL.mxd



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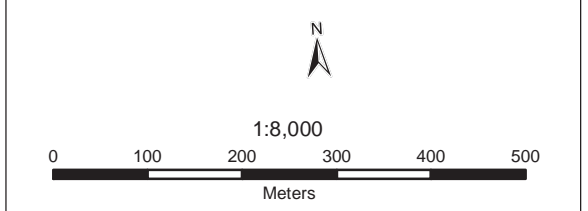
Pacific Water Shrew Habitat Suitability

- High
- Moderate
- Low
- Nil

- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

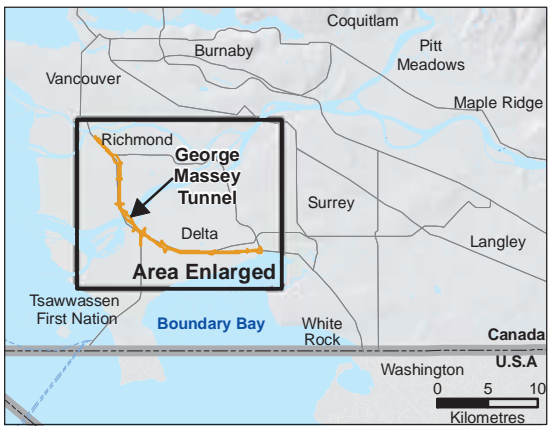
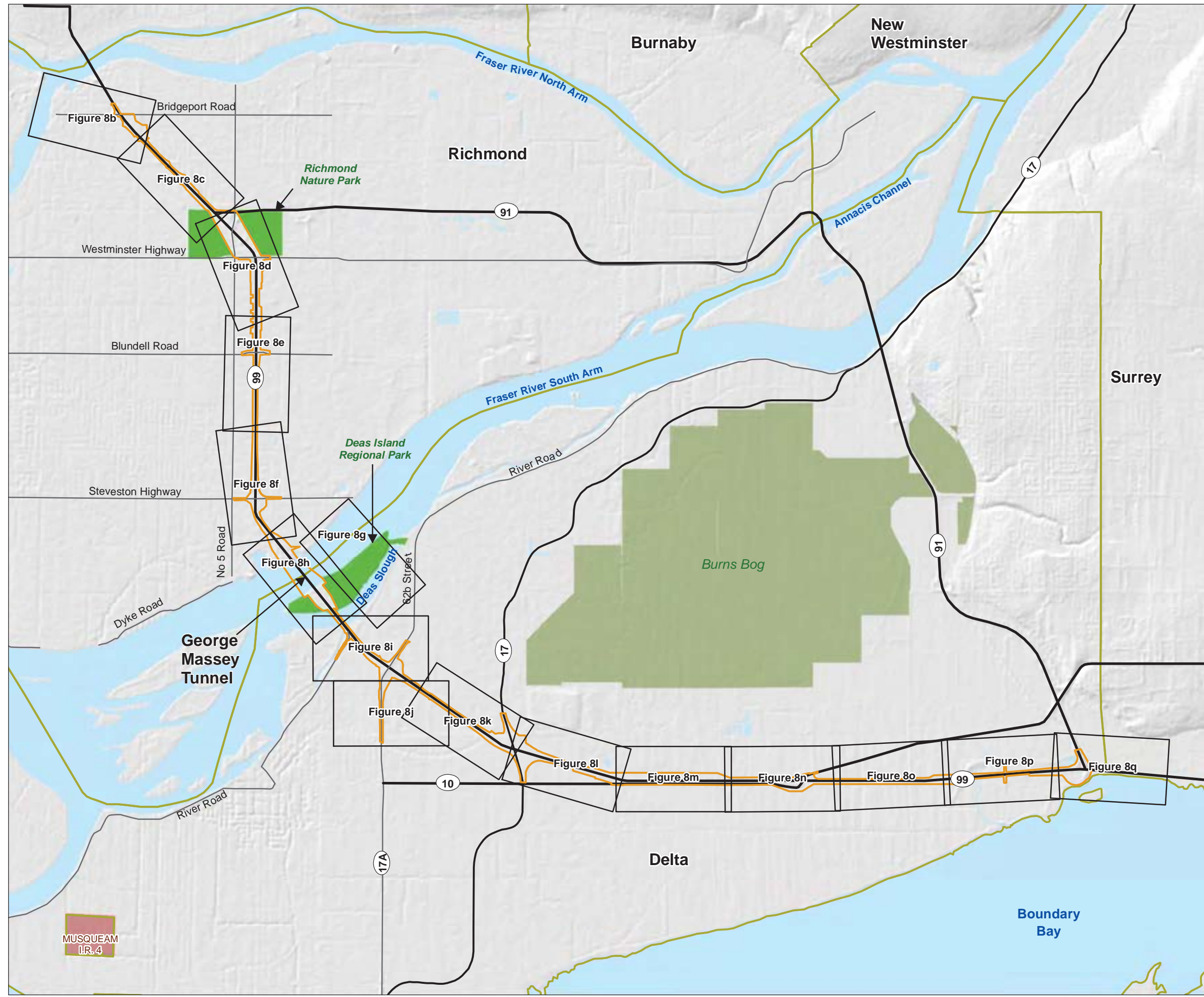


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**PACIFIC WATER SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 7q | 12/05/2016 |
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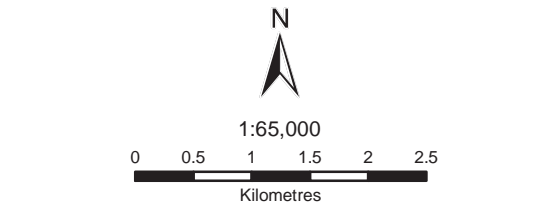


Legend

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

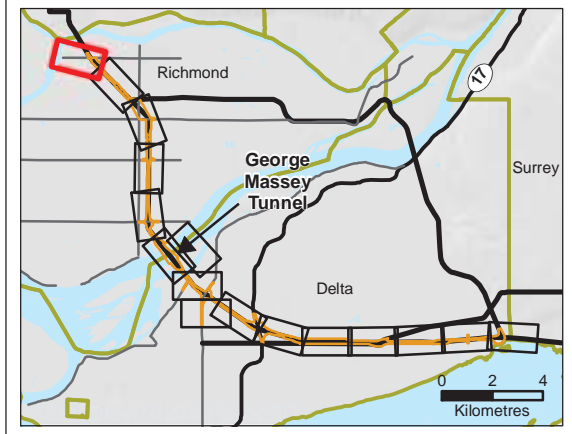
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHERN RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT OVERVIEW**

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| Figure 8a | 13/05/2016 |
|-----------|------------|



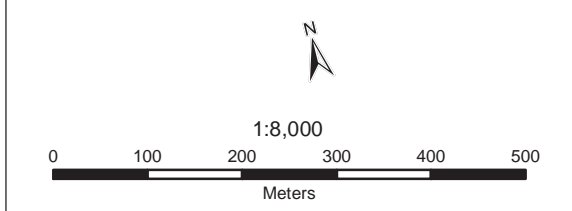
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

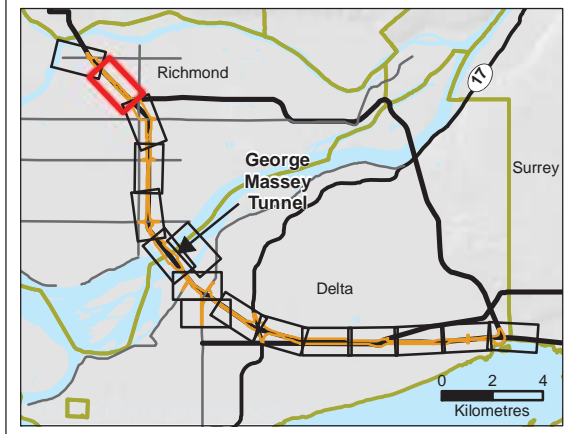
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| SOUTHER RED-BACK VOLE HABITAT SUITABILITY ASSESSMENT | |
| Figure 8b | 12/05/2016 |
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Path: O:\17-299\285077\03\mxd\Wildlife\Small_Mammals\EAF\fig8b-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



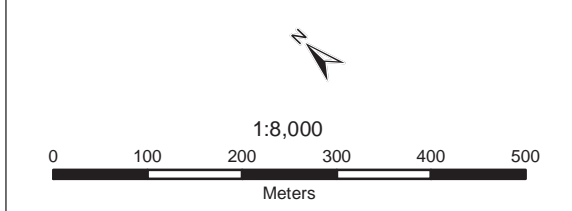
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

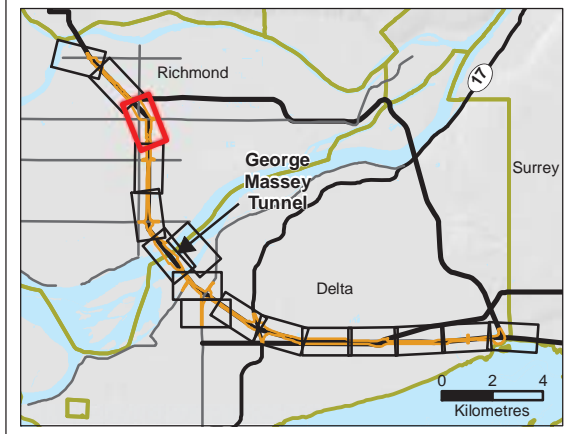


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8c | 12/05/2016 |
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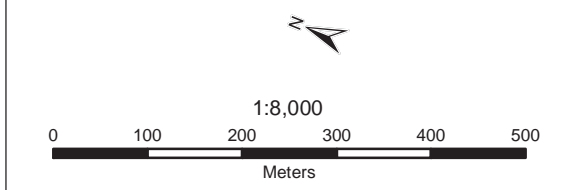
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

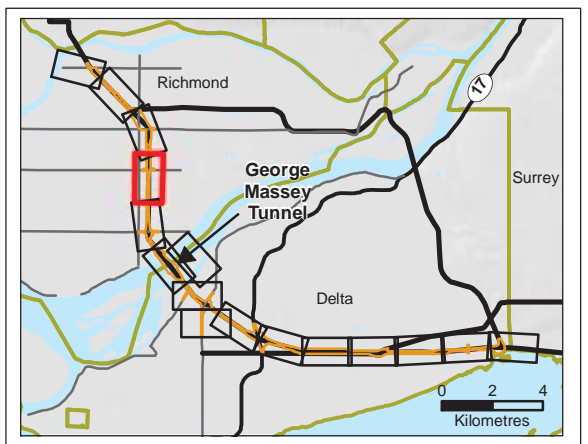


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8d | 12/05/2016 |
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Path: O:\17-299\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig8e-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



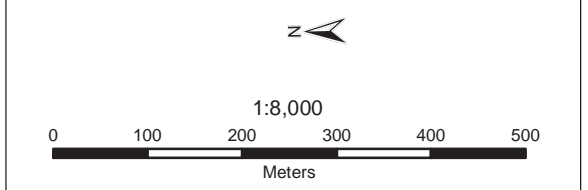
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

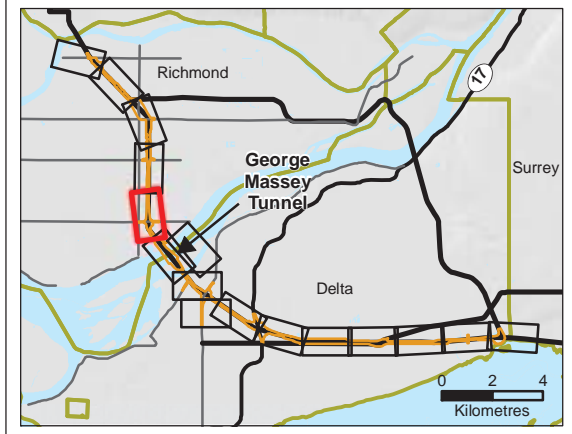
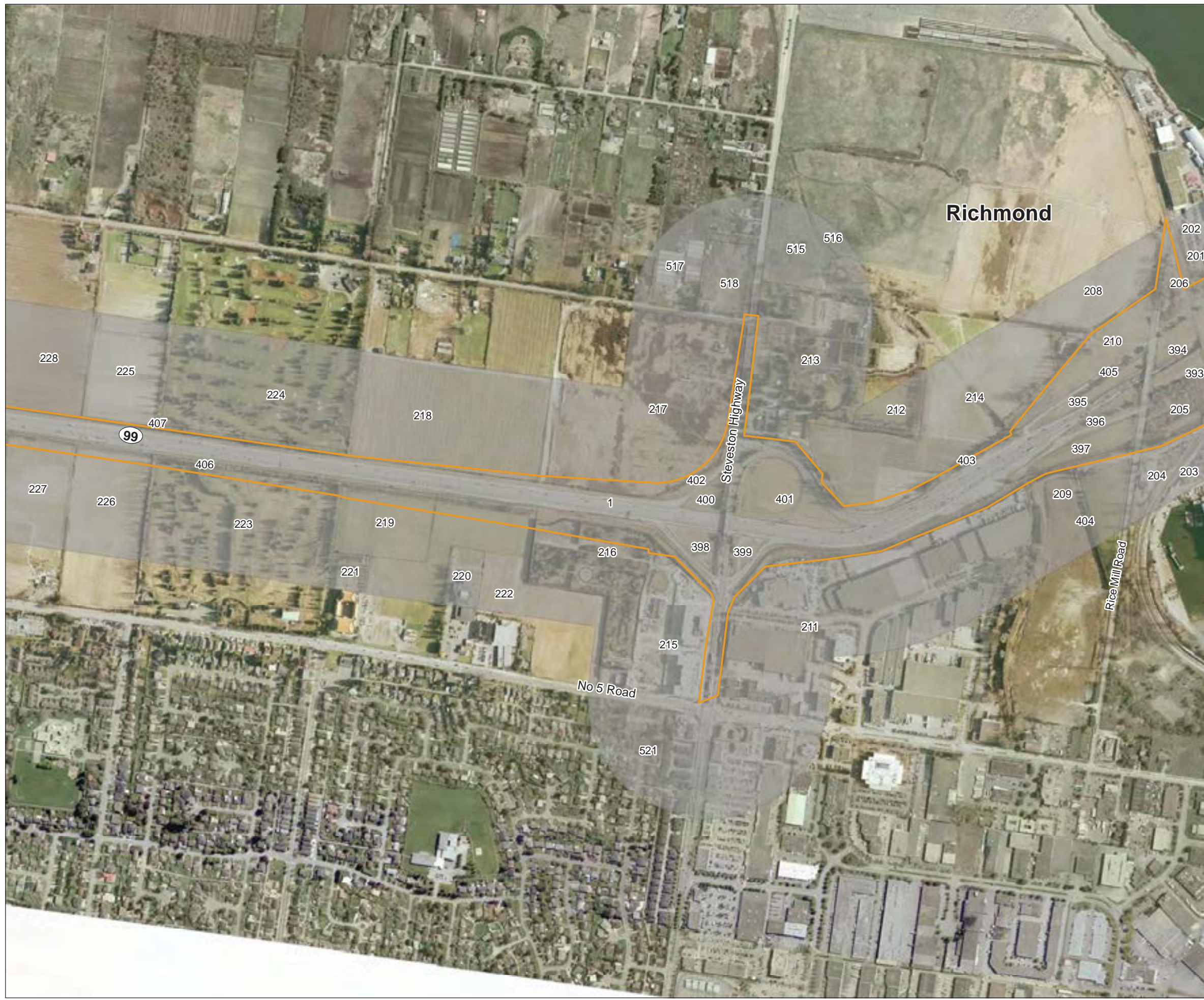


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8e | 12/05/2016 |
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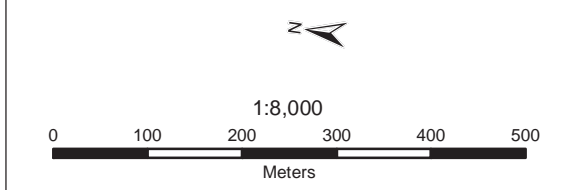
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

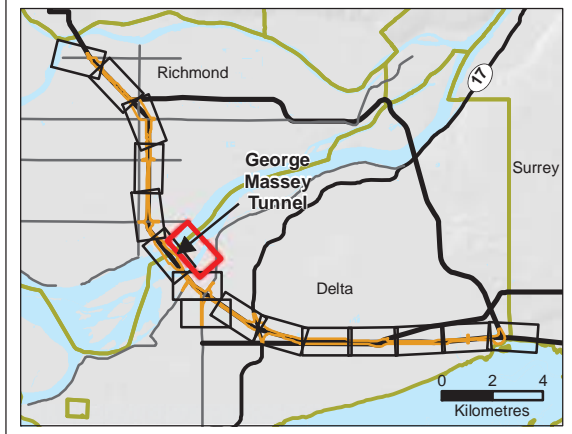


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8f | 12/05/2016 |
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Path: O:\17-299\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig8g-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



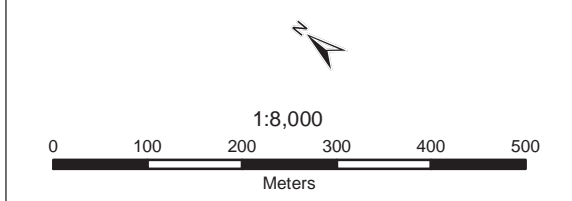
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

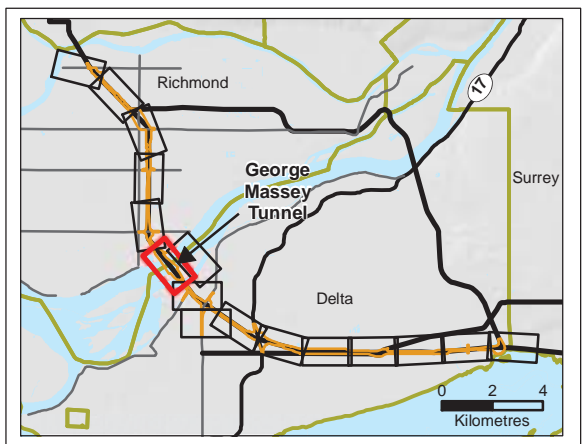


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8g | 12/05/2016 |
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Path: O:\17-299\285077\03.mxd\Wildlife\Small_Mammals\EA\Fig8B-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



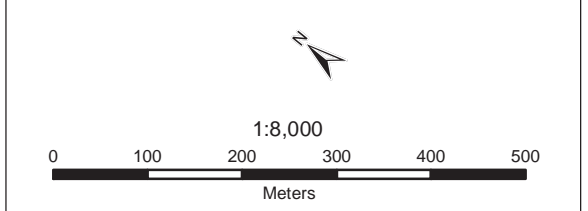
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

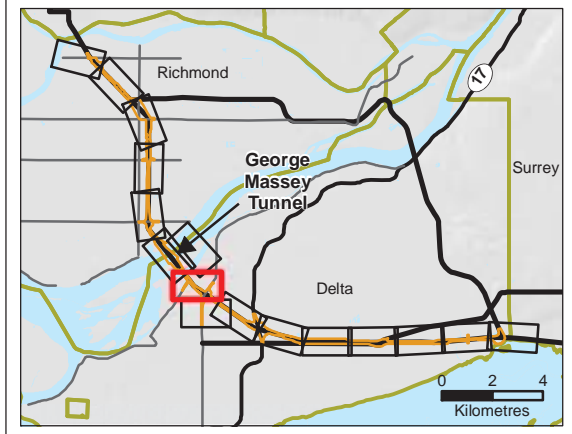


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8h | 12/05/2016 |
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Path: O:\17-299\285077\03\mxd\Wildlife\Small_Mammals\EAF\fig8b-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



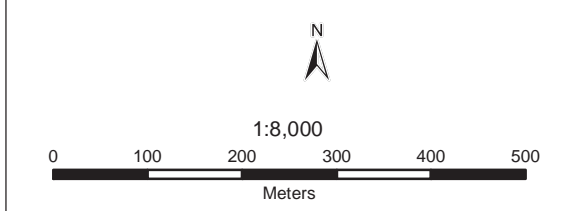
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

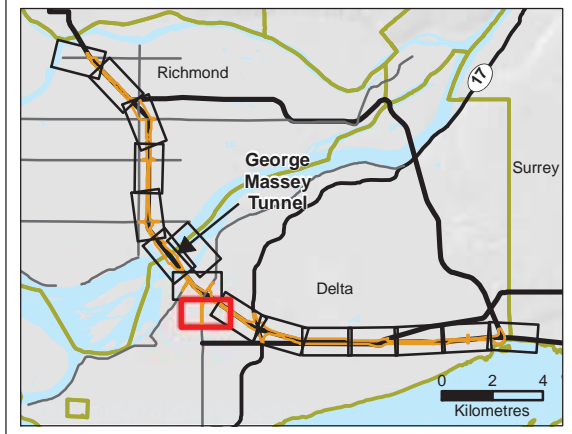


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8i | 12/05/2016 |
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Path: O:\17-299\285077\03.mxd\Wildlife\Small_Mammals\EA\FigBB-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



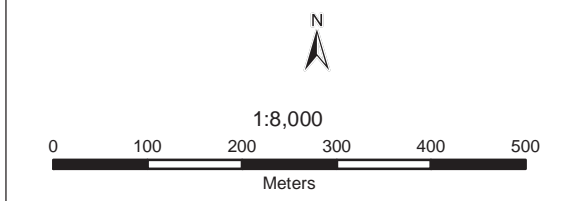
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

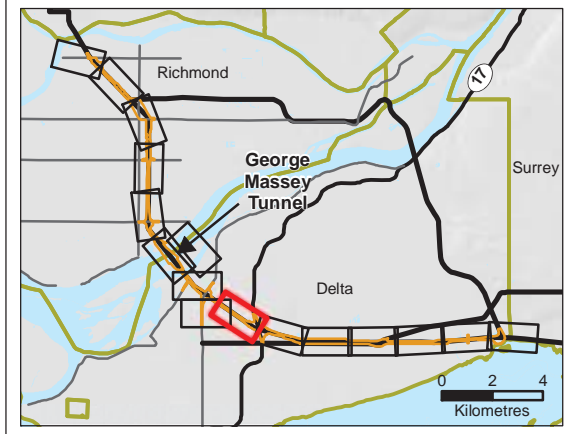


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

Figure 8j 12/05/2016

Path: O:\17-299\285077\03.mxd\Wildlife\Small_Mammals\EA\Fig8k-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



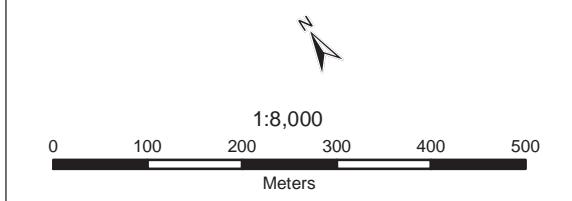
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

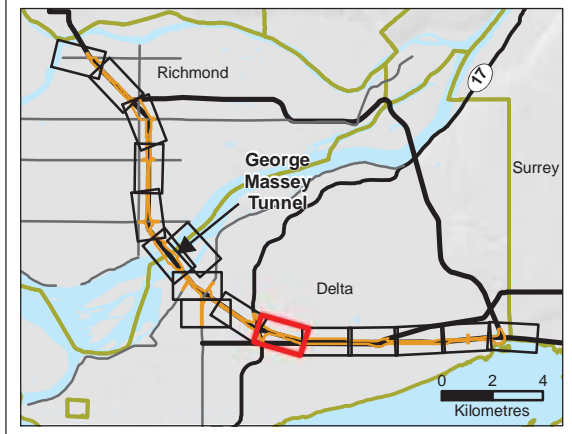


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8k | 12/05/2016 |
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Path: O:\217-299\285077\03.mxd\Wildlife\Small_Mammals\EA\Fig8B-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



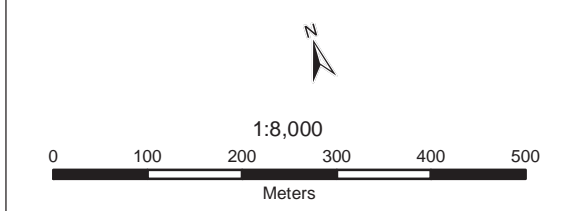
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

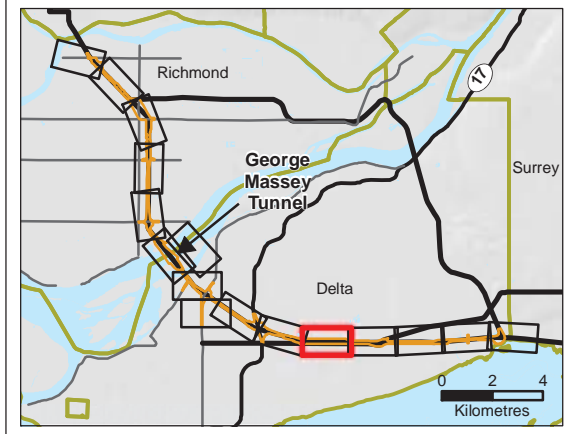


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

Figure 8I 12/05/2016

Path: O:\217-299\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig8-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



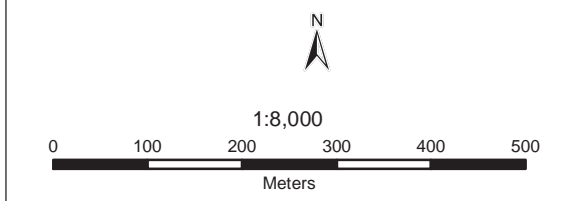
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

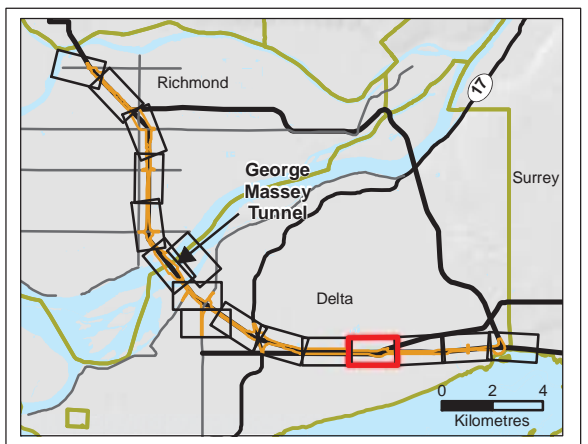


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8m | 12/05/2016 |
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Path: O:\217-299\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig8-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



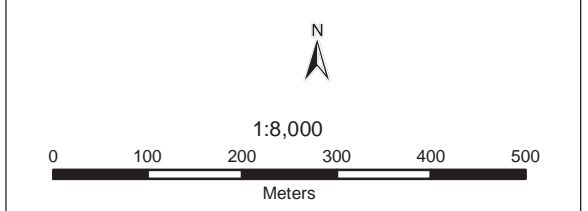
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

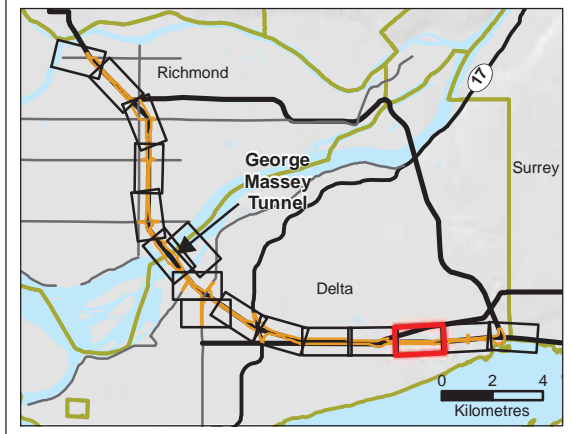
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| SOUTHER RED-BACK VOLE HABITAT SUITABILITY ASSESSMENT | |
| Figure 8n | 12/05/2016 |
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Path: O:\217-299\285077\03.mxd\Wildlife\Small_Mammals\EA\FigBB-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



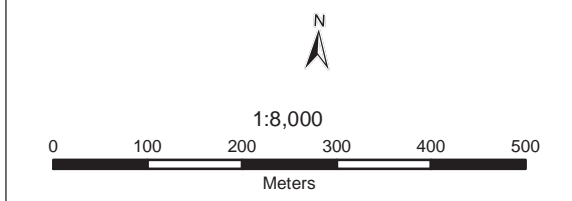
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

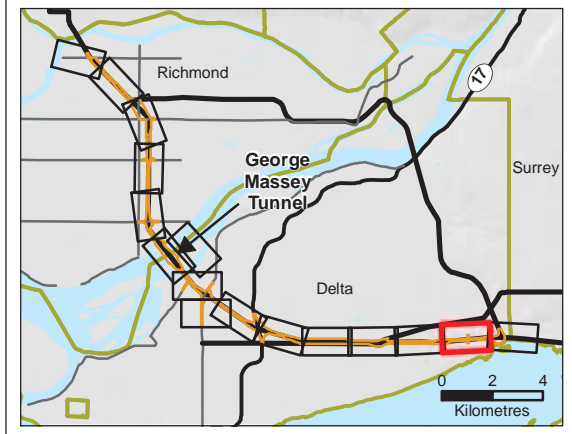
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| SOUTHER RED-BACK VOLE HABITAT SUITABILITY ASSESSMENT | |
| Figure 8o | 12/05/2016 |
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Path: O:\17-299\285077\03.mxd\Wildlife\Small_Mammals\EA\Fig8B-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



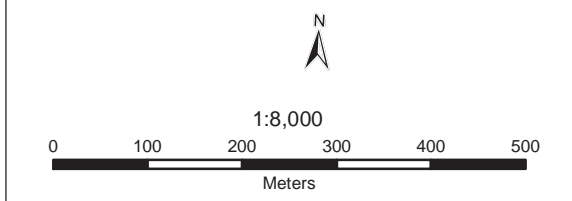
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

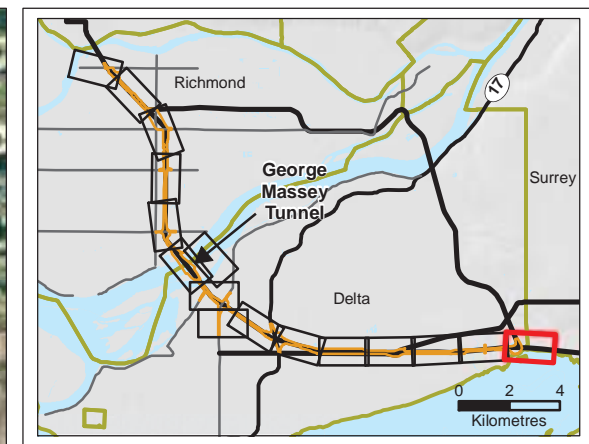


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

Figure 8p 12/05/2016

Path: O:\17-299\285077\03\mxd\Wildlife\Small_Mammals\EA\Fig8-q_285_077_03_EA_SRBV-Sheets_160506_FINAL.mxd



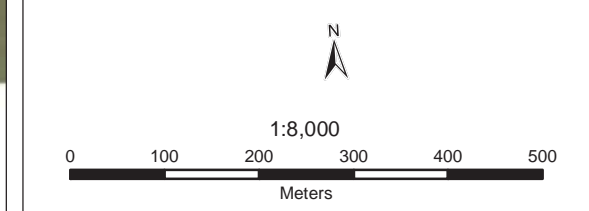
Legend

Southern Red-Back Vole Habitat Suitability

- Useable
- Likely No Value
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

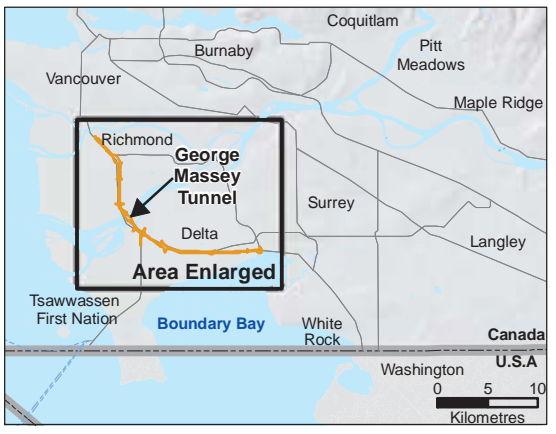


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SOUTHER RED-BACK VOLE HABITAT
SUITABILITY ASSESSMENT**

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| Figure 8q | 12/05/2016 |
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Path: C:\217-299\285\077\03\mxd\Wildlife\Small_Mammals\EA\Fig9a_285_077_03_EA_OlympicShrew-Overview_160506.mxd

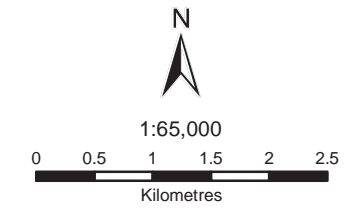


Legend

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

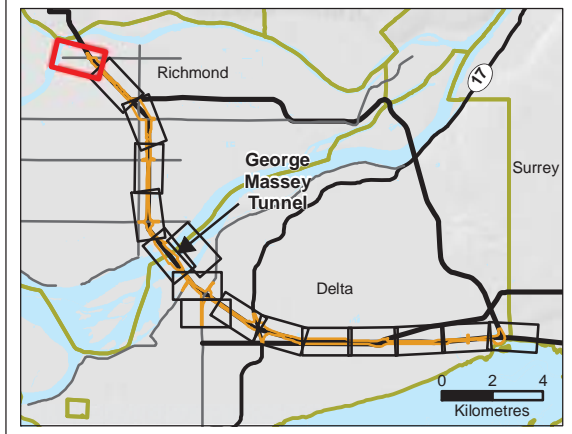
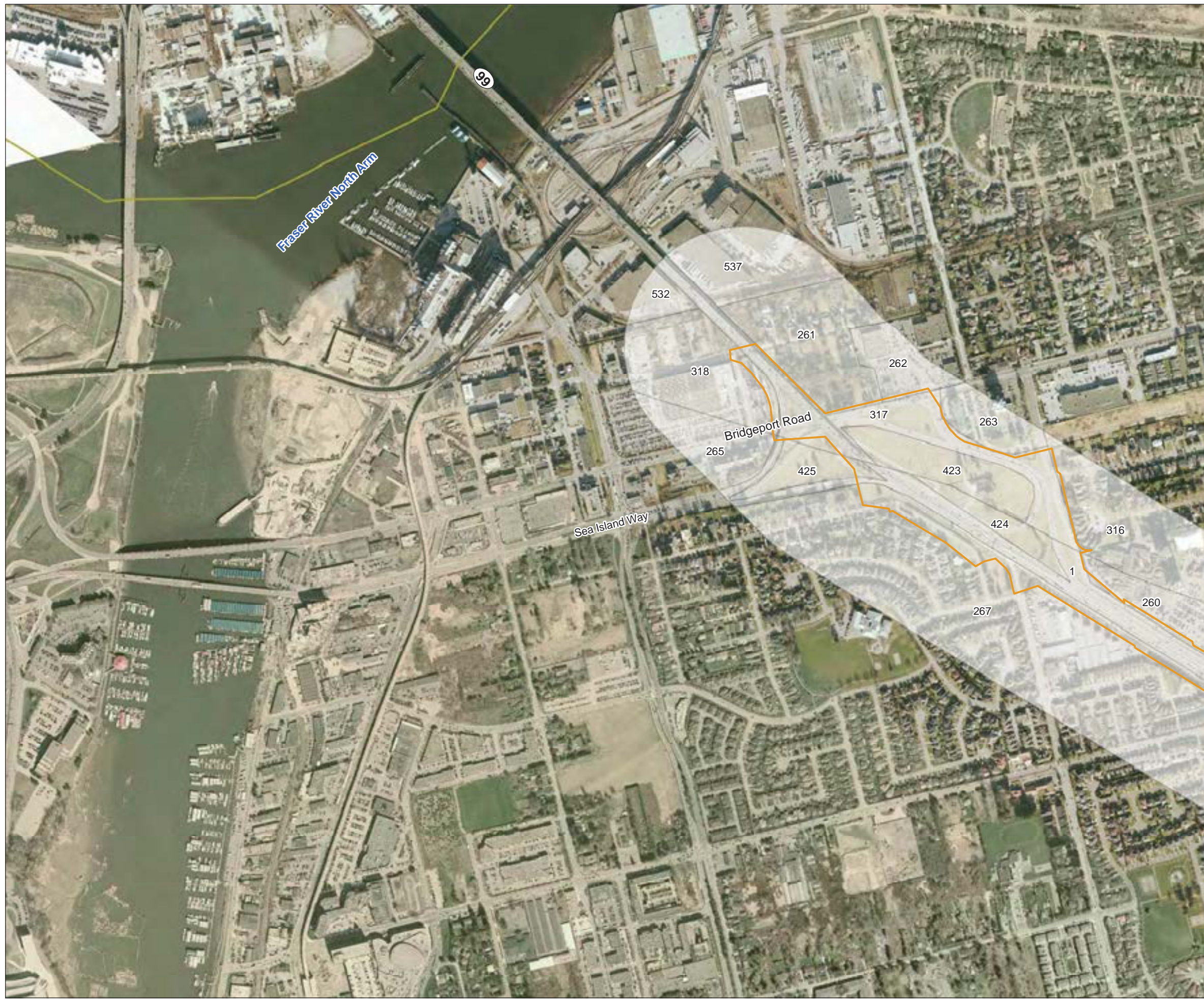


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT OVERVIEW

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| Figure 9a | 12/05/2016 |
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Path: C:\1217-299\285\077\03\mxd\Wildlife\Small_Mammals\EA\Fig9b-q_285_077_03_EA_OlympicShrew-Sheets_160506_FINAL.mxd



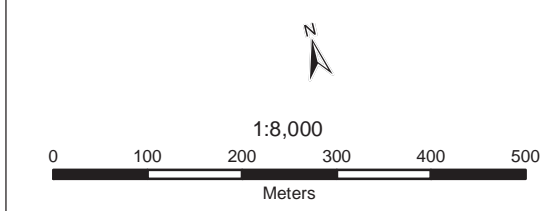
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

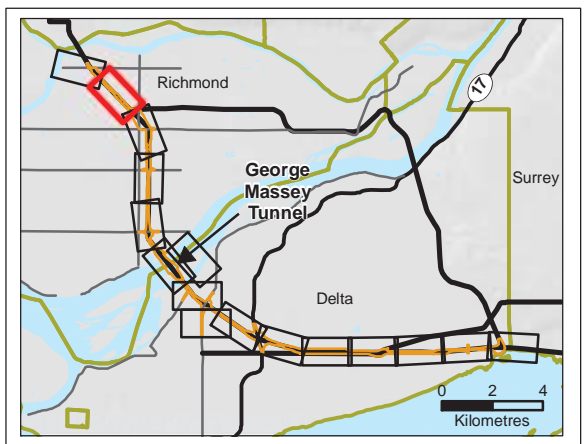
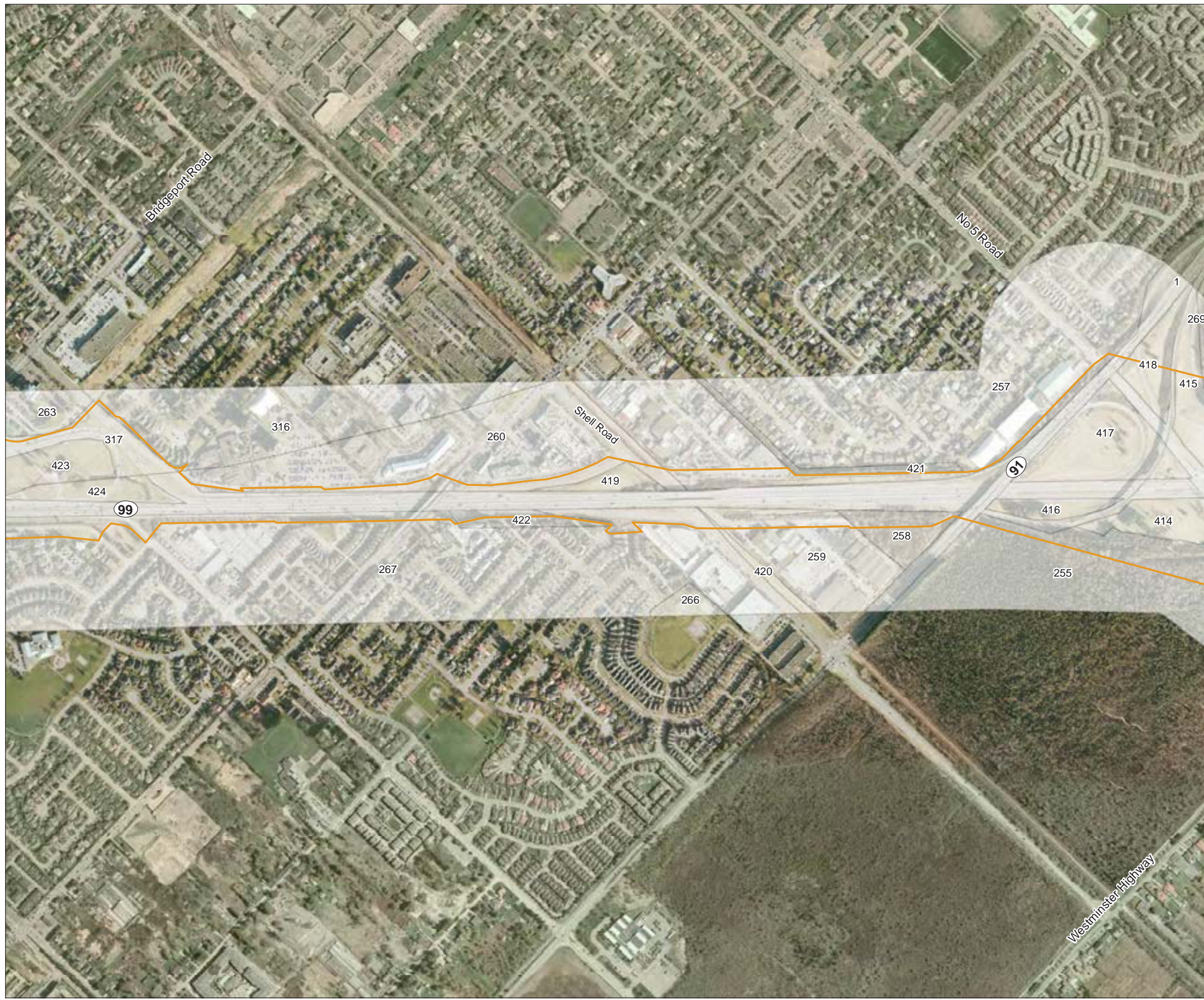
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| OLYMPIC SHREW HABITAT SUITABILITY ASSESSMENT | |
| Figure 9b | 12/05/2016 |
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Path: C:\1217-299\285\077\03\mxd\Wildlife\Small_Mammals\EA\Fig9b-q_285_077_03_EA_OlympicShrew-Sheets_160506_FINAL.mxd



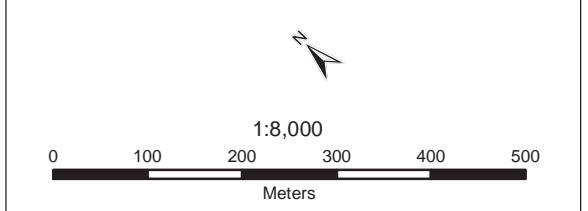
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

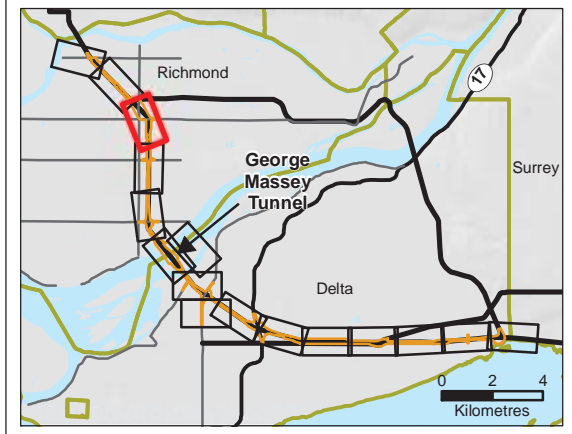
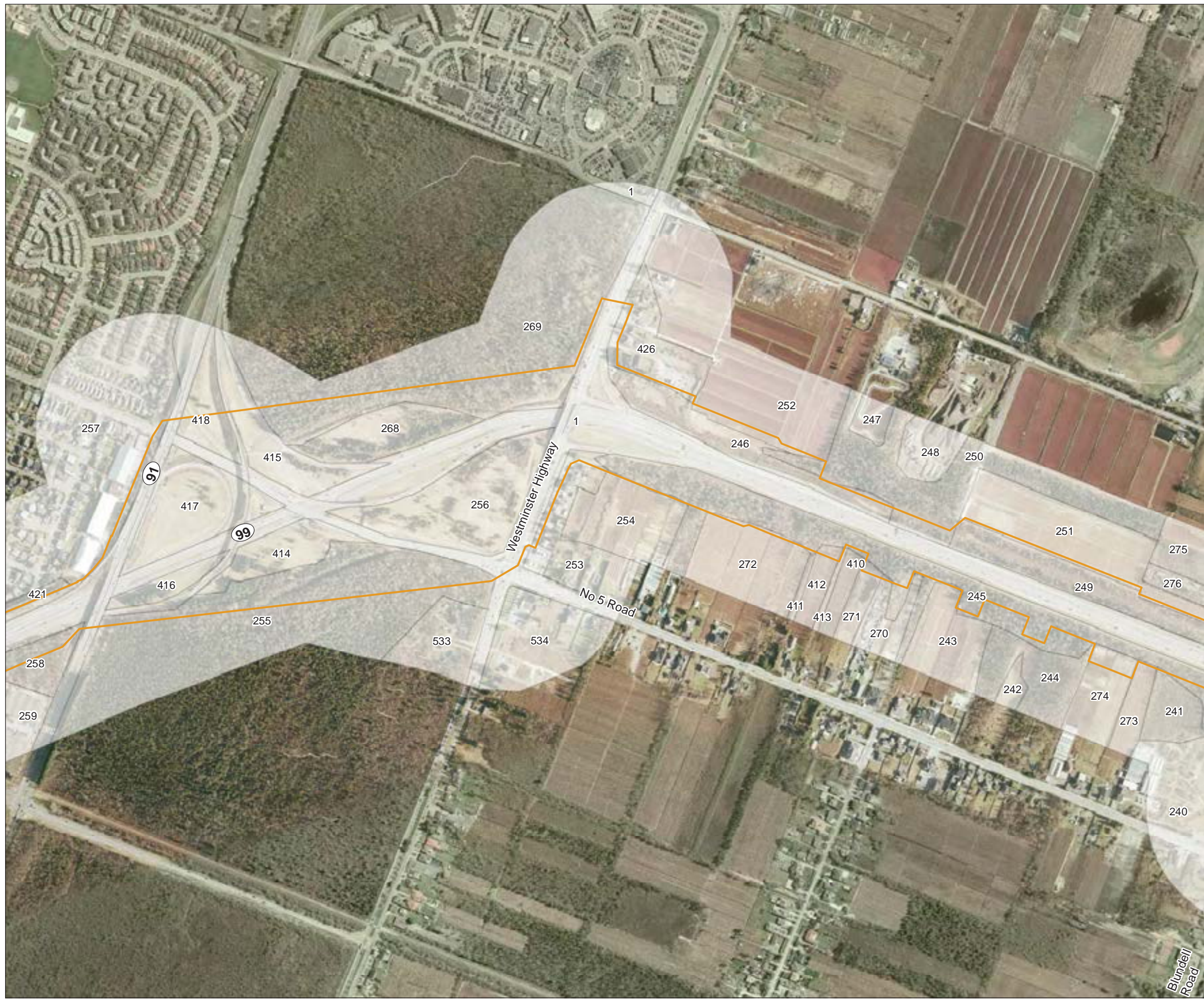


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9c | 12/05/2016 |
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Path: C:\1217-299\285\077\03\mxd\Wildlife\Small_Mammals\EA\Fig9b-q_285_077_03_EA_OlympicShrew-Sheets_160506_FINAL.mxd



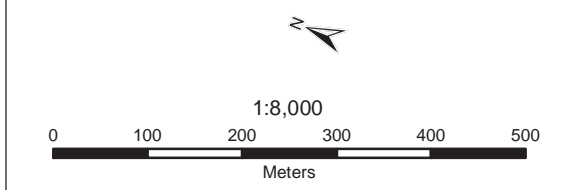
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

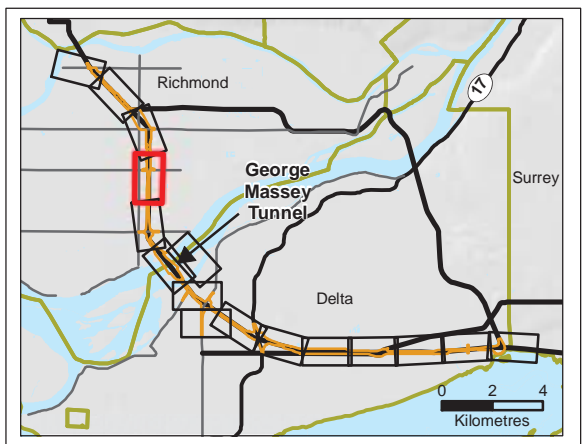


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9d | 12/05/2016 |
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Path: C:\1217-299\285\077\03\mxd\Wildlife\Small_Mammals\EA\Fig9b-q_285_077_03_EA_OlympicShrew-Sheets_160506_FINAL.mxd



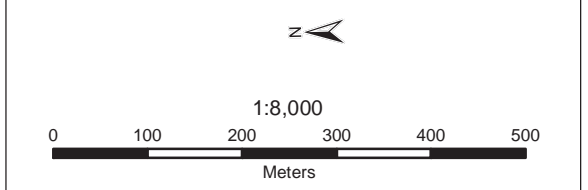
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

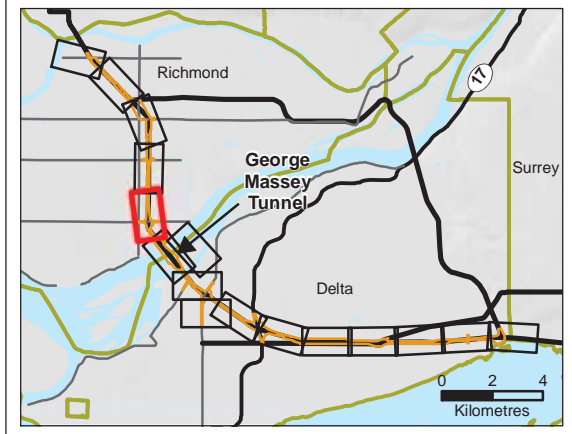
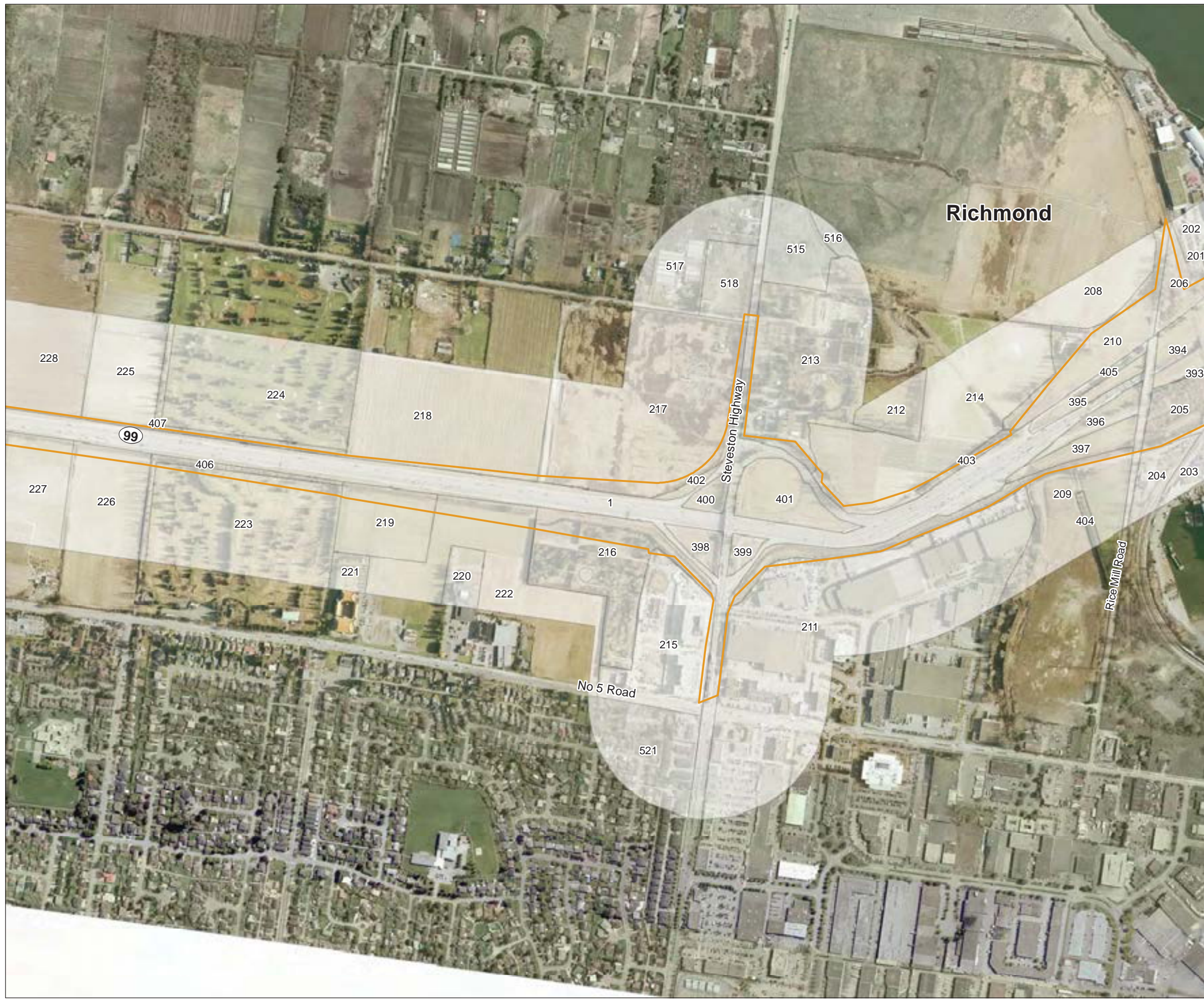


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9e | 12/05/2016 |
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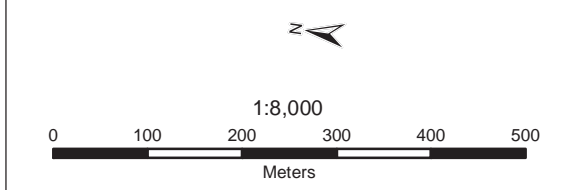
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

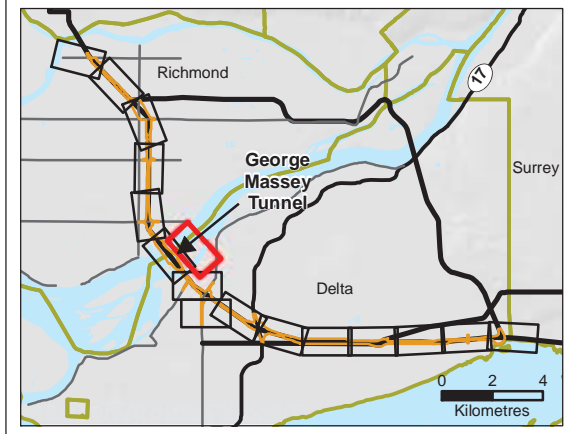


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9f | 12/05/2016 |
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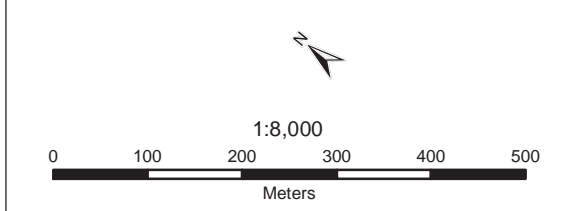
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

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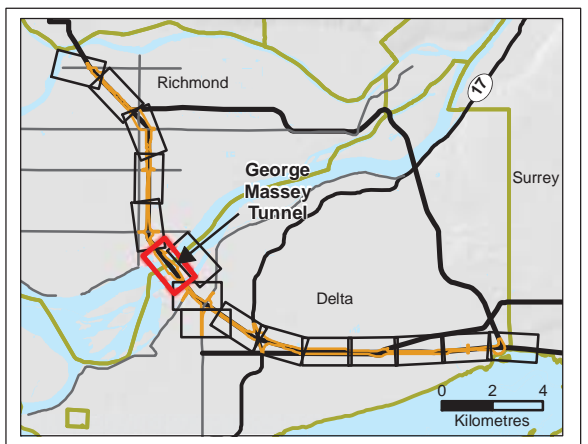


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9g | 12/05/2016 |
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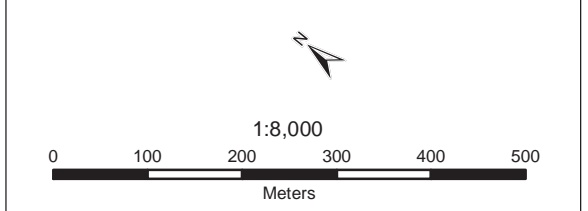
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
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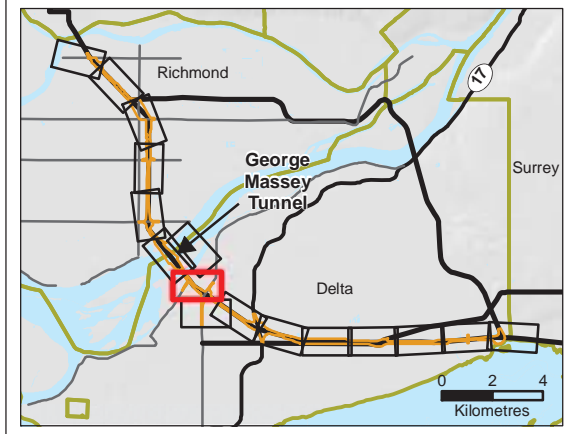


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9h | 12/05/2016 |
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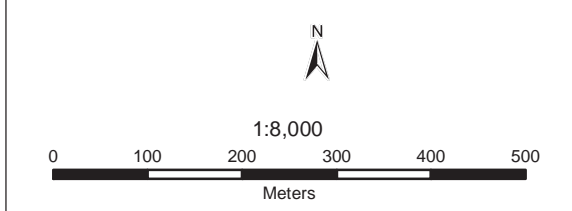
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

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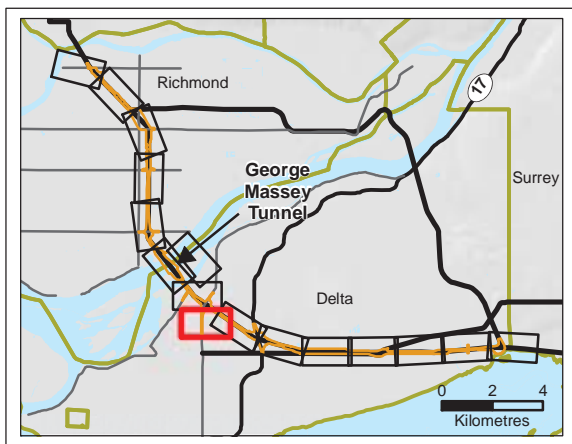


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9i | 12/05/2016 |
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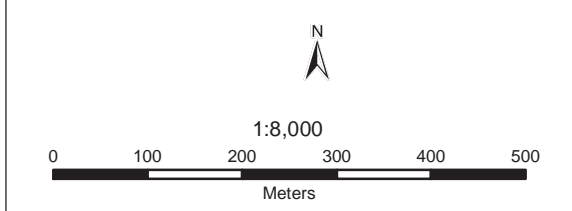
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

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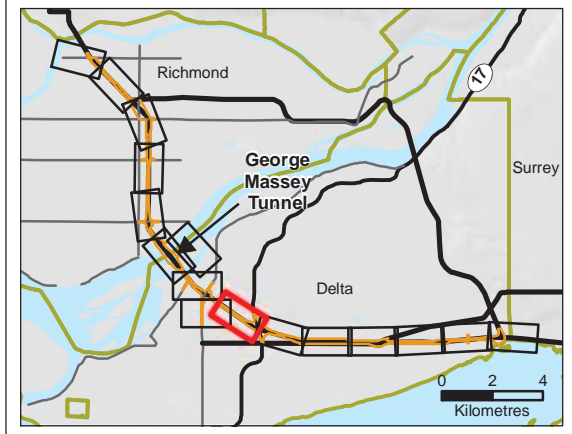


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9j | 12/05/2016 |
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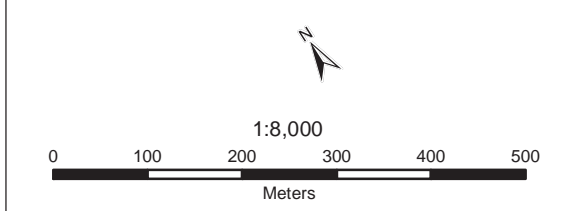
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

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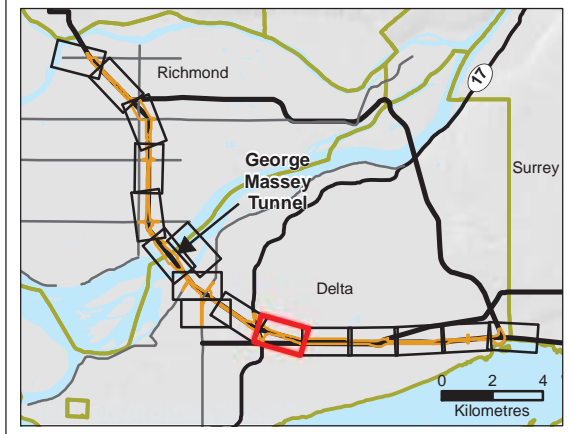


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9k | 12/05/2016 |
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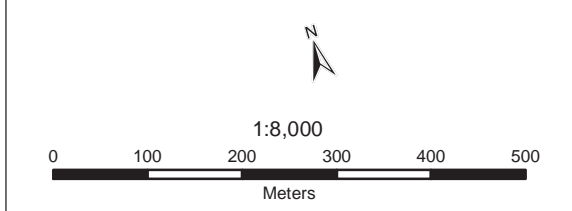
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

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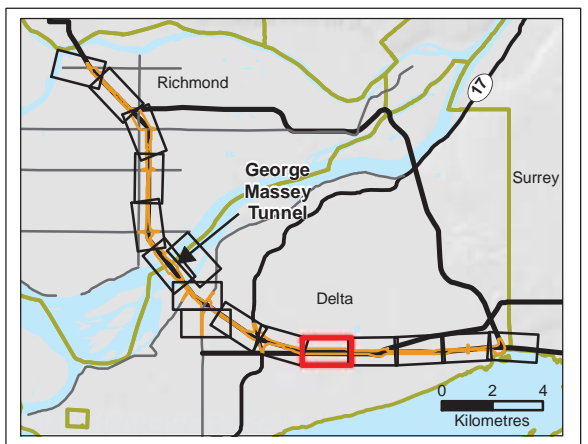


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9I | 12/05/2016 |
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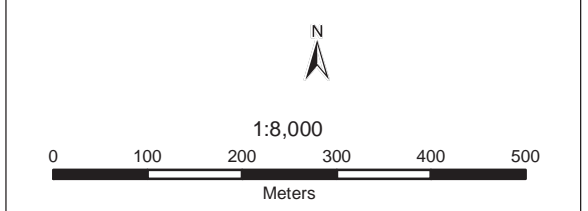
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

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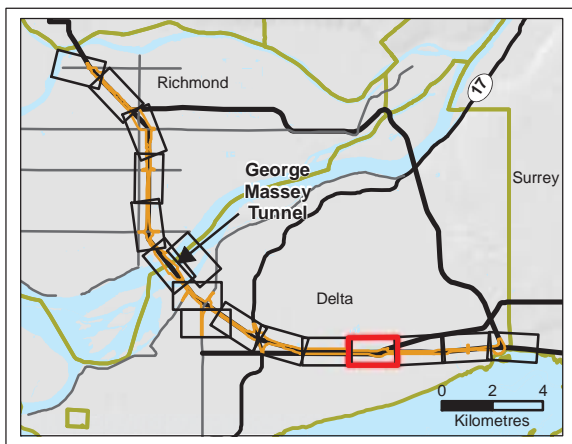


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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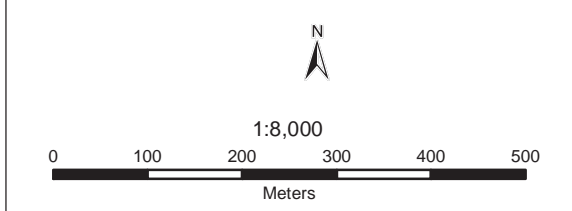
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

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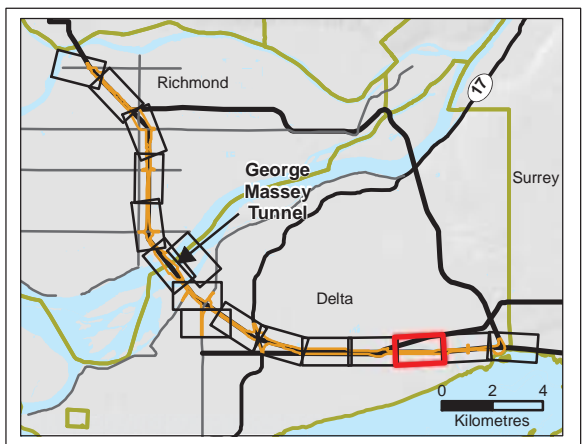


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9n | 12/05/2016 |
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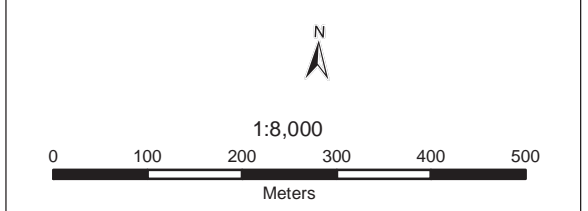
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

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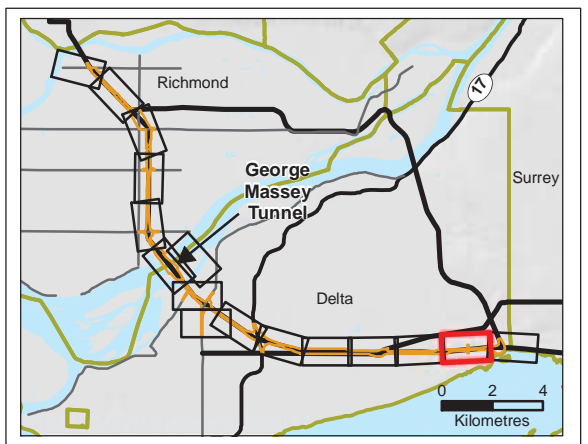


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9o | 12/05/2016 |
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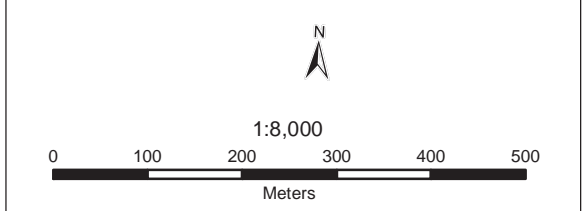
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

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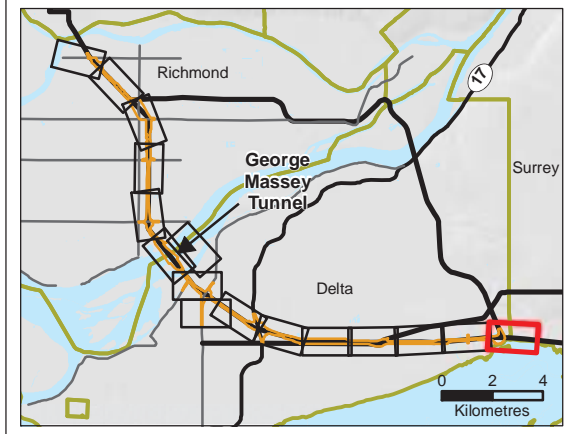


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9p | 12/05/2016 |
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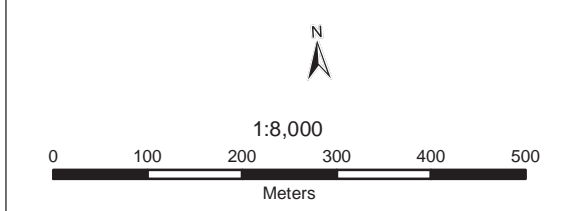
Legend

Olympic Shrew Habitat Suitability

- Useable
- Likely No Value
- Outside Range
- 10 TEM polygon number
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S Border

SOURCES

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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**OLYMPIC SHREW HABITAT
SUITABILITY ASSESSMENT**

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| Figure 9q | 12/05/2016 |
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4.9 Air Quality Assessment Highlights:

- Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.
- Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include:
 - A 35 % reduction in particulate matter emissions, as compared with a 14 % reduction without the Project.
 - A 47 % reduction in volatile organic compound (VOC) emissions, as compared with a 40 % reduction without the Project.
 - No exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.
- The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.
- Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.
- Construction-related effects on air quality will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation infrastructure projects in the Lower Mainland.
- No Project-related residual or cumulative effects on air quality are expected post construction.

4.9 Air Quality

This section describes the existing conditions related to air quality and anticipated changes resulting from Project components and activities. Air quality comprises one of the 'steps' along the pathway of effects of the Project, with human health identified as the ultimate receptor of Project-related effects. Air quality was therefore assessed as an intermediate component (IC) and predicted change in air quality was used to support the assessment of potential effects of the Project on human health, which was assessed as a valued component (VC) (**Section 7.1 Human Health Effects Assessment**).

A technical volume, **Air Quality Study**, containing further detail on existing conditions and methodology used in predicting Project-related effects is included in **Section 16.5**.

4.9.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on air quality in terms of Project setting, and defines the spatial, temporal, administrative and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

4.9.1.1 Assessment Context

During pre-Application consultation on the Project with government agencies, Aboriginal Groups, and the general public, potential influence of the Project on local and regional air quality and consequent effects on human health was identified as an area of specific interest by Metro Vancouver, Aboriginal Groups, and health authorities. The Project involves improvements to Highway 99 to eliminate congestion, which will result in a reduction in vehicle emissions. Given the predicted decrease in congestion, air quality is expected to improve with the implementation of the Project. Predicting the anticipated nature and magnitude of such changes and the temporary influence of construction-related emissions on local air quality is important for assessing Project-related effects on human health, which has been defined as a VC. Air quality has therefore been selected as an IC in the context of assessment of potential effects of the Project on human health.

Additional information on the selection of VCs, and the link between air quality and human health is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

4.9.1.2 Methodology

The assessment of air quality follows the general methodology described in **Section 3.0 Assessment Methodology**.

The overall objective of the air quality assessment was to predict potential Project-related changes in air pollutant emissions and their net effect on ambient air quality in the Project alignment. In early 2014, the Ministry initiated field and desktop studies as well as modelling to support planning and environmental assessment of the Project. The studies (outlined in **Table 4.9-1**) were designed to build on existing information and address known data gaps. The objectives of the air quality studies were to:

- Characterize existing air quality as influenced by sources other than vehicle emissions.
- Estimate existing and future vehicle emissions.
- Use dispersion modelling to predict potential changes in local and regional air quality associated with the proposed Project.

Table 4.9-1 Studies to Support the Air Quality Assessment

| Study Name | Purpose of Study |
|------------------------------------|---|
| Existing air quality data analysis | Analyze ambient air quality monitoring data to determine the contribution of sources other than vehicle emissions to air quality in the vicinity of the Project and the lower Fraser Valley. |
| Emissions modelling | Estimate emissions from vehicle activity in the Project alignment in 2011 (existing conditions) and 2031 (future conditions with and without the Project), and compare with existing and forecasted emissions in the lower Fraser Valley. |
| Air quality dispersion modelling | Model meteorology and emissions data to estimate ambient concentrations for various averaging periods, and compare them to regulatory objectives. |

The studies were focused on the following regulated compounds:

- Criteria air contaminants (CACs)
 - Carbon monoxide (CO)
 - Nitrogen oxides (NO_x, NO, and NO₂)
 - Sulphur dioxide (SO₂)
 - Volatile organic compounds (VOCs)
 - Ammonia (NH₃)
 - Particulate matter (total PM, PM₁₀ and PM_{2.5})
- Road dust (total PM, PM₁₀ and PM_{2.5})
- Toxic air contaminants (TACs)
 - Aldehydes (acetaldehyde, acrolein, formaldehyde)
 - Polycyclic aromatic hydrocarbons (naphthalene, benzo(a)pyrene)
 - Benzene
 - 1,3-butadiene
 - Diesel Particulate Matter

The CALINE3 (CALINE) model was used in this study to estimate ambient concentrations resulting from vehicle exhaust on highways. CALINE is specifically designed for vehicle emissions from exhaust along roads. Although B.C. does not mandate or recommend the use of a particular model, CALINE is the model currently recommended by the US EPA for prediction of air quality impacts of roadway (line) emission sources. Because the CALINE model is US

EPA-approved, it has gone through rigorous evaluation to ensure that the model is providing appropriate results. Due to CALINE's conservatism, its predicted concentrations tend to be higher than observed ambient air quality, but the model will provide a worst-case estimate of a Project's effects on local air quality.

Vehicle emission factors were determined using the U.S. EPA MOVES2012b modelling simulator (U.S. EPA 2012). At the core of the methodology is the emission equation:

Emission (g) = activity data (VkmT) x emission factor (g/VkmT), where VkmT is the number of vehicle kilometres travelled.

Emission calculations for vehicles are complex because of the many methods needed to determine reliable emission factors and activity data. Emission factors can vary significantly depending on:

- Vehicle type (e.g., light duty vs. heavy duty, gasoline vs. diesel)
- Mileage accumulation (age of vehicle)
- Speed (e.g., 20 km/h vs. 100 km/h)
- Control technology (e.g., catalytic converters)
- Other emission-reduction measures

The MOVES model generates emissions factors for highway motor vehicles and motorcycles fuelled by gasoline, diesel, and compressed natural gas (CNG). It also accounts for the effects on emissions caused by changes in vehicle emission standards; changes in vehicle populations and activity; and variation in local conditions such as temperature, humidity, atmospheric pressure, and fuel quality.

The CALMET model was used to determine wind and temperature fields. For each road segment (see below for definition of road segments used in the model), an hourly data set representing one year of data was generated and formatted for input into the CALINE model. Roughness length, required by the model and used to indicate turbulence characteristics of a particular type of surface, was presumed to be 100 cm.

For modelling and emission estimation purposes, the Project is divided into the following six segments:

- Segment 1: Bridgeport Road to Westminster Highway
- Segment 2: Westminster Highway to Steveston Highway
- Segment 3: Tunnel/new bridge and approaches
- Segment 4: Highway 17A to Highway 17
- Segment 5: Highway 17 to Ladner Trunk Road interchange
- Segment 6: Ladner Trunk Road interchange to Highway 91 (Delta)

Traffic Data

A range of future traffic scenarios in terms of tolling, traffic volumes, and congestion levels were considered, and the most conservative scenario was used in predicting future emissions. As discussed in Section 5.1.2.4 of the Application, average annual daily traffic volumes (AADT) for 2030 were assessed using TransLink’s RTM for two scenarios– with the new bridge in place and no tolls being applied (TL-RTM Untolled), and with a new tolled bridge in place (TL-RTM Tolled). Given the variability in the forecasting, and to ensure a conservative assessment for EA purposes, the upper range of forecast values (TL-RTM untolled, 2030 With the Project) were used as it represents the highest potential volume of traffic.

4.9.1.3 Assessment Boundaries

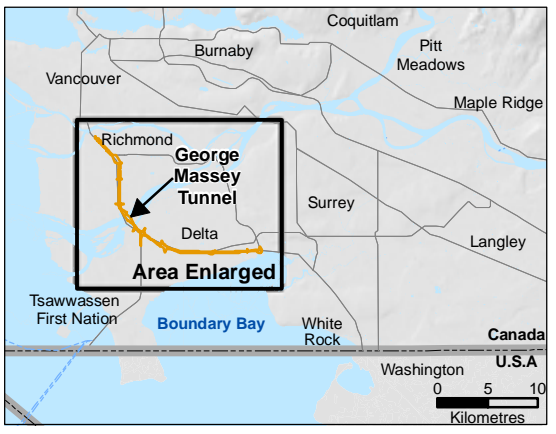
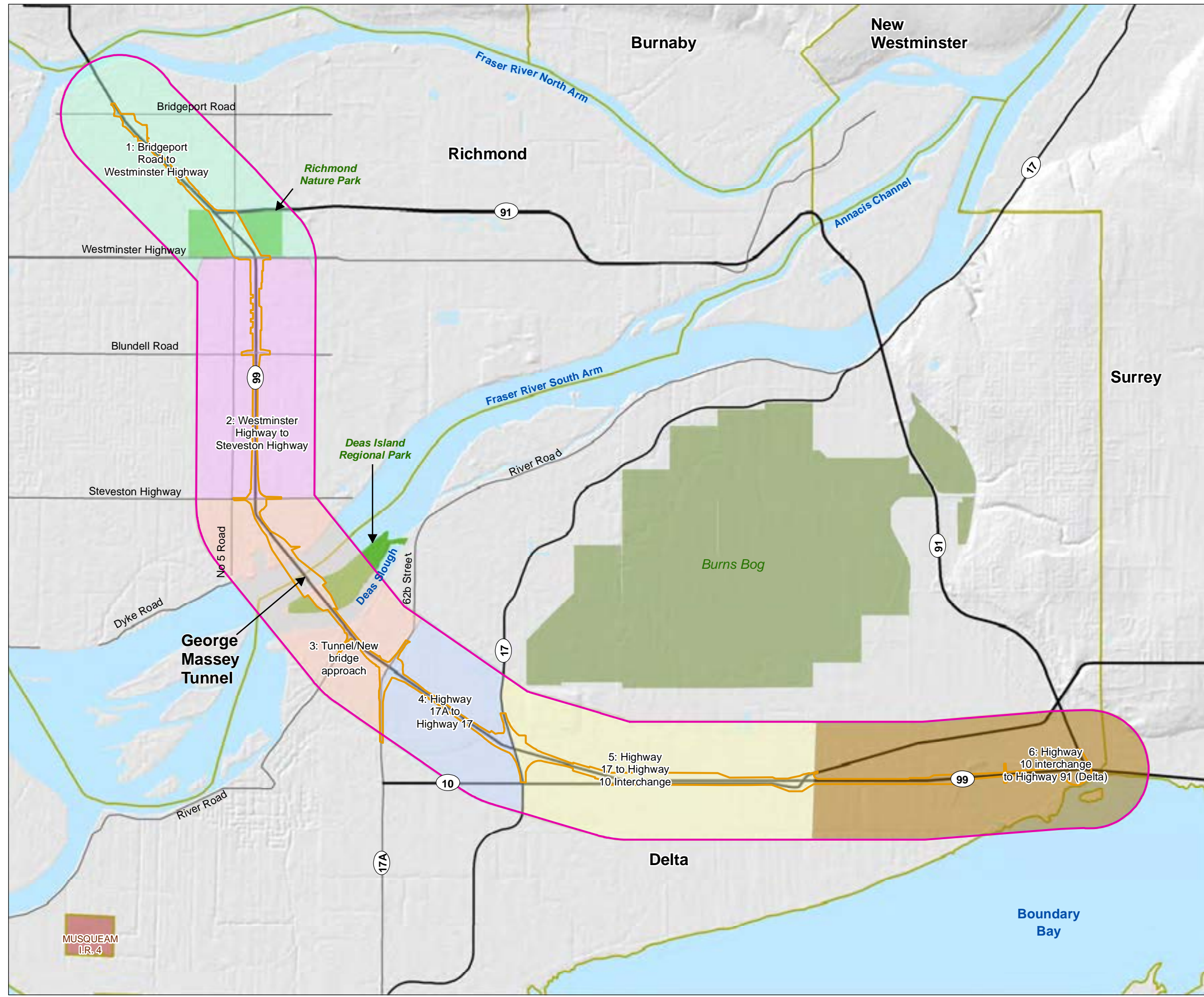
The assessment boundaries for air quality are defined below.

Spatial Boundaries

The local assessment area (LAA) and regional assessment area (RAA) for air quality is defined in **Table 4.9-2**, and shown on **Figure 4.9-1** and **Figure 4.9-2**, respectively.

Table 4.9-2 Spatial Boundaries for Air Quality Assessment

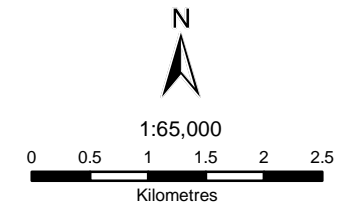
| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local Assessment Area (LAA) | The area within a one-kilometer wide corridor, extending 500 m from either side of the Highway 99 centerline, over the length of the Project alignment – from Bridgeport Road (Richmond) to Highway 91 (Delta) including interchanges. |
| Regional Assessment Area (RAA) | The lower Fraser Valley airshed defined as the area bounded to the north by North Vancouver, to the east by Hope, and to the south by the Cascade Mountains in Washington State |



- Legend**
- Air Quality Local Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

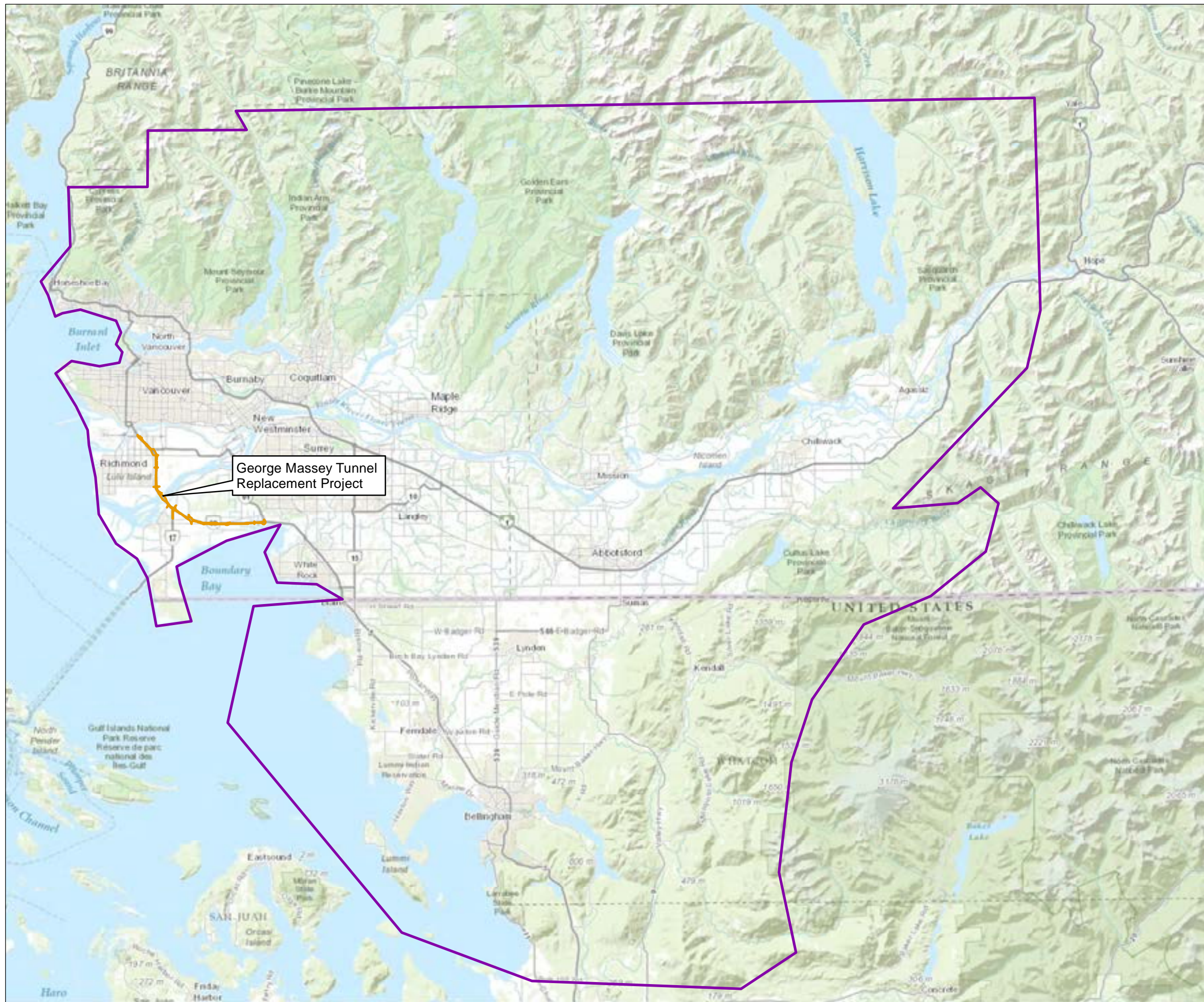
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AIR QUALITY LOCAL ASSESSMENT AREA | |
| Figure 4.9-1 | 13/05/2016 |
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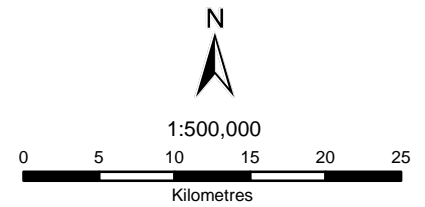
George Massey Tunnel Replacement Project

Legend

- Air Quality Regional Study Area
- Project Alignment

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AIR QUALITY REGIONAL STUDY AREA | |
| Figure 4.9-2 | 13/05/2016 |
| | |

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on air quality were established based on the potential for each phase of the Project to interact with and have an effect on air quality. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operation phase of the Project include components and activities that could interact with and affect air quality; therefore, the following temporal boundaries were defined for air quality assessment:

- Existing conditions.
- Construction phase (including decommissioning of the Tunnel).
- Operations phase (new bridge and highway in operation).

Temporal characteristics (timing) of the Project construction phase (including decommissioning of temporary construction-related facilities and the Tunnel), and operation phases are defined in **Section 1.1.3 Project Phases and Schedule**. To better understand existing conditions and support the assessment of potential effects of the Project on human health, three emission scenarios were modelled:

1. Existing (2011) conditions
2. Future (2031) conditions without the Project (i.e., no new bridge, Tunnel operational)
3. Future (2031) conditions with the Project (i.e., post-construction, new bridge operational, Tunnel decommissioned)

The year 2011 was selected to represent existing conditions because it is the most recent year for which traffic modelling data and Metro Vancouver's emissions inventory were available at the time of modelling. 2031 was selected to represent what is reasonably foreseeable for forecasting emissions into the future, and to coincide with the regional emission inventory forecast.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on air quality have been identified; therefore, no administrative boundaries are defined.

Technical Boundaries

Vehicular and construction emissions are quantified using default emission factors¹ and modelling tools. Dispersion modelling provides a worst-case estimate of the potential effects of emissions sources on the surrounding air quality, and results of assessment based on dispersion modelling may be conservative in nature.

4.9.2 Existing Conditions

This section discusses anticipated interactions of Project components and activities with air quality, and potential effects of such interactions on criteria air contaminants, road dust, and toxic air contaminants. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 4.9.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 4.9.5**. A discussion of the potential for cumulative effects on air quality is presented in **Section 4.9.6**.

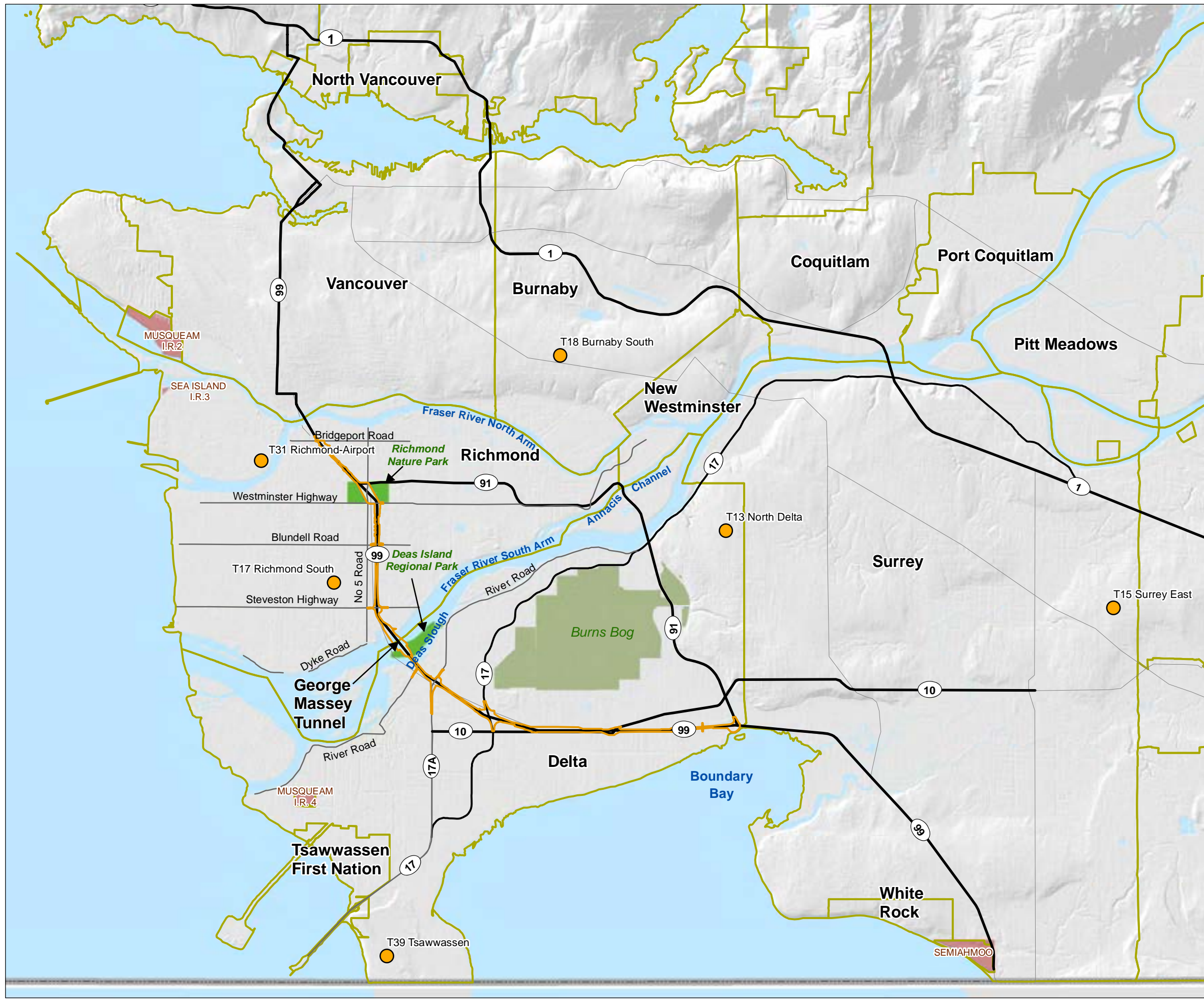
4.9.2.1 Baseline Data Collection

Ambient Air Quality

Ambient air quality for the LAA was characterized using data provided by Metro Vancouver at six monitoring stations (**Figure 4.9-3**) located within 20 km of the Project. Ambient air quality data cover the period from 2008 to 2012, and represent the highest 98th percentile (i.e., value at or below which 98% of the data fall). Data were compared to provincial, federal, or regional Ambient Air Quality Objectives (AAQOs) to determine potential Project-related changes on local air quality. Data on TACs were obtained from the National Air Pollution Surveillance network.

¹ An emission factor is defined as the average emission rate of a given pollutant for a given source, relative to units of activity (e.g., kg of SO₂ emitted per kilometre travelled).

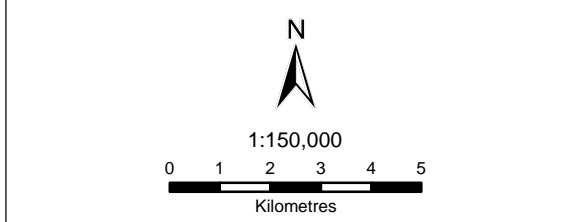
Path: C:\1217-299\285077\03\mxd\Air Quality\EA\Fig4-3_285_077_03_EA_AQ-Mon_160115_FINAL.mxd



- Legend**
- Metro Vancouver Monitoring Station
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AIR QUALITY MONITORING STATIONS | |
| Figure 4.9-3 | 13/05/2016 |
| | |

Meteorology and Climatology

Local meteorology is a strong determinant of local air quality since it is the primary driver of dispersion of pollutants within an airshed. Data on wind speed, wind direction, and ambient temperature relevant to the Project were obtained from the Vancouver International Airport station (T31 Richmond-Airport, **Figure 4.9-3**), and compared with long-term climate data from Metro Vancouver stations to select a baseline year representative of the region's climatology. Based on this analysis, the year 2012 was used in modelling studies conducted for this assessment (**Section 4.9.3.2**). Datasets for wind speed, wind direction, and ambient temperature from the six ambient air monitoring stations were used to determine data suitability for modelling. A three-dimensional meteorological model for determining wind and temperature fields, CALMET, was used to characterize the meteorology near each modelled road segment from January 1, 2012 to December 31, 2012.

Vehicle Emissions

Vehicle emission factors were determined using the United States Environmental Protection Agency (US EPA) Motor Vehicle Emissions Simulator (MOVES 2010b) computer modelling program, described in **Section 4.9.3.2**.

The B.C. Modelling Guideline, which outlines recommended steps (e.g. development of a conceptual as well as a detailed model plan) for completing modelling projects, was used to guide Project-related air-quality modelling. Metro Vancouver was involved in the model planning discussions from the early stages of model planning, and this consultation helped identify and address some of the issues noted in this assessment.

Model input data were provided by Metro Vancouver and included the following:

- Climate data.
- Fleet age distribution and profile (i.e., proportion of vehicle types) (Metro Vancouver 2013).
- Information on inspection and maintenance programs and regulatory framework (e.g., BC renewable fuel requirement of five per cent for gasoline and four per cent for diesel).
- Vancouver-specific fuel sales and fuel characteristics (e.g., Reid vapour pressure, ethanol blend market share, biodiesel content).

Road Dust

Road dust emissions were quantified using methodology developed by US EPA (2011), as described in **Section 3.2.3** of the technical volume, *Air Quality Study*, included under **Section 16.5**. Data input included highway silt content and vehicle fleet average weight obtained from Metro Vancouver, and number of precipitation days collected for 2011 from station T17 Richmond South (**Figure 4.9-3**).

Traffic Data

Pollutant emissions are dependent on the amount of traffic moving through a given roadway. Results of travel demand forecasting, completed in support of Project planning and design using the travel demand modelling system EMME/2, were used to estimate the volume of traffic expected along the Project corridor in the future (2031).

4.9.2.2 Regulatory Context

This section provides an overview of federal, provincial, and regional ambient air quality objectives (AAQOs) that are relevant to the Project.

Federal

The federal government's role in addressing air quality issues is largely defined through the *Canadian Environmental Protection Act (CEPA)*, 1999, SC 1999, c. 33. Many emission sources that lie beyond provincial authority are subject to federal regulation, standards, and guidelines. These include motor vehicles and fuels, marine vessels, railways, and off-road engines.

Provincial

The provincial *Environmental Management Act*, SBC 2003, c. 53, provides the Minister of Environment with the authority to develop objectives to manage air quality in B.C. Air quality objectives are non-statutory limits (i.e., not legally binding) that are used to:

- Gauge current and historical air quality.
- Guide decisions on environmental impact assessments and authorizations.
- Guide airshed planning efforts.
- Inform regulatory development.
- Develop and apply episode management strategies such as air quality advisories.

Under provisions of the *Environmental Management Act*, Metro Vancouver has been delegated authority to manage air quality within its boundaries. A key role played by Metro Vancouver under this delegated authority is establishing ambient air quality criteria that may be different but no less stringent (or more stringent) than requirements established by the Province.

Air Quality Objectives

AAQOs are developed by environmental and health authorities and are based on scientific studies that consider the effects of the contaminants on such receptors as humans, wildlife, vegetation, as well as aesthetic qualities such as visibility.

The current provincial, federal, and regional (Metro Vancouver) AAQOs for NO₂, CO, SO₂, PM₁₀, and PM are shown in **Table 4.9-3**. Emissions of NO₂, CO, SO₂, and PM are relevant to the assessment because of Project construction and operation activities which will result in contaminants being directly emitted in the form of construction equipment and vehicle exhaust. Management of ground level ozone is a key priority for Metro Vancouver, and the Project will support Metro Vancouver's Regional Ground Level Ozone Strategy by facilitating a reduction in VOC emissions in the Western portion of the Lower Fraser Valley (Policy Directions A3, B1, B2, and B3). The objectives for ozone (O₃) have also been included in **Table 4.9-3** because O₃ is formed as a secondary contaminant by a photochemical reaction that occurs in the atmosphere between NO_x and VOCs. NH₃ is also included in **Table 4.9-3**, as NH₃ is expected to be emitted during project construction and operation. No AAQOs exist for NH₃ in B.C.; therefore, the Ontario 24-hour guideline of 100 µg/m³ (Ontario Ministry of the Environment 2012) was adopted for comparison purposes in this assessment. Toxic air contaminants AAQOs that are relevant to the Project are discussed below.

Federal National Ambient Air Quality Objectives (NAAQOs) are classified into three categories of maximum desirable, maximum acceptable, and maximum tolerable concentrations; the maximum desirable objective is the most stringent standard. Provincial objectives for some pollutants have multiple levels (e.g., A, B, and C) reflecting the different conditions under which the objectives may be applied. For additional details, refer to **Section 2.2** of the technical volume, *Air Quality Study*, included under **Section 16.5**. Over the past few years, most Provincial objectives have been reduced to a single number for each averaging period. For pollutants with multiple objectives, Level A objectives are the most stringent, typically applied to new and proposed discharges to the environment, and are usually the same as the federal maximum desirable objective. Metro Vancouver's AAQOs are medium-term, health-based, and are a step towards the lowest observable effects levels (Metro Vancouver 2015).

Canadian Ambient Air Quality Standards (CAAQS)—Canada-wide standards for fine particulate matter (PM_{2.5}) and ozone (CCME 2012), developed under Canadian Council of Ministers of the Environment (CCME), are part of the Air Quality Management System (AQMS). These standards are set for air sheds across the country and require compliance with the concept of continuous improvement and keeping clean areas where PM and ozone ambient levels fall below numeric standards (CCME 2012). The CAAQS for NO₂, CO, SO₂, PM₁₀, PM_{2.5}, and O₃ are provided in **Table 4.9-3**.

Table 4.9-3 Summary of Federal, Provincial, and Regional Ambient Air Quality Objectives for Criteria Air Contaminants

| Parameter | Federal Objective ¹ (µg/m ³) | | | Provincial Objective ² (µg/m ³) | | | Regional Objective ³ (µg/m ³) | Most stringent objective (µg/m ³) |
|-------------------------|---|---------------------------------|--------------------------------|--|----------------------|----------------------|--|---|
| | Maximum Desirable ⁴ | Maximum Acceptable ⁴ | Maximum Tolerable ⁴ | Level A ⁵ | Level B ⁵ | Level C ⁵ | | |
| NO₂ | | | | | | | | |
| 1-hr Maximum | n/a | 400 | 1,000 | 188 | | | 188 | 188 |
| Annual Mean | 60 | 100 | n/a | 60 | | | 40 | 40 |
| CO | | | | | | | | |
| 1-hr Maximum | 15,000 | 35,000 | n/a | 14,300 | 28,000 | 35,000 | 30,000 | 14,300 |
| 8-hr Maximum | 6,000 | 15,000 | 20,000 | 5,500 | 11,000 | 14,300 | 10,000 | 5,500 |
| SO₂ | | | | | | | | |
| 1-hr Maximum | 450 | 900 | n/a | 200 | | | 196 | 196 |
| 24-hr Maximum | 150 | 300 | 800 | n/a | n/a | n/a | 125 | 125 |
| Annual Mean | 30 | 60 | n/a | 25 | 50 | 80 | 30 | 25 |
| PM₁₀ | | | | | | | | |
| 24-hr Maximum | n/a | n/a | n/a | n/a | 50 | n/a | 50 | 50 |
| Annual Mean | n/a | n/a | n/a | n/a | n/a | n/a | 20 | 20 |
| PM_{2.5} | | | | | | | | |
| 24-hr Maximum | 28 ¹ | | | 25 | | | 25 | 25 |
| Annual Mean | n/a | n/a | n/a | 8 | | | 8 | 8 |
| O₃ | | | | | | | | |
| 1-hr Maximum | 100 | 160 | 300 | n/a | n/a | n/a | 160 | 100 |
| 24-hr Maximum | 30 | 50 | n/a | n/a | n/a | n/a | 126 ⁶ | 30 |
| Annual Mean | n/a | 30 | n/a | n/a | n/a | n/a | n/a | 30 |

Notes:

¹ CAAQS (CCME 2012)

² B.C. MOE (2016)

³ Metro Vancouver (2015)

⁴ Concentrations given at 25°C, 101.3 kilopascal (kPa), dry basis.

⁵ Concentrations given at 20°C, 101.3 kPa, dry basis

⁶ 8-hour average

n/a Objective not applicable

British Columbia does not have AAQOs for the TACs listed in **Section 4.9.1.2**, except for the one-hour average objective for formaldehyde (60 µg/m³). The Alberta Ambient Air Quality Objectives (Alberta Environment and Sustainable Resource Development 2013) and the Ontario Ambient Air Quality Criteria (AAQC) (Ontario Ministry of the Environment 2012) listed in **Table 4.9-4**, are used in this assessment for TACs other than formaldehyde. In the case where standards exist for both Alberta and Ontario (i.e. annual averaging period for benzene and benzo(a)pyrene), the more stringent standard is applied.

Table 4.9-4 Ambient Air Quality Objectives for Toxic Air Contaminants

| Toxic Air Contaminants | Averaging Period | British Columbia AAQO (µg/m ³) | Alberta AAQO (µg/m ³) | Ontario AAQC (µg/m ³) |
|------------------------|------------------|--|-----------------------------------|-----------------------------------|
| Acrolein | 1-hour | n/a | 4.5 | n/a |
| | 24-hour | n/a | n/a | 0.4 |
| Acetaldehyde | 1-hour | n/a | 90 | n/a |
| | 24-hour | n/a | n/a | 500 |
| Benzene | 1-hour | n/a | 30 | n/a |
| | 24-hour | n/a | n/a | 2.3 |
| | Annual | n/a | 3 | 0.45 |
| Benzo(a)pyrene | 24-hour | n/a | n/a | 0.00005 |
| | Annual | n/a | 0.0003 | 0.00001 |
| Formaldehyde | 1-hour | 60 | 65 | n/a |
| | 24-hour | n/a | n/a | 65 |
| Napthalene | 24-hour | n/a | n/a | 22.5 |
| 1,3-butadiene | 24-hour | n/a | n/a | 10 |
| | Annual | n/a | n/a | 2 |

Notes: AAQO=Ambient Air Quality Objectives; AAQC=Ambient Air Quality Criteria; n/a=Objective not applicable.

4.9.2.3 Existing Conditions

This section describes existing conditions pertaining to air quality within the LAA, based on background air quality data analysis, and traffic and emissions model outputs. The results of dispersion modelling, undertaken for this assessment, are also summarized to offer an insight into what future (2031) air quality conditions might be in the RAA with and without the Project.

Vehicle Emissions

Annual vehicle emissions of CACs and TACs for the existing (2011) condition scenario are shown in **Table 4.9-5**. These values are based on 2011 traffic volumes and existing road infrastructure. These results were used as the base for comparison for vehicle emissions in 2031, with and without the Project.

Table 4.9-5 Vehicle Emissions from Highway 99 Traffic Within the Project Alignment – Existing (2011) Condition

| Parameters | Vehicle Emissions (tonnes/year) |
|------------------------------|---------------------------------|
| CACs | |
| VOCs | 234.4 |
| Carbon monoxide | 3,594.5 |
| Nitrogen oxides | 388.4 |
| Sulphur dioxide | 2.7 |
| Ammonia | 11.8 |
| PM (vehicles) | 14.9 |
| PM ₁₀ (vehicles) | 14.9 |
| PM _{2.5} (vehicles) | 11.0 |
| Road Dust | |
| PM | 279.5 |
| PM ₁₀ | 53.6 |
| PM _{2.5} | 13.0 |
| TACs | |
| Diesel PM | 4.1 |
| Benzene | 7.8 |
| Naphthalene | 0.5 |
| 1,3-butadiene | 0.8 |
| Formaldehyde | 2.8 |
| Acetaldehyde | 2.4 |
| Acrolein | 0.2 |
| Benzo(a)pyrene | 0.0008 |

Notes: n/a = Objective not applicable

Ambient Air Quality

Table 4.9-6 shows the results of the CALINE dispersion modelling for the existing (2011) conditions scenario. Maximum and 98th percentile emissions are presented for the estimated one-hour, 24-hour, and annual ambient concentrations for each contaminant. The 98th percentile is the value that ambient concentrations are equal to or less than 98% of the time. The 98th percentile values are important to consider, along with the maximum concentration, because maximum values can often be considered an anomaly, whereas the 98th percentile provides a better representation of maximum effects of the Project on local air quality. Shaded cells indicate an exceedance of the relevant, most stringent AAQOs. Since only one year of dispersion modelling was conducted, 98th percentile values were not estimated for the annual averaging period.

Table 4.9-6 Estimated Maximum and 98th Percentile Concentrations ($\mu\text{g}/\text{m}^3$) of Pollutants of Concern – Existing Conditions

| Pollutant | Averaging Period | Maximum Concentration ($\mu\text{g}/\text{m}^3$) | 98 th Percentile Concentration ($\mu\text{g}/\text{m}^3$) | Ambient Air Quality Objective ($\mu\text{g}/\text{m}^3$) |
|------------------------------------|------------------|--|--|--|
| VOCs | 1-hour | 2,796.7 | 1,167.9 | n/a |
| | 24-hour | 256.3 | 162.2 | n/a |
| | Annual | 73.4 | n/a | n/a |
| Carbon monoxide | 1-hour | 20,325.1 | 8,616.0 | 14,300 |
| | 8-hour | 4,980.6 | 2,491.8 | 5,500 |
| Nitrogen dioxide (100% conversion) | 1-hour | 2,574.1 | 1,086.0 | 188 |
| | Annual | 92.8 | n/a | 40 |
| Sulphur dioxide | 1-hour | 27.6 | 11.6 | 196 |
| | 24-hour | 2.7 | 1.7 | 125 |
| | Annual | 0.8 | n/a | 25 |
| Ammonia | 24-hour | 11.0 | 6.9 | 100 |
| PM ₁₀ (Vehicles) | 24-hour | 19.5 | 12.4 | 50 |
| | Annual | 5.6 | n/a | 20 |
| PM _{2.5} (Vehicles) | 24-hour | 12.1 | 7.6 | 25 |
| | Annual | 3.5 | n/a | 8 |

| Pollutant | Averaging Period | Maximum Concentration ($\mu\text{g}/\text{m}^3$) | 98 th Percentile Concentration ($\mu\text{g}/\text{m}^3$) | Ambient Air Quality Objective ($\mu\text{g}/\text{m}^3$) |
|-------------------------------|------------------|--|--|--|
| PM ₁₀ (Road Dust) | 24-hour | 37.1 | 23.1 | 50 |
| | Annual | 11.7 | n/a | 20 |
| PM _{2.5} (Road Dust) | 24-hour | 9.0 | 5.6 | 25 |
| | Annual | 2.8 | n/a | 8 |
| Benzene | 1-hour | 58.0 | 24.4 | 30 |
| | 24-hour | 6.9 | 4.3 | 2.3 |
| | Annual | 2.0 | n/a | 0.45 |
| Naphthalene | 24-hour | 0.5 | 0.3 | 22.5 |
| 1,3-Butadiene | 24-hour | 0.7 | 0.4 | 10 |
| | Annual | 0.2 | n/a | 2 |
| Formaldehyde | 1-hour | 26.3 | 11.0 | 60 |
| Acetaldehyde | 1-hour | 18.1 | 7.6 | 90 |
| | 24-hour | 2.1 | 1.3 | 500 |
| Acrolein | 1-hour | 1.7 | 0.7 | 4.5 |
| | 24-hour | 0.2 | 0.1 | 0.4 |
| Benzo(a)pyrene | 24-hour | 8.9E-04 | 5.7E-04 | 5.00E-05 |
| | Annual | 2.6E-04 | n/a | 1.00E-05 |

Notes: n/a = Objective not applicable. Shaded cells indicate an exceedance of the relevant, most stringent AAQOs.

Currently, carbon monoxide, nitrogen dioxide, benzene, and benzo(a)pyrene exceed the most stringent AAQOs. The one-hour 98th percentile of carbon monoxide concentrations does not exceed the objective of 14,300 $\mu\text{g}/\text{m}^3$; therefore, carbon monoxide is estimated to exceed the one-hour AAQO less than 0.2% of the time. While nitrogen dioxide is predicted to exceed the most stringent AAQO of 188 $\mu\text{g}/\text{m}^3$, the NO₂ concentrations are based on 100% conversion of NO_x, which is extremely conservative.

4.9.3 Potential Effects

This section provides a summary of anticipated changes to air quality related to the construction and operation of the Project. It also describes the methodology used to assess potential Project-related effects.

4.9.3.1 Project Interactions

A preliminary evaluation of the potential effects of Project interactions on air quality, intended to focus the assessment on interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: Project construction will interact with air quality through air emissions from road dust and fuel combustion in diesel, propane, and gasoline-powered machinery, equipment, and vehicles operating during highway upgrades and new bridge construction.

Operation: During Project operation, the traffic pattern, volume, and vehicle fleet composition is expected to result in changes in emissions associated with the Highway 99 corridor. Potential interactions of Project-related operations with air quality include:

- Operating reconfigured Highway 99 and interchanges.
- Operating the new bridge.

Maintenance activities associated with Project operations are not anticipated to interact with air quality as these activities generally produce minute amounts of vehicle emissions that would be too small to detect.

An overview of potential interactions between Project activities and air quality during the construction and operation of Project components is provided in **Appendix A**.

4.9.3.2 Potential Effects

The following basic steps were followed to assess potential Project-related changes in air quality:

- Estimate air contaminant emissions from vehicles and road dust for the three scenarios of existing (2011), future (2031) without the Project, and future (2031) with the Project through emissions modelling.
- Use the estimated emission values to predict contaminant concentrations in air within the LAA for the three scenarios through dispersion modelling.
- Compare estimated concentrations with applicable AAQOs to identify potential exceedances.
- Compare estimated pollutant concentrations within the LAA for the two future (2031) scenarios against existing (2011) conditions to predict potential Project-related changes.

The future conditions were assessed using the reference year 2031 to make effective use of the vehicle fleet emissions forecasts set out by Metro Vancouver, and the Regional Transportation Model. An overview of emissions modelling conducted to estimate contaminant emissions and dispersion modelling completed to predict contaminant concentrations is provided below. Additional details on the modelling methods used to support the assessment of air quality are provided in **Section 3.3** of the technical volume, *Air Quality Study*, included under **Section 16.5**.

Emissions Modelling

Vehicle emission factors were determined for 13 vehicle and three fuel (i.e., gasoline, diesel, and compressed natural gas) types, using MOVES2010b. The MOVES model accounts for changes in emissions caused by changes in vehicle emissions standards, vehicle populations and activities, and variation in local conditions (e.g., temperature, humidity, pressure, and fuel quality). Emission factors for each vehicle type were determined for a variety of vehicle speeds for pollutants listed in **Section 4.9.1.2**.

Traffic information was derived from an emissions inventory developed for the Project based on vehicle kilometre travelled (VkmT) for each vehicle category and vehicle class-specific emission factors. Traffic modelling data for all three scenarios, within the LAA, were broken down into vehicle type, based on Metro Vancouver's current and forecasted fleet profiles.

For each segment of road, the number of vehicles by type and associated emission factor were multiplied together to determine an emission rate per kilometre of road per vehicle. The dispersion model (see discussion on Dispersion Modelling below) used emission rates, road length, width, and orientation to predict ambient air quality resulting from traffic flowing on each of the six road segments. Details on the vehicle emissions factors modelling are provided in **Section 3.2.2** of the technical volume, *Air Quality Study*, included under **Section 16.5**.

Quantification of Road Dust Emissions

Road dust emissions are not generated by the MOVES model, but are considered within the scope of this study. Road dust quantification followed the methods developed by U.S. EPA (2011) and is described in detail in **Section 3.2.3** of the technical volume, *Air Quality Study*, included under **Section 16.5**.

Dispersion Modelling

Dispersion modelling was conducted for existing (2011) conditions and future (2031) conditions, with and without the Project, using CALINE3 combined with CALMET, to predict concentrations of emission-related contaminants in ambient air. CALINE predicts hourly ambient concentrations at designated receptor locations, represented as grid points with Universal Transverse Mercator (UTM) coordinates. Receptors in this study were spaced along Highway 99 at 100 m intervals and extended at intervals of 5, 10, 15, 20, 25, 50, 100, 250, 500 and 1,000 m perpendicular to the road. In addition, sensitive receptors (e.g., schools, hospitals) were included in the CALINE receptor grid. (See **Figure 1** of the technical volume, *Air Quality Study*, included under **Section 16.5** for details). The air quality predictions from dispersion modelling were compared to the most stringent of applicable federal, provincial, or regional AAQOs (**Table 4.9-3**).

Potential Construction Effects

Emissions associated with Project construction are not quantifiable at this time as the contractor has not been selected and the exact age and type of equipment that would be used in construction is not known. However, it is anticipated that the equipment fleet used on the Project will be similar to those used on previous transportation infrastructure projects in the region, as summarized in **Table 4.9-7**.

Table 4.9-7 Construction Fleet Parameters

| Equipment Type | Horsepower |
|----------------------------|------------|
| Loaders | 300 |
| Crawler tractors | 468 |
| Excavators | 286 |
| Graders | 275 |
| Haul Units – Off – Highway | 1,000 |
| Highway Trucks – Hauling | 510 |
| Compactors | 107 |
| Hydraulic excavators | 286 |
| Support equipment | 125 |

The following types of emissions are expected from Project-related construction activities: fugitive dust associated with soil stockpiles and ground disturbance; and common air contaminants (such as NO_x, SO_x, VOCs) generated by fuel combustion in construction equipment. Based on results of air quality monitoring and analysis on previous projects in the Lower Mainland, specifically the South Fraser Perimeter Road/Highway 17 project, overall construction-related emissions due to the Project are expected to be immaterial in relation to the amount of emissions occurring along the corridor.

Air quality monitoring was conducted before, during, and after the construction of many of the major infrastructure projects, and in each case monitoring results were summarized in monitoring and analysis reports submitted to regulatory agencies. Documented monitoring results, including a five year record (2009 to 2013) of monitoring particulate matter and dustfall for SFPR (the project closest to Highway 99), have demonstrated that the air quality management and dust control plans, similar to those that will be implemented for the Project, were effective in addressing potential construction-related effects on air quality and ensuring applicable air quality objectives were met. The monitoring period covered the phases pre-construction, construction, and post operation, and the data shows that there was no appreciable difference in air quality between any of the phases, which provides further evidence that influence of construction activities on air quality is immaterial when compared to other activities that influence air quality in the corridor.

Air quality is currently monitored in Richmond and Delta, and air quality monitoring will be undertaken at construction site(s) during the Project construction period to verify that construction-related emissions do not have any material effect on air quality in the area. Construction-related air quality monitoring will also be used to ensure best management practices are being followed and air quality objectives are being met. Reports summarizing results of air quality monitoring and analysis will be provided to relevant stakeholder agencies.

Potential Operation Effects

Vehicle Emissions

Table 4.9-8 presents predicted emissions of CACs, road dust, and TACs in the LAA for the two future scenarios. The 2031 scenario with the Project considers the untolled, worst-case operational phase of the Project while the other (2031 without the Project) assumes that no road improvements have been made. Vehicle emissions for the two future scenarios (i.e., 2031 with and without the Project) are compared with baseline emissions (**Section 4.9.2.3**) to assess potential changes in air quality. Existing vehicle emissions conditions are also shown for comparison, as are per cent change in emissions resulting from this comparison (**Table 4.9-8**).

Table 4.9-8 Vehicle Emissions for 2031 Without and With the Project

| Species | Emissions (tonnes/yr) | | | Change from 2011 (%) | | Difference between Future With and Without the Project (%) |
|-------------------------------|-----------------------|-----------------|--------------|----------------------|--------------|--|
| | Existing Roads | Without Project | With Project | Without Project | With Project | |
| | 2011 | 2031 | 2031 | | | |
| VOCs | 234.4 | 139.9 | 123.5 | -40% | -47% | -12% |
| CO | 3594.5 | 3216.5 | 3444.7 | -11% | -4% | 7% |
| NOx | 388.4 | 166.1 | 169.6 | -57% | -56% | 2% |
| SO ₂ | 2.7 | 2.8 | 2.6 | 4% | -2% | -6% |
| NH ₃ | 11.8 | 9.8 | 9.6 | -17% | -19% | -2% |
| PM (Vehicles) | 14.9 | 12.8 | 9.4 | -14% | -37% | -27% |
| PM ₁₀ (Vehicles) | 14.9 | 12.8 | 9.4 | -14% | -37% | -27% |
| PM _{2.5} (Vehicles) | 11.0 | 7.2 | 6.3 | -35% | -42% | -11% |
| Diesel PM | 4.1 | 0.4 | 0.4 | -89% | -91% | -18% |
| PM (Road Dust) | 279.5 | 345.4 | 383.2 | 24% | 37% | 11% |
| PM ₁₀ (Road Dust) | 53.6 | 66.3 | 73.5 | 24% | 37% | 11% |
| PM _{2.5} (Road Dust) | 13.0 | 16.0 | 17.8 | 24% | 37% | 11% |
| Benzene | 7.8 | 4.1 | 4.2 | -47% | -47% | 1% |
| Naphthalene | 0.5 | 0.3 | 0.3 | -44% | -46% | -3% |
| 1,3-Butadiene | 0.8 | 0.4 | 0.4 | -49% | -46% | 5% |
| Formaldehyde | 2.8 | 1.7 | 1.7 | -37% | -40% | -5% |
| Acetaldehyde | 2.4 | 1.3 | 1.3 | -44% | -43% | 1% |
| Acrolein | 0.2 | 0.1 | 0.1 | -47% | -50% | -5% |
| Benzo(a)pyrene | 8.4E-04 | 5.7E-04 | 5.9E-04 | -33% | -31% | 3% |

Notes: n/a = Objective not applicable

In general, vehicle emissions of most pollutants are predicted to be lower in 2031 than in 2011, with or without the Project. Although traffic volumes are projected to increase in 2031, emission factors in 2031 will have decreases that are enough to offset the increase in traffic.

The only pollutants projected to increase by 2031 are road dust and sulphur dioxide. Road dust emissions are dependent on VkmT, silt loading, vehicle fleet average weight, and precipitation days per year. These parameters are considered constant from 2011 to 2031, with the exception of VkmT. Therefore, without applicable mitigation, road dust emissions are projected to increase with the Project in a linear manner that is consistent with growth in traffic volume.

Emissions of sulphur dioxide are influenced by fuel quality. At the time of this assessment, no new fuel regulation is planned or known that would require lower sulphur fuels. As such, the increase in sulphur dioxide emissions is solely due to the number of vehicles entering the fleet resulting in higher overall fuel consumption. Although emission factors present a slight decrease from 2011 to 2031, this decrease is not enough to offset the anticipated increase in traffic volumes in future years. Sulphur dioxide emissions are lower in 2031 with the Project than without the Project due to lower levels of congestion expected as a result of the new bridge (i.e., rates of sulphur dioxide emissions increase with lower vehicle speeds associated with congestion). Overall, when compared with the other pollutants, sulphur dioxide emissions are low and thus do not present a notable concern.

Overall, greater reductions in most CAC and TAC emissions are evident in 2031 with the Project. This decrease is primarily due to congestion alleviation expected as a result of Project operation. The reduction in emission factors outweighs the increase in traffic volumes, with the exception of carbon monoxide, nitrogen oxides, benzene, 1,3-butadiene, acetaldehyde and benzo(a)pyrene.

Ambient Air Quality

Table 4.9-9 presents predicted concentrations of CACs and TACs associated with Highway 99 traffic in the Project alignment based on dispersion modelling results for the two 2031 scenarios (i.e., with and without the Project). For each pollutant, the most stringent AAQO is listed. For all pollutants except VOCs, predicted concentrations are presented for those averaging periods (i.e., 1-hour, 8-hour, 24-hour, or 1 year) that have AAQOs associated with them. There are no AAQOs for VOCs and formaldehyde. Predicted concentrations of these compounds averaged over 1 hour, 24 hours, and 1 year are presented to facilitate a comparison between future and current conditions.

Detailed results of dispersion modelling by pollutant are presented in Section 5.2 of the technical volume, ***Air Quality Study (Section 16.5)***. Section 5.3 of the technical volume includes details on how pollutant concentrations vary by location within the LAA.

Table 4.9-9 Contaminant Concentrations ($\mu\text{g}/\text{m}^3$) Associated with Highway 99 Traffic in 2031

| Pollutant | Averaging Period | 2031 Without Project | | 2031 With Project | | Most Stringent Objective |
|------------------------------------|------------------|-----------------------|-----------------------------|-----------------------|-----------------------------|--------------------------|
| | | Maximum Concentration | 98 th Percentile | Maximum Concentration | 98 th Percentile | |
| CACs | | | | | | |
| VOCs | 1-hour | 1,832.2 | 764.2 | 393.5 | 134.4 | n/a |
| | 24-hour | 193.7 | 123.1 | 49.4 | 32.9 | n/a |
| | Annual | 55.8 | n/a | 13.8 | n/a | n/a |
| Carbon monoxide | 1-hour | 17,500.5 | 7,422.3 | 10,977.6 | 3,758.8 | 14,300 |
| | 8-Hour | 4,470.6 | 2,348.2 | 2,439.8 | 1,222.7 | 5,500 |
| Nitrogen dioxide (100% Conversion) | 1-hour | 1,252.4 | 526.0 | 539.7 | 184.0 | 188 |
| | Annual | 45.4 | n/a | 18.6 | n/a | 40 |
| Sulphur dioxide | 1-hour | 29.9 | 12.5 | 8.3 | 2.8 | 196 |
| | 24-hour | 3.3 | 2.2 | 1.0 | 0.7 | 125 |
| | Annual | 1.0 | n/a | 0.3 | n/a | 25 |
| Ammonia | 24-hour | 10.5 | 6.9 | 3.8 | 2.5 | 100 |
| PM ₁₀ (vehicles) | 24-hour | 23.1 | 15.3 | 3.8 | 2.5 | 50 |
| | Annual | 6.8 | n/a | 1.1 | n/a | 20 |
| PM _{2.5} (vehicles) | 24-hour | 9.6 | 6.4 | 2.5 | 1.7 | 25 |
| | Annual | 2.8 | n/a | 0.7 | n/a | 8 |
| Road Dust | | | | | | |
| PM ₁₀ | 24-hour | 45.1 | 29.2 | 29.5 | 19.6 | 50 |
| | Annual | 14.2 | n/a | 8.1 | n/a | 20 |
| PM _{2.5} | 24-hour | 10.9 | 7.1 | 7.1 | 4.7 | 25 |
| | Annual | 3.4 | n/a | 2.0 | n/a | 8 |

| Pollutant | Averaging Period | 2031 Without Project | | 2031 With Project | | Most Stringent Objective |
|----------------|------------------|-----------------------|-----------------------------|-----------------------|-----------------------------|--------------------------|
| | | Maximum Concentration | 98 th Percentile | Maximum Concentration | 98 th Percentile | |
| TACs | | | | | | |
| Benzene | 1-hour | 32.4 | 13.6 | 13.3 | 4.5 | 30 |
| | 24-hour | 4.0 | 2.6 | 1.7 | 1.1 | 2.3 |
| | Annual | 1.2 | n/a | 0.5 | n/a | 0.45 |
| Naphthalene | 24-hour | 0.3 | 0.2 | 0.1 | 0.1 | 22.5 |
| 1,3-Butadiene | 24-hour | 0.4 | 0.2 | 0.2 | 0.1 | 10 |
| | Annual | 0.1 | n/a | 0.0 | 4.9E-02 | 2 |
| Formaldehyde | 1-hour | 18.1 | 7.6 | 0.8 | 0.3 | 60 |
| Acetaldehyde | 1-hour | 10.5 | 4.4 | 4.3 | 1.5 | 90 |
| | 24-hour | 1.3 | 0.9 | 0.5 | 0.4 | 500 |
| Acrolein | 1-hour | 0.9 | 0.4 | 0.3 | 0.1 | 4.5 |
| | 24-hour | 0.1 | 0.1 | 3.2E-02 | 2.1E-02 | 0.4 |
| Benzo(a)pyrene | 24-hour | 5.1E-04 | 3.3E-04 | 2.3E-04 | 1.6E-04 | 5.00E-05 |
| | Annual | 1.5E-04 | n/a | 6.4E-05 | n/a | 1.00E-05 |

Notes: n/a = Objective not applicable

The 2031 scenario without the Project is predicted to have more exceedances of AAQOs than the 2031 scenario with the Project. Without the Project, maximum concentrations of carbon monoxide, nitrogen dioxide, benzene, and benzo(a)pyrene associated with Highway 99 traffic in the Project alignment are predicted to exceed the most stringent AAQOs in 2031. Of note, the assessment for NO₂ concentrations is presented here. With the Project, no AAQO exceedances are predicted in 2031, except benzo(a)pyrene and the maximum 1-hour NO₂ concentration (presented here under the extremely conservative assumption of 100% conversion), both of which exhibit higher existing concentrations than predicted with the Project improvements.

In general, future air quality conditions without the Project are predicted to improve compared to existing conditions as a result of improvements to vehicle emissions through more stringent regulations, technology, and vehicle fleet turnover. Even with an increase in traffic, the 2031 scenario with the Project is predicted to result in an overall improvement in air quality compared to existing and future conditions without the Project.

4.9.4 Mitigation Measures

Mitigation measures developed to avoid or reduce potential adverse Project-related changes (e.g., during Project construction) and enhance improvements (e.g., during Project operation) to air quality are described in this section. A hierarchical approach based on avoidance of potential effects first, followed by minimization or reduction of unavoidable effects was used in identifying strategies to mitigate potential Project-related effects.

4.9.4.1 Avoidance

The new Fraser River crossing is proposed as an elevated structure, which will allow vehicle emissions to disperse rapidly and avoid effects on air quality associated with localized accumulation of pollutants.

4.9.4.2 Minimization

Measures to minimize potential Project-related effects on air quality, as outlined below, were identified based on a selection of measures and follow-up programs for other major transportation developments undertaken by the Ministry. Input from regulators and other stakeholders for major improvement projects such as the Sea to Sky Highway, Port Mann/Highway 1, and the South Fraser Perimeter Road/Highway 17 have also been considered.

Air Quality and Dust Control Management Plan

As described in **Section 12.0 Management Plans**, a Construction Environmental Management Plan (CEMP) will be developed for works to be undertaken by the Ministry or its contractors. As a component to the CEMP, an Air Quality and Dust Control Management Plan will be developed, which will describe measures to control and minimize fugitive dust and other airborne emissions associated with construction equipment, demolition, and other decommissioning activities, and soil handling. Specifically, this plan will describe the following:

- Regulatory permits necessary for the operation of construction equipment or machinery capable of producing point-source emissions
- Procedures to be implemented for the application of dust suppressants to construction areas and stockpiles to control fugitive dust and other airborne emissions
- Prohibitions regarding chemical suppressants and the burning of refuse or other material, unless otherwise authorized in an air discharge permit

The following industry standards and best management practices may be included in the Air Quality and Dust Control Management Plan for the mitigation of potential changes in local air quality resulting from Project construction:

- Operate equipment at optimum-rated loads
- Follow routine equipment maintenance procedures
- Turn off equipment, if practical, when not in use
- Maintain all heavy-duty diesel on-road vehicles (i.e., licensed vehicles, such as dump trucks) in good working order while operating on the Project site
- Install diesel PM filters in construction equipment and vehicles
- Use ultra-low sulphur diesel fuel (maximum 15-ppm sulphur content), and catalyzed particulate traps or a diesel oxidation catalyst in all heavy-duty diesel on-road vehicles and other diesel construction equipment
- To the extent possible, minimize double-handling of fill materials to limit hours that machines are operating
- Minimize generation of road dust during construction by:
 - minimizing the time unpaved surfaces are exposed
 - cleaning roadways regularly and removing debris
 - providing tire wash facilities to minimize tracking of mud and generation of road dust onto paved roads
 - watering unpaved hauling and unpacked surfaces as frequently as needed
 - covering dump truck loads that are hauling fine-grained materials, particularly to and from off-site locations

Best management practices to be followed during Project construction will be designed in accordance with appropriate regulations and the Air Quality and Dust Control Plan will be developed and submitted to relevant agencies for review and comment prior to construction.

Air Quality and Dust Control Plans and BMPs as identified above were developed and implemented during construction of previous major transportation infrastructure projects such as Port Mann/Highway 1, South Fraser Perimeter Road/Highway 17, and Sea to Sky Highway. Air quality monitoring and management conducted during the construction phase of these projects ensured that applicable air quality objectives were achieved.

Measures for Vehicle Emissions during Project Operations

Most pollutants from vehicle emissions are predicted decline in the 2031 scenario with the Project and the 2031 scenario without the Project due to fleet turnover. The 2031 scenario with the Project shows a greater decline in most pollutants from vehicle emissions due to reduced idling and more fuel efficient travel speeds. Hence, the implementation of mitigation measures for vehicle emissions is not considered necessary.

To address potential minimal incremental air quality effects during Project operation, the following mitigation measures are proposed:

- Design and manage the Project to ensure optimum traffic flow conditions
- Include options for increasing mode split by extending transit and HOV lanes, improving transit along the Project alignment with integrated transit stops and transit-only ramps at Bridgeport Road and Highway 17A, and providing multi-use pathways on the bridge and other locations for pedestrians and cyclists with connections to the regional cycling network.

Measures for Road Dust during Project Operations

Once operational, the new bridge and upgraded Highway 99 could result in an increase in road dust because of the projected growth in traffic VkmT. Road dust during Project operation will be managed at an appropriate frequency by cleaning the road where dirt, debris, sand, and gravel have accumulated, in accordance with Ministry requirements for highway maintenance (B.C. MOTI 2010).

4.9.5 Residual Effects

Implementing the mitigation measures described in **Section 4.9.4.2** will minimize potential Project-related changes on air quality during construction, although temporary, minor residual effects will be incurred.

Potential Project-related residual effects on air quality are characterized with respect to the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of each anticipated residual effect. Definitions for ratings applied to residual effects criteria, developed with specific reference to air quality are presented in **Table 4.9-10**. A summary of criteria ratings for the potential residual effect is provided in **Table 4.9-11**. Context of the residual effects assessment (i.e., sensitivity/resilience to potential Project-related effects), based on existing conditions, is also provided.

Table 4.9-10 Criteria Used to Characterize Residual Effects on Air Quality

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|---|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project. |
| | | Positive | Beneficial effect as a result of the Project. |
| | | Neutral | Neutral effect as a result of the Project. |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible | No measurable change |
| | | Low | A measurable change within the range of natural variability, but not affecting air quality |
| | | Moderate | A measurable change outside the range of natural variability, but not posing a risk to receptors |
| | | High | A measurable change outside the range of natural variability and may have long-term effect on receptors |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project alignment. |
| | | Local | Effect is restricted to the LAA. |
| | | Regional | Effect is restricted to the RAA. |
| Duration | Length of time over which the residual effect is expected to persist | Short term | Effect occurs for up to less than 3 months |
| | | Moderate term | Effect limited to construction period |
| | | Long term | Effects persist beyond construction |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor affects the IC) | Occasional | Effect occurs intermittently during Project construction. |
| | | Frequent | Effect occurs up to 5 days a week during Project construction. |
| | | Continuous | Effect occurs more than 5 days a week during Project construction. |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Baseline conditions will be naturally restored after disturbance has ceased. |
| | | Irreversible | Baseline conditions will not be naturally restored after disturbance has ceased. |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance. |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 25%. |
| | | Moderate | Likelihood of residual effect is between 25% and 75%. |
| | | High | Likelihood of residual effect is greater than 75%. |

4.9.5.1 Construction

The types of air emissions expected during Project construction (e.g., from construction equipment) are different than those associated with highway traffic, and Project construction is expected to have some influence on local air quality. **Table 4.9-11** presents a summary of the criteria ratings for potential effects on air quality during construction activities.

Context: The Project is located in an urban setting, where emissions from traffic and industries play a predominant role in influencing local and regional air quality. Air quality monitoring undertaken by the Ministry during construction of comparable transportation infrastructure projects in the past, including Sea to Sky Highway, Port Mann/Highway 1, and South Fraser Perimeter Road/Highway 17, demonstrate that, with standard best management practices and proven mitigation strategies discussed in **Section 4.9.4.2**, construction-related emissions can be considered immaterial in comparison to traffic, industry, and other emissions that contribute to ambient air quality in and around the Project area. Sensitivity of ambient air quality to emissions from Project-related construction is, therefore, considered to be low.

Table 4.9-11 Criteria Ratings: Change in Air Quality During Construction Activities

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|--------------------------|---|
| Direction | Neutral | Emissions during construction will be managed using best management practices. |
| Magnitude | Low | Change will be within the range of natural variability and is not expected to adversely affect air quality. |
| Extent | Site | Spatial extent will be restricted to the area of disturbance. |
| Duration | Short term | Effect will occur only during construction. |
| Frequency | Occasional to continuous | Frequency of effect will vary dependent on nature and location of specific construction activities. |
| Reversibility | Reversible | Potential effects cease upon completion of construction. |
| Likelihood | High | Construction-related emissions are expected to have some influence on local air quality. |

Project construction will be undertaken using standard practices and equipment employed on comparable transportation infrastructure projects in the Lower Mainland by the Ministry, with the implementation of best practices and mitigation measures. Because potential incremental changes to air quality associated with highway construction are well-understood and can be addressed through the application of mitigation measures that have been demonstrated to be effective on comparable projects, any potential adverse residual effects of Project-related construction on air quality are expected to be low in magnitude, and confined to active construction areas. Such effects will be temporary, of short-duration, and fully reversible.

4.9.5.2 Operation

Once operational, the Project is expected to result in an improvement in air quality, compared to existing conditions and future conditions without the Project, even with an increase in traffic. Based on the results of air quality modelling, without the Project, maximum concentrations of carbon monoxide, nitrogen dioxide, benzene, and benzo(a)pyrene associated with Highway 99 traffic in the Project alignment are predicted to exceed the most stringent AAQOs in 2031. With the Project, no AAQO exceedances are predicted in 2031, except benzo(a)pyrene and the maximum 1-hour NO₂ concentration, both of which exhibit existing concentrations that are higher than those predicted with Project improvements. Therefore no post-construction Project-related adverse residual effects are expected.

4.9.6 Cumulative Effects

The combination of Project-related changes, and changes from other certain and reasonably foreseeable projects and activities, as listed in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**, comprise the total cumulative changes in air quality. This includes TransLink's proposed Pattullo Bridge replacement, with a planned construction period between 2019 and 2023, which overlaps temporally with the Project; however, given the distance between the two projects, no spatial overlap of potential construction-related air quality effects are expected.

A brief overview of the predicted effects of the Project on regional air quality in 2031 is presented below. A more complete discussion is presented in **Section 6** of the technical volume, **Air Quality Study (Section 16.5)**. Greenhouse gas emissions have been identified as important to stakeholders, Aboriginal Groups, and the public. A brief discussion on Project-related change in traffic emissions in the context of regional emissions and greenhouse gas (GHG) considerations is presented below.

Regional Emissions

TransLink is currently developing a Regional Transportation Model (RTM) that will enable estimation on impacts on a regional basis. While the RTM is in early development stages, initial results indicate that implementation of the Project as proposed will result small decreases in total regional vehicle-kilometers traveled, as well as in total vehicle-hours of travel time. These results indicate that emissions are forecast to decline on a regional basis, as well as within the local assessment area, as a result of the Project.

Project-related air emissions as well as future changes in regional emissions that may occur as a result of other transportation projects or changes in regulatory policies and programs were considered in assessing potential regional air quality effects of the Project. The results of this assessment in terms of total annual vehicle emissions of key pollutants in the lower Fraser Valley, and proportion of the total emissions associated with the Project are shown in **Table 34** of the technical volume, ***Air Quality Study (Section 16.5)***. In general, total estimated emissions of CACs from traffic in the 2031 scenario with the Project are between one and five per cent of the total vehicle emissions in the lower Fraser Valley.

An overview of regional air quality in 2031 with and without the Project in terms of maximum overall pollutant concentrations (i.e., predicted maximum Project-related emission concentrations plus background concentrations) is shown in **Table 4.9-12**. Values in bold indicate an exceedance of the most stringent AAQOs. Overall ambient concentrations of all pollutants in the region are predicted to be lower in the 2031 scenario with the Project when compared to the 2031 scenario without the Project and 2011 baseline. For the 2031 scenario with the Project, NO₂ (100% conversion), PM₁₀, PM_{2.5} and benzene are the only pollutants that show some exceedance over the most stringent AAQOs, as they do in 2011. When the Ambient Ratio Method is applied to the predicted NO_x concentrations, there are no exceedances of the 1-hour objective in 2031 with the Project.

Table 4.9-12 Predicted Regional Air Quality with and without the Project in 2031

| Pollutant | Averaging Period | Background Concentration ($\mu\text{g}/\text{m}^3$) | Overall Concentration in 2031 without Project ($\mu\text{g}/\text{m}^3$) | Overall Concentration in 2031 with Project ($\mu\text{g}/\text{m}^3$) | Most Stringent AAQO ($\mu\text{g}/\text{m}^3$) |
|-------------------------|------------------|---|--|---|--|
| CO | 1-hour | 1271 | 18,771.5 | 12,248.6 | 14,300 |
| | 8-hour | 1,116 | 5,586.6 | 3,555.8 | 5,500 |
| NO ₂ (ARM) | 1-hour | - | 105.9 | 96.3 | 188 |
| | Annual | 25 | 70.4 | 43.6 | 40 |
| SO ₂ | 1-hour | 10 | 39.9 | 18.3 | 450 |
| | 24-hour | 7 | 10.3 | 8.0 | 125 |
| | Annual | 2 | 3.0 | 2.3 | 25 |
| Total PM ₁₀ | 24-hour | 29 | 97.2 | 62.2 | 50 |
| | Annual | 13 | 34.1 | 22.2 | 20 |
| Total PM _{2.5} | 24-hour | 15 | 35.6 | 24.6 | 25 |
| | Annual | 4 | 10.3 | 6.7 | 8 |
| Benzene | 24-hour | 2 | 6.0 | 3.7 | 2.3 |
| | Annual | 1 | 2.2 | 1.5 | 0.45 |
| 1,3-butadiene | 24-hour | 0.4 | 0.8 | 0.6 | 10 |
| | Annual | 0.1 | 0.2 | 0.1 | 2 |

Greenhouse Gas Emission Considerations

Greenhouse gases (GHGs) are contributors to the radiative warming effect of the environment that results in global climate change. The major GHGs include CO₂, CH₄ and N₂O, which are emitted from fuel combustion as well as other anthropogenic and natural sources. In addition, the warming effects of black carbon may be significant on a local geographic basis, especially on a shorter time scale².

² Black carbon is present in particulate matter generated by fuel combustion processes, and absorbs solar radiation at all wavelengths. Given its shorter residence time in the atmosphere than GHGs, the use of the 100-year global warming potential (GWP) factors to determine CO₂ equivalency may not be appropriate. Hence, published 20-year GWPs for GHGs and black carbon (Solomon et al. 2007, Minjares et al. 2014) were used to estimate the magnitude of the climate change effects of Project-related black carbon emission and its potential contribution to local climate change. Other components such as sulphates, nitrates, and organic carbon (OC) present in particulate matter generally reflect light and have a cooling effect that may partially offset the warming effect of black carbon.

In the context of GHG emissions generated in the Project alignment today, current congestion results in substantially more GHG emissions (CO₂e) than would occur without such congestion. As illustrated in **Table 4.9-13**, the elimination of the one million vehicle delay hours that occur annually due to existing congestion would result in a reduction in CO₂e emissions by existing traffic of more than 13,000 tonnes.

Table 4.9-13 Existing 2011 CO₂e Emissions, with and without Congestion

| | 2011 Existing Roads | | |
|--|--|--|--------------------------------------|
| | Existing Emissions with Congestion (tonnes/yr) | Emissions without Congestion (tonnes/yr) | Change from Existing with Congestion |
| CO ₂ e (20-year) ³ | 163,157 | 149,774 | -13,383 (-8.2%) |

Considering future GHG emissions in the Project alignment, **Table 4.9-14** summarizes the comparison of emissions for the 2031 scenarios, with and without the Project. For the scenario without the Project, emission estimates have taken into account the effects of traffic congestion during rush hours on a weekday. Emissions for the existing scenario (2011) are also presented to show the temporal reductions in GHG and black carbon emissions over time.

Table 4.9-14 Forecast 2031 CO₂e Emissions, with and without Project (untolled)

| Pollutant | 2011 Existing Roads Emissions (tonnes/yr) | 2031 Emissions (tonnes/yr) | | Change from Without Project Scenario in 2031 |
|------------------------------|---|----------------------------|--------------|--|
| | | Without Project | With Project | |
| CO ₂ | 146,939 | 129,338 | 121,493 | -7,845 |
| CH ₄ | 12.2 | 15.0 | 15.1 | 0.1 |
| N ₂ O | 8.0 | 3.5 | 3.5 | 0 |
| Black carbon | 4.1 | 1.1 | 1.2 | 0.1 |
| CO ₂ e (20-year) | 163,157 | 135,002 | 127,336 | -7,666 (-5.7%) |
| CO ₂ e (100-year) | 153,287 | 131,753 | 123,973 | -7,780 (-5.9%) |

Note: Because the new bridge will be tolled, CO₂e reductions with the Project are projected to be greater than those noted above.

³ CO₂e (equivalent) emissions are based on the following respective weighting factors for 20-year and 100-year global warming potential per tonne of emission: CO₂ (1 and 1), CH₄ (72 and 25), N₂O (289 and 298), and black carbon (3,200 and 900).

As illustrated in **Table 4.9-14**, a substantial decrease in GHG emissions (CO₂e) on the Highway 99 corridor is forecast between 2011 and 2031, both with and without the Project,⁴ as newer engine technologies provide significant reductions in overall CO₂e emission levels.

Even if the Project did not include tolling, CO₂e emissions in 2031 are forecast to decrease by 7,700 to 7,800 tonnes (5.7% to 5.9%) relative to without the Project. This net GHG reduction reflects savings due to congestion relief associated with Project improvements, which more than outweigh emissions associated with higher traffic volumes in an untolled scenario.

The 7,700 to 7,800 tonne annual reduction can be characterized as a “worst case” scenario, since it is based on the Highway 99 corridor being untolled. As the Project will be tolled, GHG reductions are projected to be greater due to the dampening effect on traffic volumes.

4.9.7 Follow-up Strategy

Air Quality and Dust Control Plans and BMPs as identified in **Section 4.9.4.2** will be developed and implemented to ensure potential construction-related effects on air quality are managed. Regular monitoring and analysis will be conducted during construction to confirm applicable air quality objectives are achieved.

As no Project-related effects are predicted beyond the construction phase, no post-construction follow-up strategy is proposed.

⁴ The only forecast increase in emissions, for CH₄, is due to the combination of increasing traffic and increasing frequency of diesel-engine vehicles, which are projected to outweigh the decrease in CH₄ emission rates for similar-engine vehicles. This CH₄ emissions trend is also observed in Metro Vancouver's 2010 emissions inventory and forecast (Metro Vancouver 2013).

4.9.8 References

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APPENDIX A

Overview of Potential Project Interactions with Air quality

Table 1 Overview of Potential Project Interactions with Air Quality

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|---|---|
| Pre-Construction / Site Preparation | | | |
| Pre-Construction / Site Preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Acquiring land for the Project | <p>Nature of interaction: No interaction anticipated</p> <p>Rationale: This Project activity is not anticipated to produce air emissions.</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction | <p>Potential Project-related effects include:</p> <p>Air emissions will be generated from fuel combustion in diesel, propane, and gasoline-powered machinery, equipment, and vehicles operating during pre-construction.</p> |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|--|--|
| Construction | | | |
| | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| New bridge including approaches and ramp connections | Potential Effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Potential Project-related effects include: Air emissions will be produced from fuel combustion in diesel, propane, and gasoline-powered machinery, equipment, and vehicles operating during highway upgrades and new bridge construction.</p> |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|---------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Potential Project-related effects include: Air emissions will be produced from fuel combustion in diesel, propane, and gasoline-powered machinery, equipment, and vehicles operating during highway upgrades and new bridge construction.</p> |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---------------------------------------|---------------------|--|--|
| Tunnel decommissioning | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | Potential Project-related effects include: Air emissions will be produced from fuel combustion in diesel, propane, and gasoline-powered machinery, equipment, and vehicles operating during Tunnel decommissioning. |
| Decommissioning of Deas Slough Bridge | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | Potential Project-related effects include: Air emissions will be produced from fuel combustion in diesel, propane, and gasoline-powered machinery, equipment, and vehicles operating during the decommissioning of the Deas Slough Bridge. |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|---------------------|---|---|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | <p>Nature of interaction: No interaction anticipated</p> <p>Rationale: These activities generally produce minute amounts vehicle emissions that would be too small to detect.</p> |
| | No effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges | <p>Potential Project-related effects include: Travel times, traffic patterns, traffic volumes, and vehicle fleet composition is expected to change; net-benefit to emissions is expected as a result of these changes.</p> |
| New bridge | No interaction | <ul style="list-style-type: none"> Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: No interaction anticipated</p> <p>Rationale: These activities generally produce minute amounts vehicle emissions that would be too small to detect.</p> |
| | No effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> Operating the new bridge | <p>Potential Project-related effects include: Travel times, traffic patterns, traffic volumes, and vehicle fleet composition is expected to change; net-benefit to emissions is expected as a result of these changes.</p> |

"N/A" indicates that no Project works and/or activities are applicable to the category

4.10 Atmospheric Noise Assessment Highlights:

- Ambient noise levels in the Project area are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Trains, aircraft, marine, and agricultural activities also contribute to ambient noise in and around the Project area.
- Construction-related noise can be addressed by applying mitigation and best practices, including the following, that have proven to be effective on other recent transportation infrastructure projects in the Lower Mainland:
 - Equipment and activity restrictions to minimize noise emissions
 - Noise monitoring program
 - Processes for community communication, engagement, and adaptive management.
- Appropriate mitigation measures will be implemented at select locations to address Project-related change in noise levels during operation.
- With the application of mitigation, ambient noise levels during operation are expected to be lower than current levels—on average by 4 dBA at residences and 1.5 dBA at schools and places of worship.
- Noise levels at parks adjacent to the Project, including Deas Island Regional Park, are expected to increase by varying degrees dependent on the distance from the highway, but will generally remain below levels that warrant mitigation consideration for residential and institutional use.
- No significant Project-related residual or cumulative effects on atmospheric noise are predicted post construction.

4.10 Atmospheric Noise

This section describes the existing conditions related to atmospheric noise and anticipated changes resulting from Project components and activities. Atmospheric noise is studied as an intermediate component (IC), and the information presented on predicted changes in atmospheric noise is used to support the assessment of potential effects of the Project on human health, terrestrial wildlife, and land use (**Section 4.8 Terrestrial Wildlife, Section 5.3 Land Use, and Section 7.1 Human Health**).

A technical volume, **Atmospheric Noise Study**, containing technical details on the methodology used to evaluate existing conditions and predict Project-related changes is included under **Section 16.6**.

4.10.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on atmospheric noise in terms of Project setting, and defines the spatial, temporal, administrative and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

4.10.1.1 Assessment Context

Construction activities associated with the Project, including highway upgrades, reconfiguration of interchange ramps, construction of the new bridge, and decommissioning of the Tunnel, have the potential to temporarily alter atmospheric noise conditions in and around the Project alignment. Post construction, changes in traffic volumes, vehicle types, and travelling speeds resulting from the upgraded traffic corridor, and alignment changes of some highway components, specifically the introduction of the new bridge, may result in an alteration of the noise environment in the vicinity of the Project. Predicting the anticipated nature and magnitude of such changes is important for assessing Project-related effects on human health, wildlife, and land use, which have all been defined as valued components (VCs) in this environmental assessment. The decision to undertake an assessment of Project-related effects on atmospheric noise was also informed by feedback received through pre-Application consultation on the Project with government agencies, Aboriginal Groups, and the general public. Potential influence of the Project on atmospheric noise and consequent effects on human health, terrestrial wildlife, and land use was identified as an area of specific interest by Vancouver Coastal Health, Fraser Health, Metro Vancouver, local communities (City of Richmond, Corporation of Delta), and Aboriginal Groups. Metro Vancouver expressed an interest in potential Project-related effects on noise within Deas Island Regional Park, and Aboriginal Groups expressed an interest in potential effects of Project-related changes in atmospheric noise on wildlife. Potential influence of change in noise conditions on quality of experience in the context of traditional uses was also identified as an area of interest by Aboriginal Groups.

Additional information on the selection of VCs, and the link between atmospheric noise and the above VCs, is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**. The assessment of atmospheric noise follows the general methodology described in **Section 3.0 Assessment Methodology**.

In late 2013, the Ministry initiated field and desktop studies and modelling to support the environmental assessment of the Project. The studies had the following key objectives, and were designed to build on existing information and address known data gaps:

- Describe, through monitoring, existing noise environments at locations representative of noise-sensitive land uses that may be affected by the Project
- Assess potential effects of Project-related construction noise and ground-borne vibration (associated with pile-driving only) on noise-sensitive receptors
- Predict Project-related changes in operational (traffic) noise exposures at noise-sensitive receptors

- Identify appropriate mitigation measures and best practices to eliminate or minimize atmospheric noise increases at noise-sensitive receptors
- Estimate residual Project-related changes in noise conditions that may remain after application of appropriate mitigation
- Identify cumulative changes that may result from the interaction of Project-related residual changes and changes in noise conditions attributable to other certain or reasonably foreseeable projects or activities

The objectives identified above were addressed through the completion of studies outlined in **Table 4.10-1**. Technical details of these studies are provided in the technical volume, **Atmospheric Noise Study, Section 16.6**.

Table 4.10-1 Atmospheric Noise Studies

| Study Name | Study Description |
|---|--|
| Pre-Project Noise Monitoring | Continuous noise monitoring was conducted (for 24-hour, 48-hour, and shorter periods) at noise-sensitive receptor sites in the vicinity of the Project to establish existing ambient noise conditions. |
| Post-Project (2030) Traffic Noise Modelling | Post-Project (i.e., operation phase) traffic noise levels were predicted to 2030 using numerical modelling along the new bridge and approaches, and baseline adjustment method for the remainder of the highway alignment. |
| Project Construction Noise Forecasts | A generic approach was taken to estimate noise levels typically experienced during standard highway construction activities at various setback distances. Pile driving noise was estimated using numerical modelling. |

4.10.1.2 Methodology

The following methods and procedures have been used to assess the baseline and future (post-Project) operational atmospheric noise conditions as well as construction noise levels within the extent of the Project:

- Baseline (pre-Project) noise monitoring was conducted at noise sensitive locations as shown on **Figure 4.10-1**.
- CadnaA outdoor sound propagation software was used to model post-Project noise exposures at noise-sensitive locations in the vicinity of the new bridge and its approaches, where proposed changes in the vertical alignment of Highway 99 are substantial.
- The baseline adjustment method (BAM) was used to predict post-Project noise exposures at noise-sensitive locations along Project segments where proposed changes to the horizontal and vertical alignments of Highway 99 are negligible or minor.

- Locations (residential and others) at which mitigation consideration is warranted under the Ministry’s 2014 noise policy were identified based on measured pre-Project (baseline) and post-Project (predicted) noise levels.
- The CadnaA model developed to predict post-Project noise exposures was used to assess potential effectiveness of mitigation measures in the vicinity of the new bridge. Effectiveness of mitigation measures at the remaining locations were assessed using basic acoustic principles.
- Construction noise exposures at noise sensitive locations have been estimated through a generic construction noise procedure¹ appropriate for use in the assessment stages of projects when detailed construction equipment lists and schedules are not available

An overview of the methodology used, metrics obtained in noise monitoring, and relevant thresholds considered in assessing noise conditions is provided below. Methodology used to assess potential Project-related changes is discussed briefly in **Section 4.10.3.1**. Technical details on noise monitoring and assessment methodology are included in the technical volume, **Atmospheric Noise Study, Section 16.6**.

Monitoring to Establish Existing Conditions

To document and characterize the existing (pre-Project) noise environments in the study area, monitoring was conducted at representative residential and non-residential noise-sensitive locations shown on **Figure 4.10-1**. Selected receptors were discussed with relevant stakeholders during the pre-Application consultation on the Project to confirm their suitability.

Continuous monitoring at all sites was conducted between October 2 and November 22, 2013, and between April 7 and 9, 2014. Monitoring data collected in September 2013 from an adjacent project was used for two sites.

Monitoring was conducted using logging sound level meters compliant with ANSI S1.4 standards for type 1 precision sound level meters. Technical details on methods, including equipment, noise level histories obtained at monitoring sites, site photos and descriptions, and dominant sources of existing noise are presented in the technical volume, **Atmospheric Noise Study, Section 16.6**.

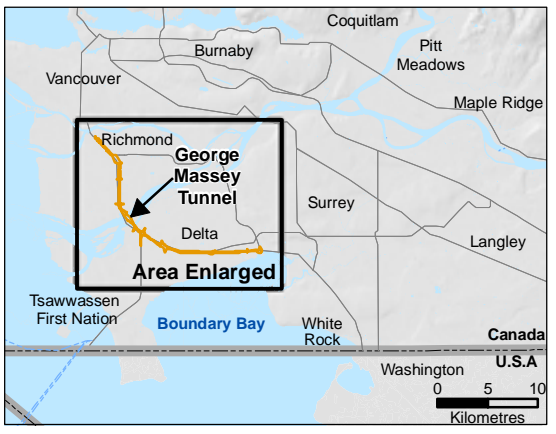
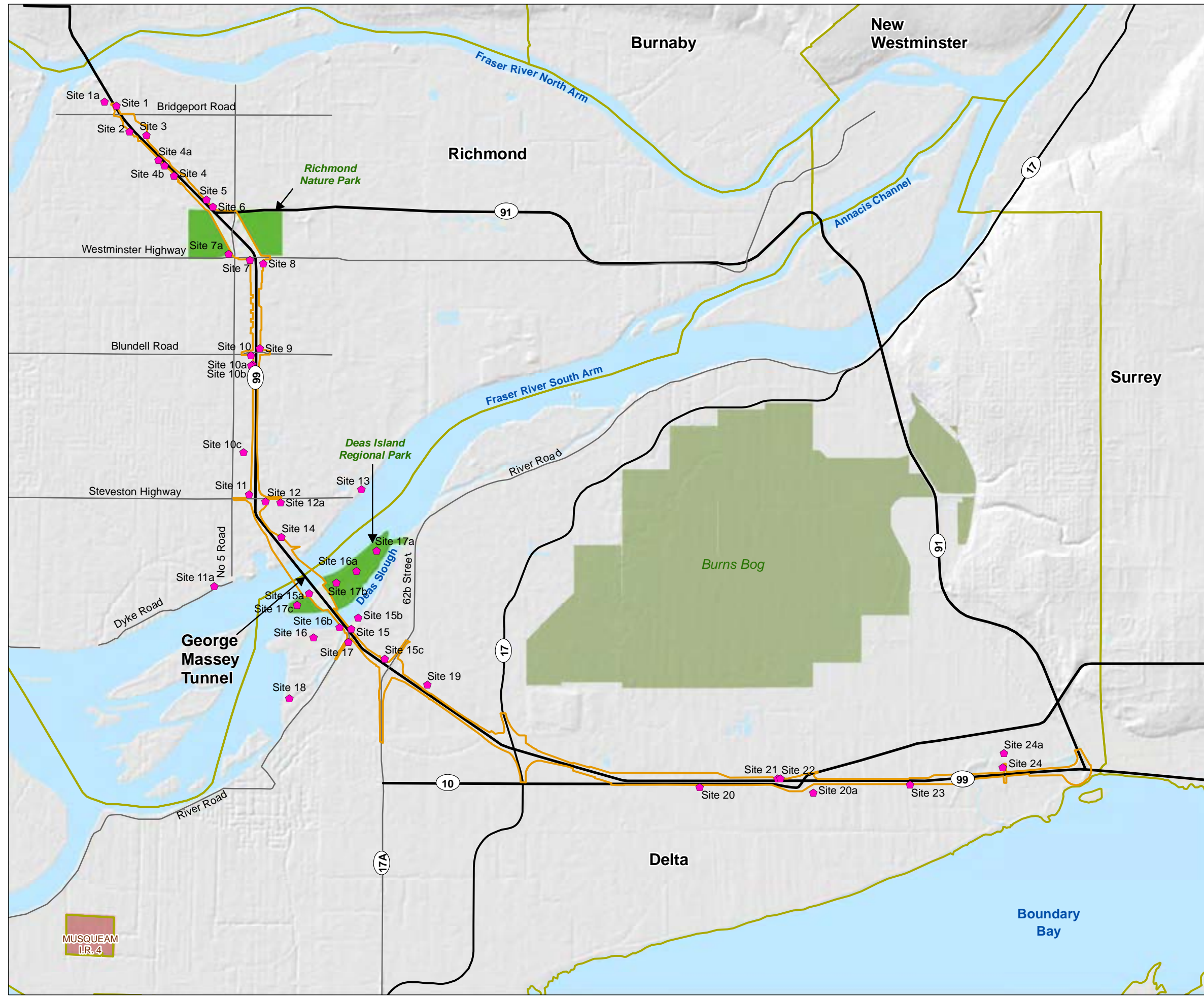
¹ This procedure has been used in previous applications for the Sea to Sky Highway Improvement, South Fraser Perimeter Road and Port Mann/Highway 1 projects.

Noise Metrics

The principal noise metric obtained for the Project, through monitoring, is the day-night average noise level (L_{dn}), which is the primary noise metric used in the Ministry's *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways* (Wakefield Acoustics Ltd. 2014), hereafter referred to as the Ministry's 2014 noise policy. Noise monitoring also provided the daytime average sound level (L_d), which is the equivalent sound level (L_{eq}) between 7 a.m. and 10 p.m., and the nighttime average sound level (L_n), which is the L_{eq} between 10 p.m. and 7 a.m. While these latter two noise metrics are not used directly in the Ministry's 2014 noise policy, they provide important information relevant to the human health effects assessment (**Section 7.1 Human Health**).

Relevant Community Noise Thresholds

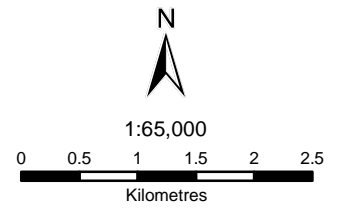
The threshold beyond which noise has the potential to interfere with sleep is identified as L_n of 30 dBA indoors, which can be reached when outdoor noise levels are in the L_n 45 to 70 dBA range (WHO 1999). Thresholds beyond which noise has the potential to interfere with conversation are identified as L_d 55 dBA for conversations indoors, and L_d 45 dBA in classrooms. Depending on the nature and condition of the school façade, indoor levels of 45 dBA can be reached when outdoor noise levels are in the L_d 60 dBA to 75 dBA range.



- Legend**
- ◆ Atmospheric Noise Monitoring Site
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| NOISE MONITORING SITES OVERVIEW | |
| Figure 4.10-1 | 13/05/2016 |
| | |

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4.10.1.3 Assessment Boundaries

The assessment boundaries for atmospheric noise are defined below.

Spatial Boundaries

The assessment area for atmospheric noise includes those areas in the vicinity of the Project where noise impacts are likely to occur. Boundaries of the assessment area were established based on the lateral distance beyond which daily-average noise levels from traffic related to the Project would not be expected to exceed what is considered acceptable for residential land uses. The metrics used to determine acceptability are based on those identified by the U.S. EPA (1974) and the Canada Mortgage and Housing Corporation (CMHC) (1981).

The lateral distance within which Project-related traffic could affect atmospheric noise will depend on the volume, average speed, and heavy truck component of the future traffic streams on Highway 99. This distance will also depend on the elevation of the traffic above the ground and the nature of the ground surface between the highway and the noise-sensitive receptors. Where sound travels close to the surface of the earth and, in particular, where the intervening surface is acoustically absorptive, or soft (i.e., grass, farmland, or wooded areas), the rate at which sound levels are attenuated with distance is relatively high. Where the sound source is elevated well above the ground and, in particular, where the intervening surface is acoustically reflective, or hard (i.e., water, pavement, or hard-packed earth/gravel), the rate of attenuation of sound levels with distance is generally lower.

For these reasons, for the majority of the study area within which Highway 99 is close to natural ground level and largely bordered by agricultural or undeveloped lands, the study area width extends 500 m from either side of the Project footprint. This width is sufficient to capture the following:

- Residences north of the Fraser River on both sides of No. 5 Road, which parallels Highway 99 to the west, and Sidaway Road, which parallels Highway 99 to the east.
- Residences south of the Fraser River along 64th, 72nd, 80th, 88th, 96th Streets, Burns Drive, and Ladner Trunk Road.

In the vicinity of the new bridge, where Highway 99 traffic will be elevated well above natural ground level, and where much of the surrounding surfaces are water, the study area extends approximately 1,600 m from either side of the Project footprint, since the rate of decrease in sound levels over these acoustically reflective surfaces is lower. This distance is sufficient to capture the following:

- Condominium buildings located along Riverport Way in Richmond on the north bank of the Fraser River to the east of Highway 99 and the new bridge.
- Townhouses along Regatta Way, Delta, to the west of Highway 99.
- Residences and parks along Dyke Road and residences along Rice Mill Road in Richmond.
- Residences along River Road and Admiral Way in Delta.

Based on the above considerations, select noise-sensitive locations along the Project alignment as shown on **Figure 4.10-1** were selected as ambient noise monitoring stations to support the assessment of Project-related changes in atmospheric noise levels.

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects were established based on the potential for each phase of the Project to interact with and have an effect on atmospheric noise. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect atmospheric noise conditions along the Project alignment; therefore, the following temporal boundaries were defined for atmospheric noise assessment:

- Existing conditions
- Project construction, which includes Tunnel decommissioning
- Project operation, including maintenance

Temporal characteristics (timing) of the Project construction phase (including decommissioning of temporary construction-related facilities and the Tunnel), and operational phases are defined in **Section 1.1.3 Project Phases and Schedule**.

Temporal boundaries for the atmospheric noise study were defined as extending from initiation of Project construction to 10 years after completion of the Project construction, in accordance with the Ministry's 2014 noise policy. The anticipated Project completion date of 2022 puts the 10-year post-completion horizon year at 2032; however, 2030, the year for which future traffic

volume projections were available, was used as the horizon year for this assessment². This temporal period encompasses existing conditions, and the Project construction and operations phases.

Administrative Boundaries

No administrative boundaries, (i.e. political, economic, or social constraints on the collection or analysis of data), relevant to the assessment of atmospheric noise, were identified.

Technical Boundaries

The level of accuracy and precision of the baseline noise measurements is ± 0.5 dBA for the instrumentation itself. Day-to-day variations in traffic volumes on major highways are generally not large enough to cause variations in daily average noise levels of more than ± 0.5 dBA.

Traffic volume modelling, which forms the basis of future traffic noise-level predictions, has a certain margin of error; however, given the relatively weak relationship between traffic volumes and average noise levels (3 dBA per doubling of volume), the influence of this margin on predicted noise levels is considered negligible.

Prediction of future (2030) traffic noise levels using the BAM method in situations where the highway alignment is not changing substantially is typically accurate to within approximately ± 0.5 dBA while predictions made using a TNM/CadnaA model are typically accurate to within ± 1.0 to 2.0 dBA when geometries are not overly complex and setback distances are not too large. However, it has to be noted that the TNM/CadnaA modelling approach considers meteorological conditions favourable for sound propagation (i.e. noise receiver downwind of noise source), which results in a somewhat conservative estimation of noise levels in situations involving sound propagation over soft ground.

4.10.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of the noise environment within the assessment areas. An overview of the regulatory context as relevant to the Project is also provided.

² The difference in noise levels due to traffic growth from one year to the next is negligible. Should Project completion occur within a few years of 2022, the difference in forecasted noise levels in between is considered to be minor and within the acceptable margin of uncertainty for the operational noise impact assessment.

4.10.2.1 Regulatory Context

Community noise impacts associated with provincial highway projects are addressed in the Ministry's 2014 noise policy. Under this policy, noise effects are assessed at noise sensitive receptors such as residences, hospitals, educational facilities, places of worship, libraries, museums, and passive recreational facilities (parks). Mitigation measures, including Project design considerations, aim to promote public health and welfare and avoid situations where noise levels are inconsistent with a healthy residential environment, are intrusive and disruptive to the communities, and compromise the intended functioning of public facilities and noise-sensitive outdoor spaces. Typically, mitigation consideration is warranted when certain noise thresholds are exceeded.

There are currently no published Canadian guidelines, noise thresholds, or standards appropriate for the assessment of noise effects. Construction contractors are typically required to meet construction noise requirements of the jurisdictions where construction is taking place. Health Canada refers to a variety of internationally recognized standards for acoustics, such as the United States Environmental Protection Agency's (U.S. EPA) Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (U.S. EPA 1974, Health Canada 2010).

4.10.2.2 Factors Influencing the Existing Noise Environment

The existing noise environment along Highway 99 between Bridgeport Road and the Highway 91 interchange in Delta is controlled primarily by traffic on the highway and connecting roadways (i.e., Bridgeport Road, Westminster Highway, Steveston Highway, River Road, and Highways 17A, 17, 10, and 91). Other sources contributing to the noise environment, but to a lesser degree, include local traffic and activities, trains, aircraft, marine, and agriculture-related activities.

Changes in the noise environment in the vicinity of the Project in recent decades have largely been due to traffic volume growth on Highway 99 and, to a lesser degree, on connecting roadways.

Opening of the South Fraser Parameter Road (Highway 17) and associated interchange with Highway 99 in December 2013 resulted in some reduction in traffic (including heavy trucks) along Highway 17A south of Highway 99, and River Road north of Highway 99 (B.C. MOTI 2014). A comparison of Ministry traffic data collected near the south Tunnel portal before and after the opening of Highway 17 (i.e. October 2013 versus February and April 2014) shows that, after a brief period of adjustment following the opening of the new highway, traffic on Highway

99 through the Tunnel returned to volumes comparable to pre-Highway 17 numbers. This suggests that traffic volume changes associated with the opening of Highway 17 are not likely to have measurably altered the noise environment for most noise-sensitive receptors along the Project alignment. An exception is the Riverport Way condominium development on the Fraser River north shore, approximately 1,600 m east of Highway 99. Before Highway 17 was in operation, the noise environment was dominated by River Road traffic, south of the river. Ministry data show that total daily average traffic volumes on River Road decreased by about 30% with the opening of Highway 17, which suggests a consequent decrease in noise levels at Riverport Way condominium development.

4.10.2.3 Range of Existing Noise Levels along the Project Alignment

Existing noise levels at the select sensitive receptors are presented in **Table 4.10-5**. Existing noise levels range between 51.5 dBA and 75 dBA L_{dn} at residential receptors, and between 61.7 dBA and 71.8 dBA L_d at places of worship and schools in the vicinity of the Project. Existing noise levels in passive parks range from approximately 46 dBA L_d in Deas Island Regional Park to 58.0 dBA L_d near the south end of Richmond Nature Park.

4.10.2.4 Highway 99 Traffic Noise in the Study Area

Based on the results of monitoring, existing noise levels in the study area are generally controlled by Highway 99 traffic, with the following exceptions:

- Near Highway 99 and Westminster Highway in Richmond, there are secondary noise contributions from Westminster Highway traffic.
- The eastern end of the parking lot and trail system in Richmond Nature Park is 300 m from Highway 99, but only 60 m from Westminster Highway and 100 m from No. 5 Road. As such noise exposures are controlled by traffic on these two routes rather than by Highway 99 traffic.
- At Site 13 (Figure 4.10-1), situated at Riverport Condominiums on the Fraser River north bank, noise exposures were measured in autumn 2013 (i.e., prior to opening of Highway 17), and were found to be dominated by River Road traffic.
- Residence on Rice Mill Road in Richmond receives noise contributions from industrial and marine sources, particularly at night.
- Noise levels at residence on Ferry Road in Delta are controlled by local traffic and activities.
- At the municipal park along Dyke Road in Richmond, daytime noise levels are slightly influenced by Highway 99 traffic.

- Noise levels at Richmond Country Farms are influenced by traffic on the northbound off-ramp from Highway 99 to Steveston Highway.
- At the eastern end of Deas Island Regional Park, daytime noise levels were measured in November 2013 (i.e., prior to opening of Highway 17) and were found to be dominated by River Road traffic.
- Noise levels at two residences on 112th Street in Surrey near the southern limit of the project are dominated by railway activities rather than Highway 99 traffic.

Residences along No. 5 Road and Sidaway Road, between Westminster and Steveston Highway, are located approximately 400 m from Highway 99 over acoustically soft ground. Consequently, existing noise levels due to Highway 99 traffic at these residences are estimated to be below the threshold for noise concerns in residential areas. Residences on No. 5 Road are typically exposed to higher noise levels from local No. 5 Road traffic (estimated to be approximately 63 dBA based on 2006 traffic information; City of Richmond 2014) than from Highway 99. Highway 99 traffic noise levels at residences on Sidaway Road are anticipated to be similar to those expected at No. 5 Road residences. Influence of local traffic on noise levels at Sidaway Road residences are expected to be relatively low.

4.10.2.5 Future Conditions without the Project

To provide context for understanding potential Project-related changes, future (2030) noise conditions without the Project were estimated based on monitoring results and supporting information. Year 2030 was used as the reference year in predicting future noise conditions to make effective use of the vehicle fleet forecasts set out by Metro Vancouver and the Regional Transportation Model. Future noise levels are generally expected to be somewhat higher than existing levels due to gradual growth in traffic volumes.

As discussed in **Section 5.1 Traffic**, by 2030, growth in Highway 99 traffic volumes without the Project, expressed as annual average daily traffic (AADT), is expected to be in the range of 20% over the northern portion of the Project alignment (north of Highway 17A interchange) to 30% over the southern portion of the Project alignment (south of Highway 17A interchange). Without the Project, heavy truck mixes on Highway 99 are expected to increase from approximately 3.5% to 5% in 2013 to 5% to 11% in 2030.

Influence of this projected growth in total traffic volumes and truck mixes between 2013 and 2030 on noise levels (L_{dn}) are expected to be increases of approximately 2 dBA over the northern portion of the Project alignment, and between 2.2 and 3.2 dBA over the southern portion.

4.10.3 Potential Effects

4.10.3.1 Assessment Methods

Project-related changes in atmospheric noise were assessed using the following methods and procedures:

- The baseline adjustment method (BAM) was used to predict post-Project noise exposures at noise-sensitive locations where proposed alignment changes are minor (e.g., lane additions, on- or off-ramp alignment adjustments, and traffic volume and posted speed changes)
- Traffic noise model (TNM) within the outdoor sound propagation software, CadnaA, was used to predict post-Project (i.e., operation phase) noise exposures at noise-sensitive locations where proposed alignment changes are substantial (e.g., construction of new bridge and approaches)
- Comparison of baseline and predicted post-Project noise levels to identify locations where mitigation consideration is warranted
- Assessment of mitigation effectiveness in the vicinity of the new bridge using the TNM/CadnaA model, and at locations with proposed minor alignment changes using fundamental acoustic principles.

As discussed in **Section 5.1.2.4**, average annual daily traffic volumes (AADT) for 2030 were assessed using TransLink’s RTM for two scenarios– with the new bridge in place and no tolls being applied (TL-RTM Untolled), and with a new tolled bridge in place (TL-RTM Tolled). Given the variability in the forecasting, and to ensure a conservative assessment for EA purposes, the upper range of forecast values (TL-RTM untolled, 2030 With the Project) were used as it represents the highest potential volume of traffic.

Further detail on the TNM/CadnaA noise model, and how the BAM was used in predicting Project-related changes in noise conditions is provided in **Section 16.6 Atmospheric Noise Study Technical Volume**.

A generic highway construction noise model was used to estimate anticipated construction-related noise levels.

4.10.3.2 Project Interactions

An overview of potential interactions between Project activities and atmospheric noise during the construction and operation of the Project is provided in **Appendix A**. A preliminary evaluation of the potential effects of Project interactions on atmospheric noise, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Temporary noise generated during Project construction, and change in traffic conditions along the Project corridor post-construction, are expected to result in changes in ambient noise conditions within the study area. Less frequent, temporary changes in noise may be experienced during maintenance activities after the Project is operational, depending on the activity required.

As discussed in **Section 4.10.1.1**, potential influence of the Project on atmospheric noise and consequent effects on human health, terrestrial wildlife, and land use was identified as an area of specific interest by Aboriginal Groups, the public, government agencies (in particular Vancouver Coastal Health, Fraser Health, and Metro Vancouver), and local communities (City of Richmond, Corporation of Delta). Project-related changes in atmospheric noise are discussed in this section and mitigation measures proposed for addressing adverse effects are discussed in **Section 4.10.4** below. The potential health effects of change in exposure to atmospheric noise are discussed in **Section 7.1 Human Health**. Changes in land use activities that may be influenced by change in atmospheric noise are discussed in **Section 5.3 Land Use**. Quality of Experience in Exercising Aboriginal Interests in the context of direct sensory disturbance to traditional users through Project-related changes noise is discussed in **Section 10 Aboriginal Consultation**. Potential influence of Project-related change in noise conditions on terrestrial wildlife (i.e., sensory disturbance) is discussed in **Section 4.8 Terrestrial Wildlife**.

4.10.3.3 Construction-Related Effects

Noise from Construction Activities other than Pile Driving

A generic analysis, originally developed for the Sea to Sky Highway Improvement Project and subsequently employed for the assessment of the Port Mann/Highway 1 Improvement Project and South Fraser Perimeter Road (Highway 17) Project, was adapted to fit Project conditions and used to estimate anticipated construction-related noise emissions. Factors considered during generic construction noise modelling, such as distance from the noise source, duration of construction activities, and setbacks from the highway, are listed in the technical volume, **Atmospheric Noise Study** included as **Section 16.6**.

Average construction noise levels predicted to be generated at various setback distances from a 200-m long, active construction zone due to cumulative noise output of all active heavy construction equipment are shown in **Table 4.10-2**. The levels presented are those that would be expected if the intervening ground was acoustically soft (i.e., grass, farms, or undeveloped land).

Table 4.10-2 Average Construction Noise Levels (L_{eq}) Expected Outdoors at Various Setback Distances from a 200 m-long, Active Construction Zone, Over Acoustically Soft Ground

| Major Construction Activity | Levels at Distances from a Typical 200-m Construction Zone (dBA) | | | | | | |
|--------------------------------|--|------|------|-------|-------|-------|-------|
| | 15 m | 30 m | 50 m | 100 m | 200 m | 400 m | 800 m |
| Clearing and grubbing | 82.5 | 78.0 | 74.5 | 69.0 | 60.5 | 51.0 | 39.5 |
| Excavation | 84.0 | 79.5 | 76.0 | 70.5 | 62.0 | 52.5 | 41.0 |
| Retaining walls and structures | 80.0 | 75.5 | 72.0 | 66.5 | 58.0 | 48.5 | 37.0 |
| Grading | 82.0 | 77.5 | 74.0 | 68.5 | 60.0 | 50.5 | 39.0 |
| Asphalt paving | 79.0 | 74.5 | 71.0 | 65.5 | 57.0 | 47.5 | 36.0 |

Construction noise exposures presented in **Table 4.10-2** are considered conservative since they assume construction activities are continuous throughout working hours. Typically, slowdowns and stoppages in construction activities occur.

More than one major construction activity may occur concurrently, which would have an additive effect on noise exposure. Such additive effects are small at locations close to the Project alignment, where construction noise levels are highest. Concurrent construction activity is anticipated to result in an increase in overall noise exposures of 1 dBA to 3 dBA at setback distances of 100 m to 200 m, and up to 4 dBA at distances of more than 400 m.

Noise from Pile Driving

Pile driving will occur during construction of the two bridge towers and the north and south bridge approach support piers. Due to the proximity of the new bridge and approaches to residential areas and Deas Island Regional Park, a more rigorous noise prediction method, CadnaA (described in more detail in **Section 16.6 Atmospheric Noise Study Technical Volume**) was applied for pile driving noise. Sound emission data (Environmental Protection Department 1997; expressed in L_{eq}) for a diesel impact hammer driving steel pipe piles was input to the CadnaA model to estimate pile driving noise levels at all noise-sensitive locations in the vicinity of the new bridge and approaches.

Ground-borne Vibration from Pile Driving

Pile driving will generate ground-borne vibration that may, at times, be perceptible at residences closest to the alignment. In such situations, ongoing vibration monitoring will be undertaken and pre-condition surveys of residences located closest to the piling areas conducted as appropriate.

Overall Estimated Construction-related Noise Effects

Project-related changes in noise levels at noise-sensitive receptors expected during construction are summarized below.

Maximum temporary construction noise levels at residential receptors are anticipated to range between 52 and 86 dBA L_d , with an average of 75 dBA L_d , for construction involving pile driving, and between 39 and 84 dBA L_{dn} , with an average of 75 dBA, for other activities.

At non-residential receptors (school, Places of Worship) along the Project alignment, temporary construction noise levels are estimated to range from 61 to 77 dBA L_{dn} , with an average of 71 dBA.

Maximum temporary daytime construction noise levels in various parks are anticipated to range between 52 and 65 dBA L_d , with an average of 58 dBA, during construction activities involving pile driving, and between 32 dBA and 57 dBA L_d , with an average of 46 dBA, during other construction activities.

4.10.3.4 Operational Effects

Predicted Project-related effects and estimated post-Project (2030) noise levels at the noise-sensitive receptors assessed as part of the noise studies are presented in **Table 4.10-5**. A brief overview of predicted future noise conditions with the Project at noise-sensitive receptors along the Project corridor, without mitigation, is presented below.

Residential Receptors

Predicted future (2030) noise levels:

- L_{dn} – 52.5 to 77.3 dBA, with an average of 68.3 dBA
- L_n - 42.9 to 70.1 dBA, with an average of 60.2.2 dBA

Existing (measured) noise levels:

- L_{dn} - 51.5 to 75 dBA, with an average of 66.3 dBA
- L_n - 41.3 to 67.8 dBA, with an average of 59.2 dBA

Passive Parks

Predicted future (2030) noise levels:

- L_d – 49.5 to 61.7 dBA, with an average of 55 dBA

Existing noise levels:

- L_d - 45.9 to 58 dBA, with an average of 49 dBA

Schools and Places of Worship

Predicted future (2030) noise levels:

- L_d – 65.3 to 75.2 dBA, with an average of 71.7 dBA

Existing noise levels:

- L_d - 61.7 to 71.8 dBA, with an average of 68.2 dBA

Deas Island Regional Park is the only park in the vicinity of the Project where readily perceptible Project-related changes to the noise environment could occur. Predicted effects of the Project within Deas Island Regional Park range from a 4 dBA increase in L_d at its eastern end (approximately 1,200 m from Highway 99), to an approximate 10 dBA increase at locations around 350 m to the east and west of the highway centreline. While noise mitigation for passive parks is considered on a case-by-case basis, post-construction noise levels within the park generally remain below levels that warrant mitigation consideration for residential and institutional use.

4.10.4 Mitigation Measures

This section outlines measures that will be implemented during Project construction and operation to avoid or minimize potential increase in noise levels at sensitive receptors. These measures will be informed by the Ministry's 2014 Noise Policy, and prior experience with comparable transportation infrastructure projects in the Lower Mainland.

4.10.4.1 Construction

Measures that will be implemented during Project construction to prevent or minimize potential effects on atmospheric noise will be outlined in a Construction Environmental Management Plan (CEMP), as described in **Section 12.0 Management Plans**. The CEMP will include a Noise Management Plan that describes standard best practices and Project-specific mitigation measures to prevent or minimize community impacts due to temporary, unavoidable construction-related noise. These measures may include, but not be limited to, the following:

- Control of noise at the source– Measures may be taken to reduce construction noise emissions at the source through the selection, appropriate operation, modification/enhancement and/or maintenance of equipment or processes. These measures include:
 - Turning off idling equipment such as diesel engines when not in use for more than 30 minutes.
 - Fitting all gas or diesel-powered equipment on site with intake (if appropriate) and exhaust silencers (i.e., mufflers) that meet manufacturer's recommendations for optimal attenuation and maintain these silencers in effective working condition.
 - Using hydraulic-powered equipment where appropriate/feasible.
 - Supplying and operating all equipment with appropriate covers, hoods, shields etc., in place and latched shut.
 - Carrying out regular maintenance on all equipment, including lubrication and replacement of worn parts, especially exhaust systems.
 - Operating all equipment at minimum engine speeds consistent with effective operation.
- Noise control along the source-receiver path–Community noise exposures may be reduced by blocking the dominant sound path (usually the line of sight) between the noise source zone and noise-sensitive receivers. For effectively shielded individual noise sources, noise reductions of 5 to 10 dBA may be achieved in this manner. Reductions in overall construction site noise emissions will generally be less and will depend on the degree to which all prominent noise sources can be effectively shielded. The following approaches to path noise control may be considered:
 - Where possible, locating and/or orienting noisy stationary equipment (e.g., compressors, generators) so as to take advantage of any inherent noise shielding available from the natural terrain, roadway fill or shoulder or other large objects (equipment, buildings, material piles) and to direct as little noise as possible towards nearby noise sensitive areas.

- When working in close proximity to noise sensitive areas and where no inherent shielding elements are available, locating temporary, perhaps portable, noise barriers close to fixed sources of noise such as compressors and generators. Use plywood, strand-board or other convenient, solid materials. If practical, the barrier will be made wider and higher than the noise source and line the source-facing surface with sound absorptive material such as 25 to 50 mm semi-rigid fiberglass insulation.
- Where permanent noise barriers are warranted to shield residents from operation (traffic) noise, installing them early in the construction phase, if possible, so as to shield construction noise as well.
- Selection of quieter equipment and processes—In some cases, construction processes can be selected that, by nature or design, produce less noise while doing similar work. Similarly, standard equipment or processes can be selected that have had additional noise control features added, such as better mufflers and enclosures on diesel or gas-powered equipment, exhaust silencers on air tools, etc. Equipment involved in any necessary night construction work near residential areas should be fitted with better-than-standard (i.e., "residential-rated") mufflers/silencers.
- Community engagement—Early engagement with communities on the scheduling of particularly noisy activities will help to reduce negative reaction to construction-related noise. As such, the following approaches are recommended for consideration:
 - Hold information meetings with community representatives throughout the Project corridor to identify site-specific construction activities and the timing of these activities. If there are any activities that must be done outside of regular work hours, the measures to be taken by the contractor to minimize the noise produced and/or received in the community should be discussed in advance.
 - Communicate with affected communities on a regular basis to advise them well in advance of the types of activities that will be taking place in the future (especially for pile driving, riveting and other operations involving noise impacts) and to notify them of any changes in the estimated start and/or completion dates for the various phases of construction. This can be achieved in a number of ways, including, but not limited to an information telephone line; and updates on the Project website (e.g. construction schedule with scheduled detours & traffic delays, electronic postcard updates with photos, construction bulletins, etc.).
 - Carry out monitoring of construction noise as appropriate to ensure mitigation measures are effective.

The above mitigation measures and best practices have been successfully implemented by the Ministry on comparable projects in the Lower Mainland, and are expected to effectively address construction-related noise.

4.10.4.2 Operation

The Ministry's 2014 noise policy provides a procedure to determine whether noise environments that will exist within adjacent communities ten years after completion of a highway project warrant mitigation consideration. Mitigation may be considered when the absolute post-project noise levels exceed certain fixed upper limits, and may also be considered when project-related changes in noise levels relative to pre-project conditions are predicted to be of certain magnitudes. The principal noise metric for residential areas is the L_{dn} , with fixed upper noise limits of 65 dBA for moderate impacts and 75 dBA for severe impacts. Details on mitigation thresholds under the Ministry's 2014 noise policy are provided in **Section 16.6 Atmospheric Noise Study Technical Volume**.

Noise impacts at residential receptors are classified as Severe under the noise policy if post-project total noise levels exceed a fixed threshold of L_{dn} 75 dBA, and Moderate if post-project total noise levels exceed a fixed threshold of L_{dn} 65 dBA. Classification of noise impacts under the policy also takes into account pre-Project noise levels and project-related change in noise levels. In cases where pre-Project noise levels are high, noise impacts due to a relatively small increase in noise level could be classified as Moderate or Severe, whereas in cases where pre-Project noise levels are low, noise impacts associated with a larger increase in noise levels may be classified as Minor (additional detail on noise impact classification under the Ministry's noise policy can be found in **Section 16.6 Atmospheric Noise Study Technical Volume**).

Predicted total noise levels and changes from existing noise levels at noise-sensitive receptors were compared against the mitigation thresholds under the Ministry's 2014 noise policy (see **Section 16.6 Atmospheric Noise Study Technical Volume**) to identify locations where Project-related noise mitigation may be required.

Table 4.10-5 identifies existing (2013) and predicted post-Project (2030) noise levels at noise-sensitive receptors (i.e., residences, schools, places of worship, and parks) along the Project alignment, and indicates whether the resultant noise impact warrants mitigation consideration under the Ministry's 2014 noise policy. The table also provides an overview of locations where Project-related mitigation considerations are warranted and the approximate spatial extent of such mitigation works. Mitigation measures will be implemented at these locations as warranted to meet the objectives of the Ministry's noise policy and achieve a minimum target noise reduction of 5 dBA. These measures identified in the Ministry's 2014 Noise Policy involve methodologies (e.g. noise barriers) that have been proven to be effective in mitigating traffic-related noise impacts associated with comparable projects. Noise mitigation measures will be integrated into Project design and construction to ensure that mitigation is effective when the Project becomes operational.

4.10.5 Residual Effects

Potential residual effects of the Project on atmospheric noise conditions are characterized with respect to the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of each anticipated residual effect. Definitions for ratings applied to residual effects criteria, developed with specific reference to atmospheric noise are presented in **Table 4.10-3**.

A summary of criteria ratings for the potential residual effect is provided in **Table 4.10-5** and **Table 4.10-7** for operational phase noise and construction phase noise respectively. The context of the residual effects assessment (i.e., sensitivity and resilience to change, based on existing conditions) is also taken into account in characterizing potential residual effects of the Project.

Context: Existing (pre-project) traffic noise environments at several residential and other noise sensitive land uses (schools, places of worship) along the Project alignment are generally high. Such land uses would be sensitive to any increases in traffic noise that might be associated with the Project. With mitigation, however, residual effects of the Project on ongoing operational (traffic) noise exposures are generally expected to be positive, particularly at those locations which are closest to the alignment and therefore have the highest levels of existing noise. Temporary residual effects due to construction noise cannot be avoided, but will be minimized through the development and implementation of a construction noise control plan, which would include the employment of best practices. Notwithstanding, temporary construction noise levels will, at some residential locations (particularly near the bridge approaches where pile driving is required) and over some limited time periods, exceed the existing noise levels.

Table 4.10-3 Criteria Used to Characterize Residual Effects on Atmospheric Noise

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|---|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project. |
| | | Positive | Beneficial effect as a result of the Project. |
| | | Neutral | Neutral effect as a result of the Project. |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible | No change in day-night average operational noise levels (L_{dn}). |
| | | Low | An increase in day-night average operational noise levels (L_{dn}) of 1 to 4 dBA. |
| | | Moderate | An increase in day-night average operational noise levels (L_{dn}) of 5 to 10 dBA. |
| | | High | An increase in day-night average operational noise levels (L_{dn}) of more than 10 dBA. |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project alignment. |
| | | Local | Effect is restricted to the LAA |
| | | Regional | Effect extends beyond the LAA |
| Duration | Length of time over which the residual effect is expected to persist | Short term | Effect occurs for a period of less than 3 months |
| | | Moderate term | Effect persists for up to 12 months |
| | | Long term | Effect persists beyond 12 months |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor affects the IC) | Occasional | Less than 5 days a week, up to 8 hours/day |
| | | Frequent | Five or more days a week, up to 12 hours/day |
| | | Continuous | 7 days a week, up to 16 hours/day |
| | | Permanent | Permanent change |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Baseline conditions will be naturally restored after disturbance has ceased. |
| | | Irreversible | Baseline conditions will not be naturally restored after disturbance has ceased. |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance. |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 25%. |
| | | Moderate | Likelihood of residual effect is between 25% and 75%. |
| | | High | Likelihood of residual effect is greater than 75%. |

4.10.5.1 Construction-related Residual Effects

During construction, mitigation measures and best practices as discussed in **Section 4.10.4.1**, including equipment and activity restrictions, appropriate scheduling of construction activities, noise monitoring, and community communication, will be implemented to minimize potential Project-related effects on ambient noise conditions. However, frequent construction noise will be experienced in areas near active construction sites. **Table 4.10-4** presents a summary of the criteria ratings for potential change in atmospheric noise conditions during construction activities.

Magnitude of residual construction noise effects will vary from low to high, depending on receptor location relative to construction site, and nature of construction activity. Effects will be short-term during construction of interchanges etc., and of moderate term during pile installation for the new bridge. During other construction activities, effects of lower magnitude will be experienced occasionally to frequently at receptor sites along the corridor for short durations. All construction-related effects on atmospheric noise will be temporary and fully reversible. Project-related changes in atmospheric noise levels are not expected to overlap temporally or spatially with similar effects of other project or activities and result in cumulative effects.

Table 4.10-4 Criteria Ratings for Residual Effect: Construction Noise

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|-----------|------------------------|--|
| Direction | Adverse | Construction noise will create adverse residual effects resulting in increases in total noise exposures relative to baseline traffic levels. |
| Magnitude | Low to High | Residual construction noise effects will vary substantially with receiver location and construction phase. Generally the magnitude of such residual construction noise effects will be low to Moderate. However, at some locations (within roughly 350 m of active pile driving at bridge approaches) and for some limited time periods, increases of more than 10 dBA may be experienced. |
| Extent | Local | Spatial extent will be restricted to within the LAA. |
| Duration | Short to Moderate term | Individual construction phases, including pile driving, within specific segments of the project corridor will have durations of one year or less. |

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|------------------------|--|
| Frequency | Occasional to Frequent | Within the various segments of the project, and during the various stages of construction, construction noise is expected to be present from less than 5 days per week and 8 hours per day, to seven days per week and up to 16 hours per day. |
| Reversibility | Reversible | Construction noise will cease upon completion of the project. |
| Likelihood | High | Construction noise residual effects will occur, but their magnitudes and durations will vary depending on nature and schedule of specific construction activities. |

4.10.5.2 Operation

Table 4.10-5 provides an overview of the predicted residual effects of the Project on community noise levels at all relevant noise receptors (residence, schools and places of worship, and parks), after implementation of mitigation measures in accordance with the Ministry’s 2014 noise policy. The ranges and average values of residual changes (i.e. change from existing noise levels) for each of these types of land uses are as follows:

- Residences: 0 to -7 dBA; average of -4 dBA
- School and Places of Worship: range of -2 to -1, average -1.5 dBA
- Parks: range 11 to 4 dBA

Note that a negative residual effect indicates that, with mitigation, post-Project noise levels will be lower than existing levels.

Table 4.10-5 Anticipated Project-related Changes, Mitigation Considerations and Residual Changes at Noise-Sensitive Receptors¹

| Site # | Location | Land Use | 2013 Baseline Noise Levels (dBA) | | Total Unmitigated Post-Project (2030) Noise Levels (dBA) | | Total Change from Baseline (before mitigation) | Mitigation Consideration Warranted under Noise Policy? | Location (extent) of Anticipated Mitigation Works | Total Post-Project (2030) Noise Levels after Mitigation ³ (dBA) | | Total Change from Baseline (after mitigation) |
|--------|---|----------------------|----------------------------------|----------------|--|----------------|--|--|---|--|----------------|---|
| | | | L _{dn} | L _d | L _{dn} | L _d | Δ (dBA) | | | L _{dn} | L _d | Δ (dBA) |
| 2 | 9700 block, Capella Drive, Richmond | Residential | 72 | - | 74 | - | 2 | Yes | Southbound on-ramp from Sea Island Way and along Hwy 99 (approximately 600 m). | 69 | - | -3 |
| 3 | 10100 block, Caithcart Road, Richmond | Residential | 70 | - | 72 | - | 2 | Yes | St. Edwards Drive between Bird Road and access road to Sandman Signature Hotel (approximately 150 m). | 67 | - | -3 |
| 4 | 10400 block, Hall Avenue, Richmond | Residential | 72 | - | 73 | - | 1 | Yes | Southbound Hwy 99 starting approximately 100m north of Kilby Drive to within 100 metres of Shell Road trail (approximately 750 m). | 68 | - | -4 |
| 4a | 10500 block, Kilby Drive, Richmond | Residential | 70 | - | 71 | - | 1 | Yes | Included in Site #4, see comment above. | 66 | - | -4 |
| 4b | 10300 block Bryson Drive, Richmond | Residential | 69 | - | 70 | - | 1 | Yes | Included in Site #4, see comment above. | 65 | - | -4 |
| 5 | 4500 block Dallyn Road, Richmond | Residential | 68.7 | - | 70.3 | - | 1.6 | Yes | North bound Hwy 99, starting approximately 170 m south of Shell Road trail and ending on shoulder of northbound Highway 91 on-ramp (approximately 450 m). | 65 | - | -3 |
| 6 | 11600 block Dewsbury Drive, Richmond | Residential | 74 | - | 76 | - | 2 | Yes | Included in Site #5, see comment above. | 71 | - | -3 |
| 7 | 12200 block Old Westminster Highway | Residential | 67 | - | 71 | - | 4 | Yes | Southbound on-ramp to Highway 99, extending to the west along Westminster Hwy. | 66 | - | -1 |
| 7a | Richmond Nature Park, 11800 block Westminster Highway, Richmond | Municipal - Park | - | 58 | - | 62 | 4 ² | No | N/A | - | 62 | 4 |
| 8 | 12200 block Old Westminster Highway, Richmond | Residential | 64.2 | - | 67.6 | - | 3.4 | Yes | Northbound off-ramp from Highway 99, extending to the east along Westminster Hwy (200 m to 300 m). | 63 | - | -2 |
| 9 | 12400 block Blundell Road, Richmond | Daycare/ residential | 73 | - | 77 | - | 4 | Yes | Northbound along Highway 99, extending 150 - 200 m to north and south of Blundell Road (300 m to 400 m). | 72 | - | -1 |

| Site # | Location | Land Use | 2013 Baseline Noise Levels (dBA) | | Total Unmitigated Post-Project (2030) Noise Levels (dBA) | | Total Change from Baseline (before mitigation) | Mitigation Consideration Warranted under Noise Policy? | Location (extent) of Anticipated Mitigation Works | Total Post-Project (2030) Noise Levels after Mitigation ³ (dBA) | | Total Change from Baseline (after mitigation) |
|--------|--|---------------------|----------------------------------|----------------|--|----------------|--|--|--|--|----------------|---|
| | | | L _{dn} | L _d | L _{dn} | L _d | Δ (dBA) | | | L _{dn} | L _d | Δ (dBA) |
| 10 | 12200 block, Blundell Road, Richmond | Daycare/residential | 67 | - | 70 | - | 3 | Yes | Southbound along Highway 99, south of Blundell overpass (250 m to 300 m). | 65 | - | -2 |
| 10a | Mosque, 12300 block, Blundell Road Richmond | Worship | - | 72 | - | 75 | 3 | Potentially ⁴ | Southbound along Highway 99, possibly merged with treatment at Site 10 (approximately an additional 200 m). | - | 70 | -2 |
| 10b | School, 12300 block, Blundell Road Richmond | School | - | 71 | - | 74.5 | 3.5 | Potentially | Southbound along Highway 99, possibly merged with treatment at Site 10 (approximately an additional 200 m). | - | 70 | -2 |
| 10c | Ling Yen Mountain Temple, No. 5 Road, Richmond | Worship | - | 61.7 | - | 65.3 | 3.6 | Potentially ⁵ | Mitigation to be determined by interior noise level measurements. | - | 60 | -1 |
| 11 | 10600 block, No. 5 Road, Richmond | Residential | 66 | - | 71 | - | 5 | Yes | Southbound along Highway 99 extending along Steveston Hwy to west (approximately 650 m); mitigation may not be warranted if the nearby residential towers have fixed windows). | 66 | - | 0 |
| 11a | 11500 block, Dyke Road, Richmond | Municipal - Park | - | 46.4 | - | 49.5 | 2.9 ⁶ | No | None | - | 50 | 3 |
| 12 | 12900 block, Steveston Highway, Richmond | Commercial | 70 | - | 69 | - | -1 | No | None | 69 | - | -1 |
| 12a | 13000 block, Steveston Highway, Richmond | Residential | 59.3 | - | 61.5 | - | 2.2 | No | None | 62 | - | 2 |
| 13 | 14100 block Riverport Way, Richmond | Multi-family | 62 | - | 62 | - | 0 | No | None | 62 | - | 0 |
| 14 | 12900 block, Rice Mill Road, Richmond | Residential | 63 | - | 65 | - | 2 | Yes | Northbound along Highway 99 near Rice Mill Road. | 60 | - | -3 |
| 15 | River Woods, 6100 block, River Road, Delta | Multi-family | 68.4 | - | 67.5 | - | -0.9 | Yes | East side of the southern bridge approach at River Road (approximately 800m). | 63 | - | -6 |
| 15a | Deas Island Regional Park, Delta | Regional Park | - | 54 | - | 57 | - | - | This location is very close to the future southern bridge approach | - | 57 | 3 |
| 15b | River Watch, 6200 block, River Road, Delta | Multi-family | 60 | - | 62 | - | 2 | No | N/A ⁷ | 62 | - | 2 |

| Site # | Location | Land Use | 2013 Baseline Noise Levels (dBA) | | Total Unmitigated Post-Project (2030) Noise Levels (dBA) | | Total Change from Baseline (before mitigation) | Mitigation Consideration Warranted under Noise Policy? | Location (extent) of Anticipated Mitigation Works | Total Post-Project (2030) Noise Levels after Mitigation ³ (dBA) | | Total Change from Baseline (after mitigation) |
|--------|---|---------------|----------------------------------|----------------|--|----------------|--|--|---|--|----------------|---|
| | | | L _{dn} | L _d | L _{dn} | L _d | Δ (dBA) | | | L _{dn} | L _d | Δ (dBA) |
| 15c | Town & Country Inn, Highway 17A, Delta | Hotel | 70 | - | 69 | - | -1 | No | N/A | 69 | - | -1 |
| 16 | Woodwards Landing, 5300 block, Admiral Way, Delta | Multi-family | 57.6 | - | 57.4 | - | -0.2 | No | N/A ⁸ | 57 | - | 0 |
| 16a | East of Parking, Deas Island Regional Park, Delta | Regional Park | - | 46 | - | 53 | 7 | No | N/A | - | 53 | 7 |
| 16b | Captain's Cove Marina, Ferry Road, Ladner | Multi-family | 67 | - | 68 | - | 1 | Yes | West side of the southern bridge approach at Captain's Cove (approximately 800m). | 63 | - | -4 |
| 17 | 5954 River Road, Ladner | Residential | 68 | - | 66 | - | -2 | Yes | West side of the southern bridge approach at River Road (part of the treatment for Captain's Cove). | 61 | - | -7 |
| 17a | Burr House, Deas Island Regional Park, Delta | Regional Park | - | 47 | - | 51 | 4 | No | N/A | - | 51 | 4 |
| 17b | First Fork, Deas Island Regional Park Delta, | Regional Park | - | 46 | - | 57 | 11 | No | N/A | - | 57 | 11 |
| 17c | Second Fork, Deas Island Regional Park, Delta | Regional Park | - | 46 | - | 56 | 10 | No | N/A | - | 56 | 10 |
| 18 | 5400 block, Ferry Road, Ladner | Residential | 52 | - | 53 | - | 1 | No | None | 53 | - | 1 |
| 19 | 5600 block, 64th Street, Delta | Residential | 61 | - | 64 | - | 3 | Yes | Northbound along Highway 99, just north of 64 th Street, centred on receptors | 59 | - | -2 |
| 20 | 8600 block, Ladner Trunk Road, Delta | Residential | 68 | - | 70 | - | 2 | Yes | Southbound along Highway 99, centred on receptors. | 65 | - | -3 |
| 20a | 4700 block, 96th Street, Delta | Residential | 53.6 | - | 56.1 | - | 2.5 | No | None | 56 | - | 3 |
| 21 | Delta View Life Enrichment Centre, Delta | Multi-family | 75 | - | 77 | - | 2 | Yes | Northbound along Highway 99, just north of 96 th Street (400-500m). | 72 | - | -3 |
| 22 | Delta View Life Enrichment Centre, Delta | Multi-family | 74.5 | - | 77.2 | - | 2.7 | Yes | See comments for Site 21. | 72 | - | -3 |

| Site # | Location | Land Use | 2013 Baseline Noise Levels (dBA) | | Total Unmitigated Post-Project (2030) Noise Levels (dBA) | | Total Change from Baseline (before mitigation) | Mitigation Consideration Warranted under Noise Policy? | Location (extent) of Anticipated Mitigation Works | Total Post-Project (2030) Noise Levels after Mitigation ³ (dBA) | | Total Change from Baseline (after mitigation) |
|--------|---------------------------------|-------------|----------------------------------|----------------|--|----------------|--|--|---|--|----------------|---|
| | | | L _{dn} | L _d | L _{dn} | L _d | Δ (dBA) | | | L _{dn} | L _d | Δ (dBA) |
| 23 | 4700 block, 104th Street, Delta | Residential | 69 | - | 71 | - | 2 | Yes | Highway 99 at 104 th Street. | 66 | - | -3 |
| 24 | 4900 block, 112th Street, Delta | Residential | 74 ⁹ | - | - | - | - | No | N/A | - | - | - |
| 24a | 5000 block, 112th Street, Delta | Residential | 76 ¹⁰ | - | - | - | - | No | N/A | - | - | - |

Notes:

- Numbers shown in the table have been rounded off to nearest whole decibels except in cases where such rounding off would result in an erroneous representation of post-Project conditions in the three rightmost columns. In such cases, the tenth decibel has been retained.
- Where warranted under the Ministry's 2014 Noise Policy, a minimum mitigation objective of 5 dBA noise level reduction at the receptor sites will be applied.
- This is the projected change in Highway 99 traffic noise; however, overall noise levels at this site are not dominated by Highway 99 noise, and the actual Project-related noise increase will be lower than indicated here.
- The Ministry's 2014 noise policy specifies that for educational institutions, the potential need for mitigation must be investigated where post-project noise levels at a school facade are predicted to be Leq(max-hr) 60 dBA or higher. This will often involve measurement of (post-project) noise levels inside unoccupied classrooms. The target minimum noise level reduction objective of 5 dBA will be applied to these receptors.
- Under the Ministry's 2014 noise policy, the same impact thresholds as specified above for educational institutions apply to places of worship. Given the setback distance of the temple from the highway, which influences mitigation effectiveness, the need for mitigation and appropriate mitigation approach at this location will be determined by post-construction interior noise level monitoring. The target minimum noise level reduction objective of 5 dBA will be applied to this receptor as well.
- This is the projected change in Highway 99 traffic noise; however, overall noise levels at this site are not dominated by Highway 99 noise, and the actual Project-related noise increase will be lower than indicated here.
- This receptor would benefit from mitigation treatment at River Woods; however, this reduction in noise levels is not considered in the post-Project noise levels presented.
- This receptor would benefit from mitigation treatment at for Captain's Cove; however, this reduction in noise levels is not considered in the post-Project noise levels presented.
- Overall noise exposures at this site are controlled by railway activities; no Project-related influence on noise is anticipated, and therefore future noise predictions were not made.
- Overall noise exposures at this site are controlled by railway activities no Project-related influence on noise is anticipated, and therefore future noise predictions were not made.

As can be seen in **Table 4.10-5**, with the application of mitigation measures (e.g. noise barriers) in accordance with the Ministry’s Noise Policy, post-construction ambient noise levels at most residential and institutional receptors along the Project alignment are predicted to be lower than current levels. This long-term operational residual effect of the Project on noise conditions at residential and institutional receptors are considered to be positive, and of negligible to low magnitude.

Once the new bridge becomes operational, noise levels within Deas Island Regional Park, specifically in proximity to the bridge approach, will increase, but will generally remain below levels that warrant mitigation consideration for residential and institutional use.

Table 4.10-6 presents a summary of the criteria ratings for Post-construction residual effects.

Table 4.10-6 Criteria Ratings for Residual Effect: Operational Noise

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-------------------|--|
| Direction | Positive | Overall, residual (with mitigation) effects will be positive |
| Magnitude | Negligible to Low | Typical residual effects in residential areas will be between -1 and -7 dBA (i.e., approx. perceived loudness reductions of from 7 to 38%) |
| Extent | Local | Spatial extent will be restricted to the LAA – 500 to 1500 m.. |
| Duration | Long term | Effects will persist into future; 10 years or more. |
| Frequency | Permanent | Effects will exist on a daily basis well into the future. |
| Reversibility | Irreversible | Operational noise levels will persist at or near predicted levels as long as traffic conditions are relatively free flowing. |
| Likelihood | High | Changes in operational noise levels are quite certain to occur. Likelihood greater the 75%. |

4.10.6 Cumulative Effects and their Significance

The combination of Project-related changes and changes from other present and certain and reasonably foreseeable future projects and activities, listed in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**, comprise the total cumulative changes to atmospheric noise. This section provides an assessment of these cumulative changes.

Short-term noise exposures are unavoidable especially during Project-related construction activities. However, implementation of standard industry and best practices, informed by the Ministry's experience with prior projects of similar scale and nature, will minimize residual changes in atmospheric noise to the extent practically possible.

Changes in overall traffic noise levels associated with any other certain or reasonably foreseeable projects within the Project alignment are anticipated to be small during Project construction. It has therefore been assumed that cumulative changes due to the interaction of any such increase in non-Project-related traffic noise with Project-related construction noise would be negligible.

A list of other certain and reasonably foreseeable projects and activities that could interact with a Project-related change to atmospheric noise (operation phase) and result in a cumulative change is presented in **Table 4.10-7**. A map showing the locations of these projects and activities in relation to the Project is included as **Figure 3.10-2** in **Section 3.10**. The types of potential cumulative change resulting from these interactions are described below.

Road traffic growth associated with major projects (e.g., Roberts Bank Terminal 2, Fraser Surrey Docks) planned within or near the Project alignment has been considered in the Ministry's EMME 2 traffic modelling, and therefore was included in the 2030 Highway 99 traffic volumes used in the atmospheric noise assessment.

The increase in daily average noise exposures with traffic volume is very gradual, about 3 dBA per doubling of total traffic volume, all else being equal. For example, if, conservatively, over a 10-year period all foreseeable projects in or near the Project alignment collectively resulted in a 15% increase in total daily traffic on Highway 99, the increase in daily average traffic noise exposures from Highway 99 traffic (expressed in terms of L_{dn}) would be 0.6 dBA and would be imperceptible.

Projects that could increase the volumes of other types of transportation movements in the Project alignment are provided in **Table 4.10-7**. These include rail movements along the Canadian National Railway line paralleling Highway 99 to the south between 72 and 96 streets as a result of Roberts Bank Terminal 2, and increased vessel traffic on the Fraser River South Arm beneath the new bridge, as a result of the Vancouver Airport Fuel Delivery project, Fraser Surrey Docks Direct Transfer Coal Facility (Texada Coal), and WesPac LNG Marine Jetty Project. While these transportation-related noise events are expected to be audible, they will be transient, not present for long enough to interact with Project-related noise effects, and are not expected to contribute in a measurable or readily perceptible way to the daily average noise levels. At locations where noise from Project operations will be audible, the average daily noise levels are expected to be dominated by the continuous noise created by new bridge traffic.

Table 4.10-7 Potential Cumulative Changes Due to the Interaction of Other Certain and Reasonably Foreseeable Projects on Atmospheric Noise

| Other Certain and Reasonably Foreseeable Project | Relevant Source of Change | Anticipated Change | Anticipated Cumulative Change |
|---|--|--|--|
| Roberts Bank Terminal 2 | Increase in rail traffic volumes on rail line parallel to Highway 99 between 72 and 96 streets | Increase in numbers of relatively low level rail noise events experienced at rural residences along west side of Ladner Trunk Road approximately 700 m east of rail line | Cumulative change in overall daily noise exposure will be very minor |
| Vancouver Airport Fuel Delivery Project | Increase in vessels transiting the Fraser River South Arm beneath the new bridge | Increase in noise levels in Fraser River South Arm beneath new bridge | No incremental cumulative change expected. Noise from ships in transit is not present long enough to interact with Project noise and is not expected to measurably affect 24-hour average noise levels |
| Fraser Surrey Docks Direct Transfer Coal Facility (Texada Coal) | Increase in vessels transiting the Fraser River South Arm beneath the new bridge | Increase in noise levels in Fraser River South Arm beneath new bridge | No incremental cumulative change expected. Noise from ships in transit is not present long enough to interact with Project noise and is not expected to measurably affect 24-hour average noise levels |
| WesPac LNG Marine Jetty Project | Increase in vessels transiting the Fraser River South Arm beneath the new bridge | Increase in noise levels in Fraser River South Arm beneath new bridge | No incremental cumulative change expected. Noise from ships in transit is not present long enough to interact with Project noise and is not expected to measurably affect 24-hour average noise levels |

In summary, no cumulative changes of readily measurable or perceptible magnitude are predicted within the Project alignment. A small cumulative change is identified as the combined effect of projects on traffic volumes on Highway 99 and other components of the roadway system. However, such traffic growth is expected to have been included in the EMME 2 traffic modelling for the Project and hence in the 2030 noise predictions made herein.

4.10.7 Follow-up Strategy

During Project construction, monitoring of construction noise will be undertaken as appropriate to ensure mitigation measures are effective.

Once the new bridge and upgraded highway become operational, and traffic patterns have stabilized (no more than a year after completion), post-project, 24-hour noise monitoring will be carried out at selected, representative noise receiver locations. Such monitoring will serve to both confirm noise predictions and to assess the effectiveness of mitigation measures.

4.10.8 References

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APPENDIX A

Project Interaction Table

Table 1 Overview of Potential Project Interactions with Atmospheric Noise

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|---|--|
| Pre-Construction / Site Preparation | | | |
| Pre-Construction / Site Preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Acquiring property for the Project | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • An increase in atmospheric noise levels near the Project alignment. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|--|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • An increase in atmospheric noise levels near the Project alignment. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • An increase in atmospheric noise levels near the Project alignment. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|--|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • An increase in atmospheric noise levels near the Project alignment. |
| Decommissioning of Deas Slough Bridge | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • An increase in atmospheric noise levels near the Project alignment. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|---|--|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | Potential Project-related effects include: <ul style="list-style-type: none"> • An increase in atmospheric noise levels along the Project alignment. |
| New bridge | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Operating the new bridge • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | Potential Project-related effects include: <ul style="list-style-type: none"> • An increase in atmospheric noise levels along the Project alignment. |

"N/A" indicates that no Project works and/or activities are applicable to the category

5.1 Traffic Assessment Highlights:

- The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling, and walking.
- With implementation of recognized mitigation measures and best management practices, impacts to traffic during Project construction will be minimized.
- During operations, the Project will provide travel time savings of 25-35 minutes per day for commuters, improve safety with a forecast 35% reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling.
- As proposed, Project-related improvements, which include better travel mode options, and tolling will help moderate traffic growth while effectively serving forecast demand at the crossing.
- The Project will have a positive effect on future traffic conditions along the Highway 99 corridor.

5.1 Traffic

This section describes the existing conditions related to traffic safety, traffic volumes, congestion, and mode share, and the anticipated changes resulting from Project components and activities. Traffic is studied as an intermediate component (IC), and the information presented on predicted changes in traffic, with and without the Project, is used to support the assessment of potential Project-related effects on terrestrial wildlife (**Section 4.8**), atmospheric noise (**Section 4.10**), air quality (**Section 4.9**), land use (**Section 5.3**), and human health (**Section 7.1**).

Relative to VCs and other ICs assessed in the Application, traffic is unique because changes in traffic conditions are both a potential effect and also a primary objective that supports the Project rationale. Specifically, addressing existing adverse effects of congestion on the movement of people and goods and efficiently operating the local and regional road network are fundamental goals. The Project was developed to address current and anticipated traffic challenges that are resulting in adverse effects on environmental, economic, social, and health values. In this context, the effects of the Project during operation will be positive. **Section 1.1.10 Benefits** provides a summary of benefits associated with the Project.

5.1.1 Context and Boundaries

This section describes the context for assessing Project-related effects on traffic, and defines the spatial, temporal, administrative, and technical assessment boundaries. The rationale for selecting the assessment boundaries as defined is also provided.

5.1.1.1 Assessment Context

The Project involves changes to the Highway 99 corridor and related road, transit, and cycling and pedestrian networks that influence the movement of people and goods, as represented by changes in future traffic volumes, traffic flows, origins and destinations, and travel mode choice. Project-related changes to the road network have been designed to facilitate travel time savings and reduced idling, while providing greater travel time reliability and substantial safety improvements, which will result in health benefits. These changes will also offer improved community connections across the Highway 99 corridor while helping to reduce congestion on adjacent municipal streets, which can provide future benefits to local area social and economic values. Changes in traffic conditions have the potential to affect noise, air quality, land use, and terrestrial wildlife.

Changes to existing transit infrastructure along the Highway 99 corridor that have been integrated into the Project design are intended to result in travel time savings, improved travel time reliability, and greater travel mode choices. These changes can provide future benefits to social, economic, health, and environmental values, both locally and regionally.

Expanding pedestrian and cycling networks in the Highway 99 corridor, as part of the design of the Project, will also enhance travel mode choices, which in turn facilitate healthy lifestyles and improved access to recreational activities.

5.1.1.2 Methodology

The assessment of traffic follows the general methodology described in **Section 3.0 Assessment Methodology**. In early 2013, the Ministry initiated desktop studies, traffic data collection, and traffic forecast modelling to support Project planning and the assessment of potential Project-related effects. These studies focus on projected traffic conditions within the Project corridor during construction and operation. Results will be discussed in terms of:

- Safety
- Traffic volumes
- Mode share
- Travel time and reliability

5.1.1.3 Assessment Boundaries

Spatial, temporal, administrative, and technical boundaries identified for the assessment of Project-related effects on traffic, and the rationale for selecting them, are discussed below.

Spatial Boundaries

The Project alignment extends from Bridgeport Road in Richmond to Highway 91 in Delta. The spatial scope of the traffic assessment is divided into a local assessment area (LAA) and a regional assessment area (RAA) as shown in **Figure 5.1-1** and summarized on **Table 5.1-1**.

The LAA considers the spatial area of physical works proposed to be undertaken and includes the Highway 99 right-of-way (ROW) from Bridgeport Road in Richmond to Highway 91 in Delta. Where the physical scope of the Project extends beyond the ROW to tie into connecting highways and roads, the LAA has been widened to match the physical scope.

The RAA is defined as the Greater Vancouver region as represented in TransLink’s Regional Transportation Model (RTM), which incorporates Metro Vancouver’s future land use plans, population and employment growth forecasts, goods movement forecasts, changes that may be made to the regional transportation infrastructure (roads and transit), and decisions that individuals and goods movers are likely to make regarding regional transportation travel and mode choices.

Information on traffic conditions within the RAA, presented in **Section 5.1.2**, provides context for the assessment of potential changes to traffic in the LAA. Such information includes traffic forecasts on adjacent highway corridors and nearby bridges with and without the Project and a discussion of key trends.

Table 5.1-1 Spatial Boundaries for Traffic Assessment

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|---|
| Local Assessment Area (LAA) | Project alignment, including Highway 99 right-of-way from Bridgeport Road in Richmond to Highway 91 in Delta. Where the physical scope of the Project extends beyond right-of-way in order to connect other highways and roads, the LAA has been widened to match the physical scope. |
| Regional Assessment Area (RAA) | The Greater Vancouver Region as represented in TransLink’s Regional Transportation Model. |

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on traffic were established based on the potential for each phase of the Project to interact with and have an effect on traffic. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that may interact with and affect traffic; therefore, the following temporal boundaries were defined for the traffic assessment:

- Existing conditions
- Project construction, including Tunnel decommissioning
- Project operation, including maintenance

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of the Proposed Project**. Specific temporal considerations for the assessment of traffic and its sub-components are discussed in the context of Project interactions and potential effects in **Section 5.1.3**.

Administrative Boundaries

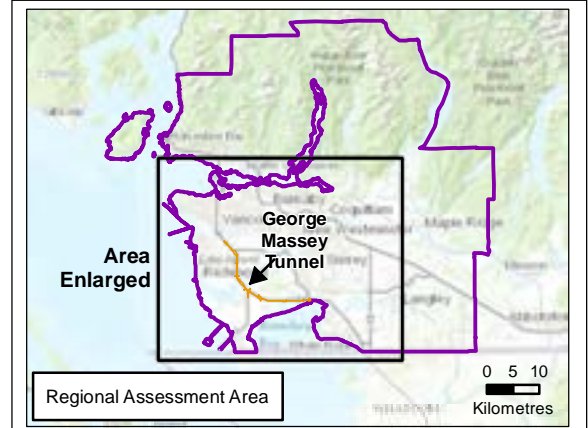
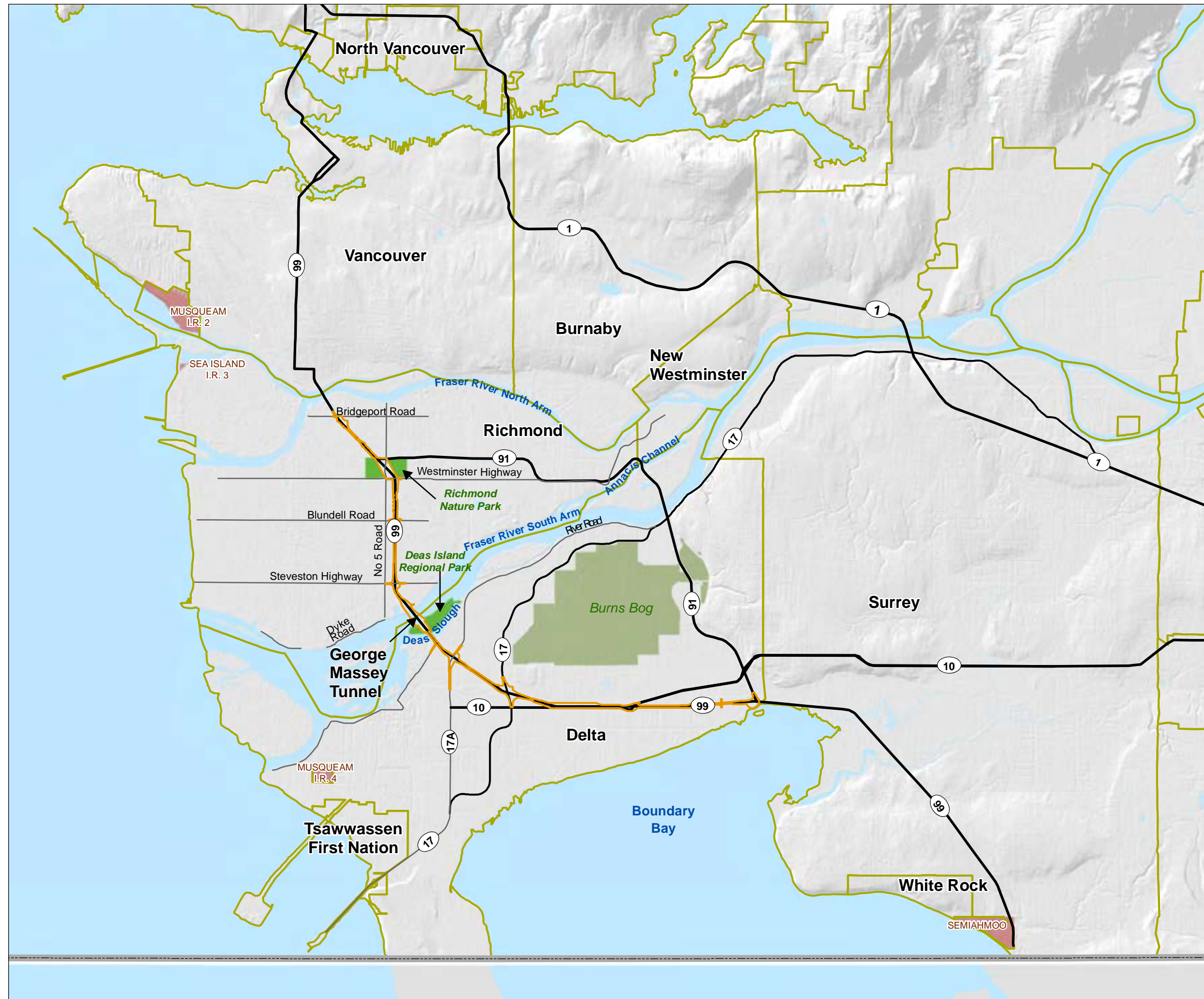
No economic, social, or political constraints have been identified that could impose limitations on the assessment of potential Project-related effects on traffic; therefore, no administrative boundaries are defined.

Technical Boundaries

Traffic forecasting is based on assumptions regarding the timing of land use plans build-out, population and employment growth, and future changes to regional transportation infrastructure, as well as decisions that individuals will make regarding transportation choices. As such, there is some inherent uncertainty in the predictive capacity of traffic models. Such uncertainty has been mitigated by using multiple methodologies and considering a range of forecasts.

Provincial *Guidelines for Tolling* (B.C. MOTI 2003) have been used as the basis for assumptions related to traffic forecasts that include tolling. Specifically, the Port Mann Bridge tolling framework has been applied to the new bridge, with the adjacent Alex Fraser Bridge (AFB) and Highway 91 corridor considered as the free alternative. Tolling is discussed in more detail in **Section 1.1.7.3 Project Operations and Maintenance**.

The Ministry recognizes current discussions about the possibility of regional tolling or other forms of road pricing in Greater Vancouver. Such changes, if implemented, would affect all Fraser River crossings and the underlying RTM assumptions about traffic movements. However, as uncertainty exists about the specific framework that might be adopted or when it would be put into place, the existing tolling framework is considered the best currently available technical information for the purposes of this traffic assessment.



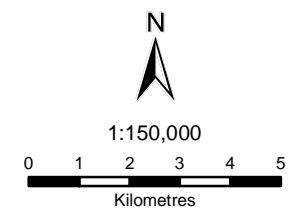
Legend

- Project Alignment/Traffic Land Use Local Assessment Area
- Traffic Regional Assessment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TRAFFIC LOCAL AND REGIONAL ASSESSMENT AREAS | |
| Figure 5.1-1 | 13/05/2016 |
| | |

5.1.2 Existing Conditions

This section discusses anticipated interactions of Project components and activities with traffic, and potential effects of such interactions on traffic volumes, patterns, and mode share. Information on the mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 5.1.4**. Residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 5.1.5**.

5.1.2.1 Baseline Data Collection

The objective of the traffic assessment is to develop an understanding of current and future traffic conditions to support the prediction of potential Project-related changes in traffic in the LAA. Baseline data collection to support the assessment commenced in 2013, and includes:

- Desktop studies to review past planning studies and traffic data to understand historical trends and identify data gaps
- A review of regional transportation and growth management plans
- A traffic data collection program to study traffic volumes, mode share (cars, trucks, buses, cyclists, passengers, etc.), origin-destinations, and travel time reliability and congestion along the Highway 99 corridor and adjacent major routes and bridges
- Traffic forecasting (modelling) to predict future conditions, with and without the Project, using several methodologies

Data collection sources, and reports created from the data collection program are summarized in **Appendix B, George Massey Tunnel Replacement Project Traffic Data Overview**.

5.1.2.2 Regulatory Context

The two pieces of legislation relevant to the Project in the context of traffic include the *Transportation Act*, S.B.C. 2004, c. 44, and the *South Coast British Columbia Transportation Authority Act*, S.B.C. 1998, c. 30.

The *Transportation Act* deals with public works related to transportation, as well as the planning, design, holding, construction, use, operation, alteration, maintenance, repair, rehabilitation and closing of provincial highways. The act also enables the designation of arterial and controlled access highways.

The *South Coast British Columbia Transportation Authority Act* provides the mandate for the South Coast British Columbia Transportation Authority to manage and operate the regional transportation system, develop and implement transportation demand management strategies and programs, generate and manage funds necessary for its purpose, and prepare and implement strategic, service, capital and operational plans for the regional transportation system.

In addition to the above legislation, the Ministry's Guidelines for Tolling (MOTI 2003) would apply to tolling of the new bridge.

5.1.2.3 Existing Conditions

Since opening in 1959, traffic demand and the needs of Highway 99/Tunnel users have changed substantially. Today, an average of 80,000 vehicles use the Tunnel every day. In addition, influences on transportation infrastructure along the Highway 99 corridor have changed including origins and destinations within the corridor and the demand for greater transportation choice.

While the Tunnel remains an important commuter crossing to City of Vancouver (Vancouver) for south of the Fraser River residents, travel patterns within the Lower Mainland in general, and south of the Fraser River in particular, also have changed substantially since the Tunnel opened. At present, traffic to Vancouver accounts for only 40 per cent of the total traffic through the Tunnel, while almost 60 per cent of daily trips are between Richmond and communities south of the Fraser River.

This section presents a discussion of existing conditions in the Highway 99 corridor in terms of safety, traffic volumes and mode share, and travel time and reliability. A brief overview of the relationship between traffic movements on Highway 99 and Highway 91/AFB is also provided.

Information obtained from the baseline data collection program that supports the description of existing traffic conditions is presented in **Appendix B**.

Traffic Safety

Traffic safety is assessed by comparing collision rates for a segment of a roadway to provincial averages for the same roadway type and classification. The average collision rate is measured in units of collisions per million vehicle kilometers (c/mvk), and provides a measure of the frequency of collisions in the study segment. An assessment of collision rates for the LAA is presented in the report titled *George Massey Tunnel Replacement Project Collision Data Analysis* (Delcan 2015).

Results show that the segment of Highway 99 which includes the Steveston Highway interchange, the Tunnel, and the Highway 17A interchange, has an average collision rate of 0.44 c/mvk, which is much higher than the 0.30 c/mvk provincial average (Delcan 2015).

These high traffic collision rates present an ongoing risk to safety and human health. The Steveston Highway interchange has the highest number of collisions along the assessment corridor, including relevant nearby intersections and roadways. There were 625 collisions at this interchange between 2008 and 2012. Additionally, the Steveston Highway/No. 5 Road intersection, immediately west of Highway 99, had the second highest number of collisions (545) during this period. There were 491 collisions at the Highway 99/Highway 17A interchange between 2008 and 2012, which is the third highest number of collisions along the study corridor (Delcan 2015).

Anecdotal evidence suggests that driver behaviour specific to the Tunnel contributes to safety concerns – some drivers brake or slow down upon entering the Tunnel to adjust to the Tunnel's low clearances, narrow lanes, and low lighting built to 1950s standards. Currently, approximately one half of Tunnel collisions involve an injury (Delcan 2015). Congestion and access-related delays in emergency responders' access to the Tunnel, to attend to vehicle collisions, are an additional safety concern. Counter-flow operation leads to opposing traffic travelling side-by-side without median separation, which causes driver discomfort and is a potential safety concern.

Traffic Volume and Mode Share

Since the Tunnel opened in 1959, the volume of traffic along the corridor has steadily increased as the population and economy of Metro Vancouver have grown. The Tunnel currently carries an average of 80,000 vehicles each day, and without the new crossing, traffic through the Tunnel will grow to approximately 100,000 vehicles per day by 2045 (MOTI 2015d). In addition to growth in traffic on Highway 99 since it opened, the profile of users (mode share) of the corridor and Tunnel has changed. This section presents an overview of the profile of the range of current users of the corridor, including trucks, transit, and cyclists, and their present and emerging needs.

Trucks – Highways 99 and 91 are key components of the regional truck transportation network that supports local, provincial, and international trade. During the work week, 7,000 trucks per day use the Tunnel, while 9,000 trucks per day use the AFB. Truck traffic has grown by over nine per cent at all major river crossings in the Lower Mainland from 2008 to 2014, with increases of nine per cent and 5.4 per cent at the Tunnel and AFB respectively (CTS 2008, Acuere 2014).

It is important to note that more than 50 per cent of truck traffic crosses the Fraser River South Arm (Tunnel and AFB) during the midday (TransTech 2009, TransLink 2013a). This is due in part to heavy congestion at these crossings during peak periods, which trucks avoid. Therefore, the midday period at these crossings is also becoming increasingly congested.

Current conditions also create inefficiencies for commercial and agricultural businesses, including scheduling traffic movements during congested periods and navigating poor connections across Highway 99.

Transit – During the morning rush hour, approximately 60 per cent of trips to downtown Vancouver by residents of South Delta and South Surrey are made by transit. The Tunnel has the highest number of buses crossing the Fraser River daily, connecting buses from transit exchanges in South Surrey and Ladner to the Bridgeport Road Canada Line station in Richmond. On an average weekday, 559 buses carry 10,535 passengers through the Tunnel (TransLink 2013a). Nine northbound TransLink bus routes use the Tunnel during the morning rush period; this equates to a bus every two to three minutes (TransLink 2014). While northbound morning rush hour buses comprise only one per cent of traffic, they carry approximately 17 per cent of all Tunnel travellers (TransTech 2014).

High-Occupancy Vehicles (HOV) – Highway 99 has some of the highest HOV use in the region. A key driver of this high mode share is Highway 99 and the Tunnel's proximity to gateways in the region, including the Tsawwassen Ferry Terminal and the Canada–U.S. Border. HOV use through the Tunnel is heaviest on weekends, when HOVs account for 40 per cent of total vehicles and transport 56 per cent of total passengers (TransTech 2014).

During weekdays, HOVs represent 10 per cent of northbound weekday commuter Tunnel traffic, carrying 16 per cent of passengers; and 17 per cent of southbound weekday commuter Tunnel traffic, carrying 25 per cent of passengers (TransTech 2014).

Transit and HOV traffic enjoy high utilization and obvious benefits in terms of the queue-jumper access to the Tunnel during periods of high congestion. However, given the high proportion of goods movement, services, and extra-regional trips through the Tunnel each day for which transit and HOV travel is not a viable option, analysis indicates that improvements in HOV and transit alone will not substantially address the current Highway 99 traffic challenges.

Cycling – Currently, cyclists and pedestrians are not permitted to use the Tunnel for safety reasons. In the absence of a viable alternate route for these travellers, the Ministry operates a year-round free shuttle service through the Tunnel. In 2014, the shuttle transported an average of 910 people per month. Demand is higher in the summer, but averages 30 people per day

over the year (Mainroad 2014). The shuttle service does not operate on weekends during the winter months. The new bridge will include a multi-use pathway on either side for cyclists and pedestrians, eliminating the need for the shuttle service.

Highway 91/Alex Fraser Bridge Traffic

While the Highway 99 corridor and Tunnel provide a critical component of the regional road network, they also operate in concert with the adjacent Highway 91 and Alex Fraser Bridge. Together, the Tunnel and AFB serve traffic demand between Surrey and Delta and communities in Richmond and north of the Fraser River. Combined traffic growth at these two crossings has averaged 0.64 per cent per year between 2003 and 2013 (see Section 2 of **Appendix B**). However, during this period, due to lack of available capacity at the Tunnel, the AFB has absorbed this growth.

Travel Time and Reliability

The four-lane Tunnel operates with a counter-flow system during the commuter rush periods, with only one lane open in the non-peak direction. Traffic volumes in the non-peak direction have grown steadily over the past 15 years. Traffic volumes outside of the rush periods have also grown to the point where the Tunnel is close to capacity throughout the day (B.C. MOTI 2015b).

Due to the fact that traffic demand exceeds Tunnel capacity, Tunnel congestion currently accounts for more than one million hours of vehicle delay annually. Congestion within the corridor is defined by variable and unpredictable delays throughout the day. Key trends include the following:

- Despite the three lanes available (counter flow) during the morning peak for northbound traffic, there is congestion from just after 6:00 a.m. until 10:30 a.m. Delays associated with this congestion are typically 5 to 10 minutes, but can often be as high as 23 minutes.
- Congested conditions return from 3:00 p.m. until after 6:00 p.m. when the counter-flow system reduces the northbound traffic to one lane. This results in typical delays of 20 to 50 minutes.
- Southbound traffic is reduced to one lane during the morning peak period, which results in congestion with delays up to 20 minutes from just after 6:00 a.m. to just after 9:00 a.m.
- Conditions are again congested, with delays up to 15 minutes, from 3:00 p.m. until 6:00 p.m., despite the three lanes available via the counter-flow system (B.C. MOTI 2015c).

5.1.2.4 Traffic Forecasting

Forecasts were undertaken to assess Project-related changes in traffic in the LAA by comparing existing conditions and future conditions with and without the Project. This section provides a description of the methodologies used to develop such traffic forecasts.

In the Metro Vancouver region, traffic demand forecasts are developed using a computer-based transportation planning tool called EMME2 (a bilingual acronym for multimodal equilibrium/équilibre multimodal). TransLink develops and maintains models using this software, including the regional assumptions used as inputs to the model, and distributes updates, as appropriate, to planning agencies for the purposes of transportation project planning and assessments.

Traffic forecasts were developed for the LAA and RAA using TransLink's models for scenarios with and without the Project, as well as with and without tolling. Alternative forecasting methods were also used to further analyze and substantiate traffic forecasts for the new bridge and Highway 99 improvements.

Traffic Modelling

In 2012, the Ministry retained Parsons Corporation (Parsons), a recognized transportation engineering consulting firm, to develop forecast traffic volumes for the Project using TransLink's regional transportation planning models. Over the four-year planning period for the Project, the following models have been used:

EMME2 Gateway Program (GSAM) Model

The GSAM model was collaboratively developed by the Ministry and TransLink, and used to model forecast demand to 2031 for the Gateway Program projects from 2003 to 2009. The Ministry updated and used this model again in 2012 and 2013 during the early planning stages of the Project. The GSAM model forecasts were used to test TransLink's new EMME2 model, which was released for use in 2014.

EMME2 Regional Transportation Model (RTM)

This is the latest transportation demand model developed and maintained by TransLink. The RTM contains two road networks (2011 and 2045), and is based on land use assumptions consistent with Metro Vancouver's Regional Growth Strategy (RGS) (2014). A number of alternative future scenarios are also included in the RTM, primarily reflecting different levels of investment in transit.

As advised by TransLink, the RTM forecasts used for the Project are based on the Alternative 3 regional network scenario. This scenario assumes that the transportation priorities outlined in the Mayors Council Vision *Regional Transportation Investments, a Vision for Metro Vancouver* (Mayors' Council 2014) have been implemented. These priorities include a new four-lane Pattullo Bridge, upgrades to the major road network (MRN), the Evergreen and Broadway rapid transit extensions, light rail transit in Surrey and Langley, expanded bus and Sea Bus services, and expanded pedestrian and cycling networks.

TransLink provided the RTM State 0 (Beta) version of the model to the Ministry's Project team in 2014, and initial results were compared to the GSAM forecasts. Differences in traffic forecasts between the two models indicated a need to upgrade RTM State 0 with newer road and transit networks; updated truck trip generators from airports, port facilities (e.g., Roberts Bank Terminal 2 expansion), and industrial areas; new major developments; and updated Canada-U.S. border traffic for cars and trucks. These updates were carried out and provided to TransLink. Subsequent modelling for the Project has used the RTM State 0 version with these updates.

Modelled Forecast Adjustments

TransLink continues to carry out updates and model calibrations, but the RTM remains primarily a regional model for long term forecasting. Considering this, and to provide confidence that the traffic forecasts required to support the environmental assessment are robust and based on reasonable assumptions, the Ministry also commissioned an in-depth research and analysis program to consider alternative methods for developing traffic forecasts for the Project. The following section provides an overview of alternative information that was obtained and considered to strengthen confidence in the modelled traffic forecasts noted above.

Historic and Current Tunnel Traffic Growth and Delay Patterns

A comprehensive analysis of long-term traffic growth patterns at the Tunnel, AFB, and other Fraser River crossings was undertaken. While the Tunnel has been congested for many years, AFB has absorbed most of the area's traffic increases over the past decades. Analysis showed that traffic has now increased to the point where both the Tunnel and AFB face significant peak-direction congestion and delays during rush hours. Between 2003 and 2013, combined traffic growth at the Tunnel and AFB averaged 0.64 per cent annually (B.C. MOTI 2015c). This information was used to support sensitivity analysis of modelled demand at the Tunnel.

Historic Truck Traffic Growth

A number of key sources of truck traffic information were reviewed including traffic count station data, TransLink screenline surveys (TransTech 2009, TransLink 2013a), and the *Metro Vancouver Truck Classification and Dangerous Goods Survey* (CTS 2008, Acuere 2014). Between 2008 and 2014, Tunnel truck traffic increases averaged 1.4 per cent annually (CTS 2008, Acuere 2014). This confirmed the need for RTM adjustments to truck forecasts. In the meantime, modelled truck forecasts were adjusted upward to reflect the additional demand.

Origin-Destination Travel Surveys

A detailed analysis of 2013 and 2014 origin-destination travel patterns was performed for the Project and Highway 91/AFB traffic, by time of day and day of week. This data collection and analysis provided essential information for forecasting shifts in traffic patterns caused by the new bridge. As previously noted, almost 60 per cent of daily vehicle trips through the Tunnel are between Richmond and communities south of the Fraser River. In addition, some AFB trips appear to be for the purpose of avoiding Tunnel congestion, despite Highway 99 offering a more direct route (Parsons 2015). These findings provided a greater level of confidence in the modelled results at the Oak Street Bridge, which show little change at the Oak Street during peak hours with or without a new bridge to replace the Tunnel.

Future Population and Employment Growth

The Metro Vancouver RGS and other regional and community planning initiatives were reviewed, including commercial and industrial economic development opportunities, and the anticipated population and employment growth for Richmond, Delta, and Surrey. Between 2011 and 2041, the RGS forecast is for more than a 50 per cent increase in population and employment in these communities. These very high growth rates provided further confidence in continued increase in demand for travel in the future, even with the significant investments in transit that are assumed in the RTM.

Evaluation of Port Mann Bridge Experience

A detailed analysis of the traffic pattern changes, by hour of day and day of week, for the new Port Mann Bridge was undertaken to identify lessons learned that should be applied to traffic forecasting for this Project. This analysis confirmed implementation of tolls at Port Mann Bridge resulted in a 14 per cent drop in traffic between 2011 and 2014 (no tolls to full tolls). In the following year, however, the Port Mann Bridge traffic grew by more than four per cent (B.C. MOTI 2015c). Developing a comprehensive understanding of the actual traffic impacts at the Port Mann Bridge has been key to developing traffic forecasts associated with this Project.

Independent Forecast

Independent of the Project team’s traffic forecasts for the new bridge, international transportation consulting firm Steer Davies Gleave (SDG) developed traffic forecasts for the Project, considering a tolling regime similar to the current Port Mann Bridge. SDG’s report, *George Massey Tunnel Replacement – Traffic Forecasts*, is included as **Appendix C**.

5.1.2.4.1 Local Assessment Area Traffic Forecasts

The following section presents various traffic forecasts that have been undertaken as part of Project planning to support Project design as well as assessment of traffic in the LAA.

In consideration of the limitations and uncertainties involved in traffic forecasting, a range of forecasts from the various sources of information were developed and are illustrated in **Figure 5.1-2**.

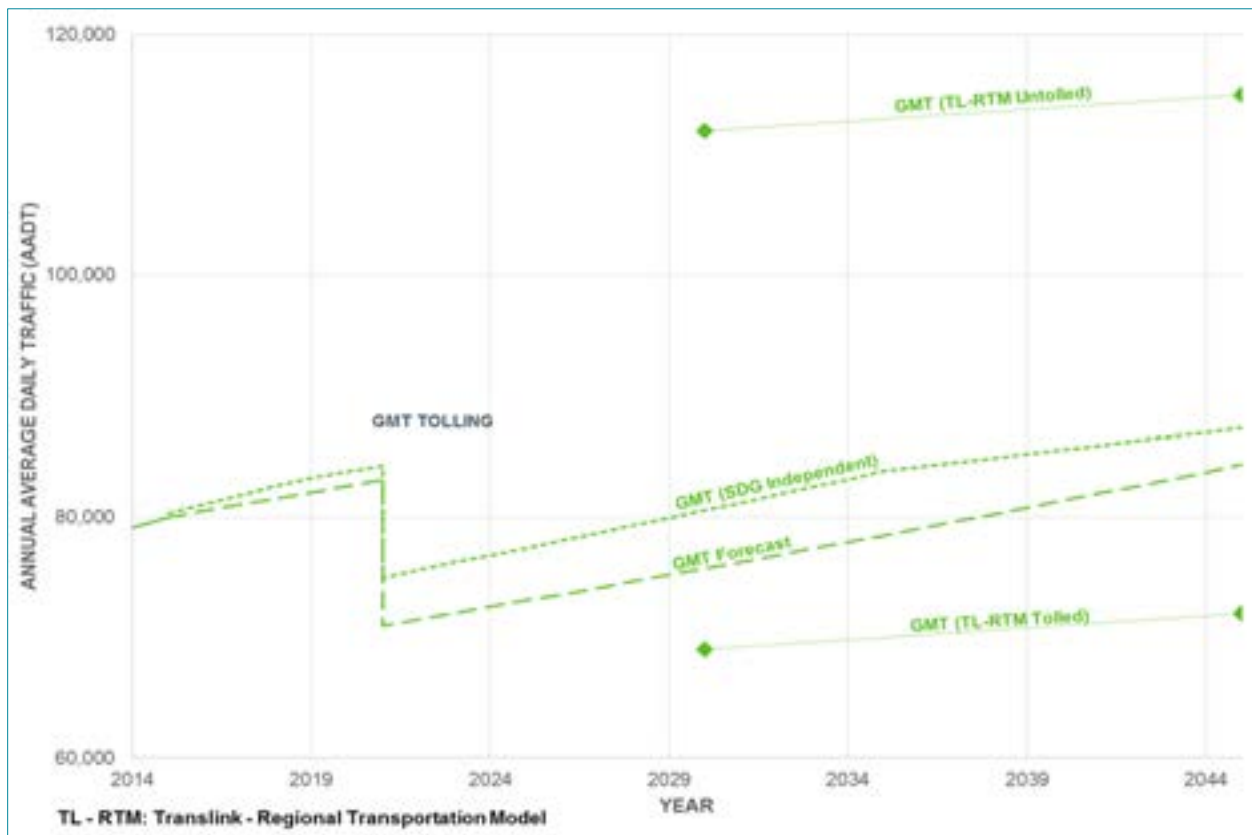


Figure 5.1-2 George Massey Tunnel Replacement Bridge Range of Traffic Forecasts

The upper line, GMT (TL-RTM Untolled), shows modelled annual average daily volumes (AADT) for 2030 and 2045 using TransLink's RTM with the new bridge in place and no tolls being applied. This represents the highest potential future traffic volumes in the LAA. The lowest line, GMT (TL-RTM Tolled), shows modelled AADT for 2030 and 2045 using TransLink's RTM model with the new tolled bridge in place, using the Port Mann Bridge tolling framework. The variance in daily traffic volumes between the tolled and un-tolled scenarios is due to a change in travel patterns and driver behaviour in response to the implementation of tolls at the crossing. The majority of this difference applies to drivers who avoid crossing the river at all or divert to the Alex Fraser Bridge, primarily during off-peak periods and weekends. Only minor changes in traffic volumes at other crossings are anticipated with the implementation of tolls at the new bridge crossing. Limitations in the current version of TransLink's RTM do not permit exact estimates of travel pattern changes whether in terms of not crossing the river, diversion to an alternate crossing, or changing modes.

The GMT Forecast line, derived from an examination of traffic pattern changes at the new Port Mann Bridge – including time of day and day of week changes and an analysis of the availability of alternate routes using origin-destination data, as well as projected growth rates for auto and truck traffic at the replacement crossing for the Tunnel, shows AADT forecasts from the present to 2045 with the new tolled bridge in place and with adjustments to reflect current experience at the Port Mann Bridge. Specifically:

- **New Bridge Baseline Traffic Forecast** – First-year daily traffic with the new bridge is forecast to be 71,000, representing a 14 per cent drop from forecast volumes under continued Tunnel operation. This is consistent with the actual Port Mann Bridge experience, as well as with the analysis of the potential for existing Tunnel and AFB traffic to redistribute between the two crossings.
- **New Bridge Growth Forecast** – Future auto growth is forecast to average approximately 0.65 per cent annually – consistent with recent-year trends for Richmond and Delta traffic via the Tunnel and AFB, and at about half of RGS population and employment growth forecasts for south-of-Fraser municipalities. Future truck growth is forecast to average 1.5 per cent annually – consistent with recent-year truck growth trends at the Tunnel, and in line with RGS forecast population and employment growth (Ministry 2015b). Based on this growth, traffic demand at the new bridge is forecast to be 84,000 vehicles per day by 2045.

The GMT (SDG Independent) line shows AADT volumes based on independent forecasts developed by Steer Davies Gleave (SDG 2015) from the present to 2045 with the new bridge in place and a tolling regime matching the one at the Port Mann Bridge applied. The independent forecast indicates a slightly lower drop in opening-year daily traffic and a slightly different future growth rate when compared to the GMT Forecast line.

Traffic forecasts are used to support the assessments of atmospheric noise, local air quality and wildlife. These assessments measure With and Without the Project 10 years after implementation (or 2030 as a proxy, given best available modelled traffic information). Given the variability in the forecasting, and to ensure a conservative assessment for EA purposes, the upper range of forecast values (TL-RTM untolled, 2030 With the Project) were used as it represents the highest potential volume of traffic. These traffic assumptions support the assessments undertaken in **Section 4.8 Terrestrial Wildlife**, **Section 4.9 Air Quality** and **Section 4.10 Atmospheric Noise**.

The “TL-RTM tolled, 2045 With the Project” forecasts were used to describe trends in traffic within the RAA because they provide the best-available level of detail necessary for the required comparative analysis (see Regional Traffic Forecasts discussion below).

Traffic Forecasts for Roadway Design

Geometric design of roads, bridges, intersections, and interchanges requires current and forecast a.m. and p.m. design hourly volumes (DHVs), rather than AADT, to ensure safe and efficient traffic flows during peak traffic conditions. The DHVs that have been used to support the design of Project elements within the LAA are provided in **Appendix D**. In addition, the DHV forecasts and operational requirements were used to determine the number of lanes required for the bridge as described in **Section 1.3 Project Design and/or Alternative Means of Carrying out the Project**.

5.1.2.4.2 Regional Traffic Forecasts

The Metro Vancouver RGS and other regional and community planning initiatives forecast significant growth in population and employment within the RAA, as well as growth in travel demand for people and goods. To evaluate the potential influence of the Project on future regional traffic conditions, in the context of forecast growth associated with the RGS, region-wide vehicle kilometers travelled (VKT) and vehicle hours travelled (VHT) using TransLink’s RTM long-range forecasts to 2045 were examined. **Table 5.1-2** and **Table 5.1-3** show region-wide VKT and VHT for a regional morning peak hour (a.m.), and an afternoon peak hour (p.m.) for 2014, for 2045 without the Project, and for 2045 with the Project (tolled).

Table 5.1-2 Regional Vehicle Kilometers Travelled Using TransLink’s Regional Transportation Model (State 0)

| Hour | 2014 VKT (Current) | 2045 VKT (Without Project) | 2045 VKT (With Project and Tolled) |
|-------------------|-----------------------|-------------------------------|---------------------------------------|
| AM – 7:30 to 8:30 | 4,120,000 | 5,405,500 | 5,373,500 |
| PM – 4:30 to 5:30 | 4,565,000 | 5,956,500 | 5,910,300 |

The forecasts in **Table 5.1-2** indicate regional annual average rush hour VKT will increase over the next 30 years without the Project, as population, employment, and goods movement continue to grow. The Project, including tolled access across the new bridge, will result in lower VKT compared to a future without the Project in 2045.

Table 5.1-3 Regional Vehicle Hours Travelled Using TransLink’s Regional Transportation Model (State 0)

| Hour | 2014 VHT (Current) | 2045 VHT (Without Project) | 2045 VHT (With Project and Tolled) |
|-------------------|-----------------------|-------------------------------|---------------------------------------|
| AM – 7:30 to 8:30 | 81,900 | 120,500 | 120,400 |
| PM – 4:30 to 5:30 | 95,400 | 145,000 | 142,600 |

The forecasts in **Table 5.1-3** indicate that regional annual average rush hour VHT will increase over the next 30 years without the Project, as compared to current levels. The Project is not expected to change this, as there is virtually no change in forecast VHT when comparing with and without the Project in 2045.

Given the integrated nature of the regional road network, and the Ministry’s role in the operation of the network, assessment of potential effects of the Project on the operation of other nearby Fraser River crossings in the RAA has also been undertaken.

Current AADT volumes at nearby crossings and the highest potential 2045 future traffic forecasts without the Project and with the Project (tolled) are provided on **Table 5.1-4**. The 2045 forecasts derived from TranLink’s RTM show an increase in AADT at the nearby Fraser River crossings without the Project, when compared to current levels. When comparing with and without the Project for the Fraser River North Arm crossings, Knight Street Bridge, Arthur Laing Bridge, and Oak Street Bridge, results show a small decrease in traffic with the Project. For the AFB, however, results show a 17 per cent increase in daily traffic with the Project when compared to without the Project, primarily because of off-peak diversion from the tolled facility to the untolled facility.

Table 5.1-4 Two-way Annual Average and Daily Traffic Volumes on Adjacent Fraser River Crossings, With and Without the Project Using TransLink’s Regional Transportation Model (State 0)

| Crossing | 2014-2015 | 2045 | |
|----------------------|-----------|-----------------|-------------------------|
| | Measured | Without Project | With Project and Tolled |
| Alex Fraser Bridge | 107,000 | 120,000 | 140,000 |
| Knight Street Bridge | 92,000 | 94,000 | 93,000 |
| Arthur Laing Bridge | 76,000 | 90,000 | 91,000 |
| Oak Street Bridge | 80,000 | 87,000 | 85,000 |
| Knight + Laing + Oak | 248,000 | 271,000 | 269,000 |

Oak Street Bridge

Although Oak Street Bridge is outside of the LAA, during the Pre-application public comment period, some members of the public and the Technical Working Group asked questions regarding current and future traffic conditions at the Oak Street Bridge. As a result, the Ministry conducted a detailed analysis on current and future traffic conditions at the Oak Street Bridge. The findings of that analysis are presented below.

Figure 5.1-3 shows measured traffic at the Oak Street Bridge from 2005 to 2014 for Annual Average Weekday Traffic (AAWDT), AADT, and Annual Average Weekend Traffic (AAWET). The figure shows that since commuters have adjusted to the introduction of the Canada Line, vehicle volumes on the Oak Street Bridge have been declining year over year, particularly on weekdays. After a drop in 2011, weekend volumes have plateaued at slightly lower than 2010 volumes.

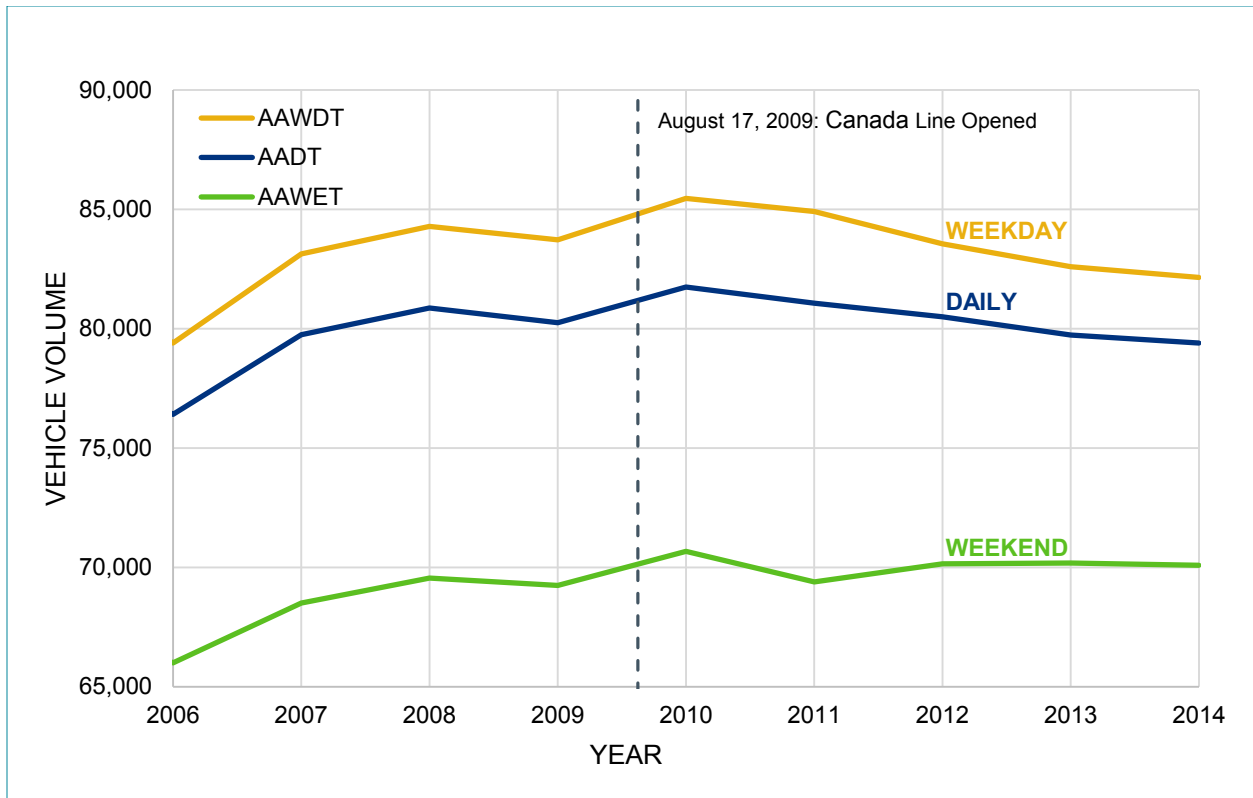


Figure 5.1-3 Oak Street Bridge – Daily Traffic Volumes, 2006 to 2014

Hourly traffic patterns at the Oak Street Bridge were also examined to consider potential effects on northbound rush-hour traffic flow conditions. **Figure 5.1-4** shows vehicle volumes by time of day for an average September weekday when traffic volumes are traditionally high. The figure indicates that Oak Street Bridge traffic volumes during rush-hour periods – when congestion is of primary concern – have dropped between 2010 and 2015, since the introduction of the Canada Line.

Notwithstanding decreases in traffic volumes in recent years, the intersection of Oak Street and 70th Avenue at the north end of the Oak Street Bridge in Vancouver is likely to remain congested for northbound a.m. rush hour traffic in the future due to the signal lights at this location. During Project operation, some northbound a.m. south-of-Fraser commuters may change their preferred travel time to take advantage of the time savings and reliability that the new bridge provides. This could make queue lengths at Oak Street a little longer during the busiest part of rush hour. However, the transit improvements included in the Project, in conjunction with tolling, will support and enable a mode shift towards greater use of transit in the Highway 99 corridor, including the Canada Line, and away from single occupancy vehicle-based commuting trips across the Oak Street Bridge.

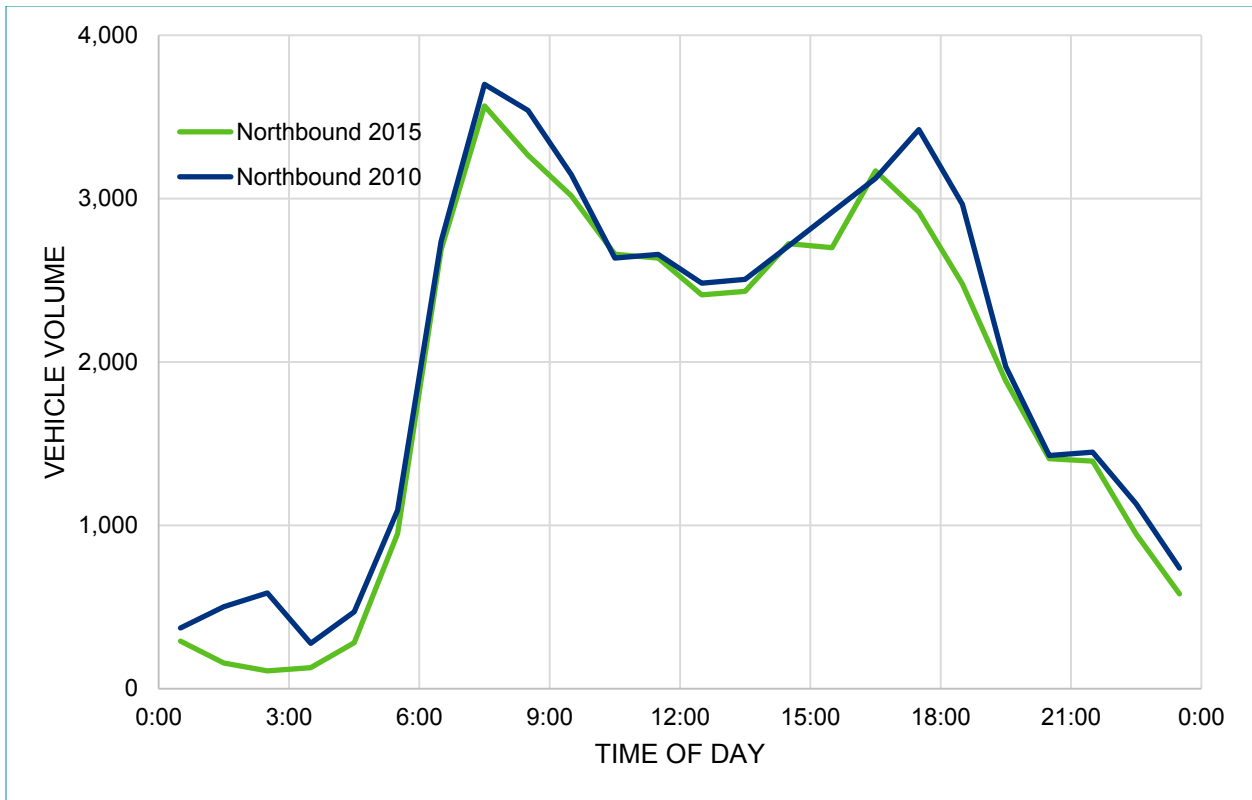


Figure 5.1-4 Oak Street Bridge – September 2010 and 2015 Northbound Weekday Vehicle Volumes, by Hour

5.1.3 Potential Effects

This section provides a summary of potential Project-related effects on traffic as a result of construction and operation of the Project. It also describes the methodology used to assess potential Project-related effects.

5.1.3.1 Project Interactions

An overview of the potential effects of Project interactions on traffic within the LAA is provided in **Appendix A**, and is summarized below.

Highway upgrades, reconstruction of interchanges, and new bridge construction will necessitate temporary detours, temporary lane closures, and changes to the existing counter-flow system, which will affect traffic. Additionally, construction vehicles will temporarily add incremental growth in traffic to existing Highway 99 traffic volumes.

During Project operation, traffic volumes, patterns, mode share, and travel choices are expected to change as a result of the reconfigured Highway 99, new interchanges, and the new bridge. Maintenance activities associated with Project operation are anticipated to have negligible interactions with traffic, and are not assessed further.

5.1.3.2 Potential Effects

The following section identifies potential Project-related effects on traffic as a result of Project activities during the construction and operational phases of the Project.

5.1.3.2.1 Construction

Based on the Ministry's knowledge of road construction in urban areas, including recently completed work on the Port Mann/Highway 1 improvements, the Project has been developed with the following key traffic management elements:

- Full access for emergency and first responders will be maintained at all times.
- The Highway 99 corridor and connecting interchanges will remain operational to current levels of service during the day and early evenings. The counter-flow system will be maintained during weekdays as per the current schedule.
- Transit service will be maintained.
- Access to existing roads, driveways, bus stops, and cycling and pedestrian networks will be maintained.
- Nighttime lane closures may occur, as is currently permitted for road maintenance, but at least one lane of traffic in each direction will be maintained. Special restrictions will apply during holidays or special events.
- Temporary relocations and detours of existing highway ramps, roads, driveways, bus stops, and cycling and pedestrian networks will be permitted.
- Limited full closures of the highway will be permitted for unique circumstances such as bridge deck lifts directly over the Tunnel and approaches. Criteria for the timing and duration of full closures will be set when adjacent roads such as Highway 91 are able to accommodate additional traffic.

In concert with the establishment of lower construction speed zones, traffic management strategies, including safety requirements for travellers and workers, as well as incident management measures to assure effective responses to emergencies will be employed during the construction period. As a result of these measures, no variance in the number of incidents within the Project corridor, relative to baseline conditions, is anticipated and no residual effects pertaining to traffic safety during construction are expected. The following potential effects have been identified:

- Increased travel times along the Highway 99 corridor resulting from implementation of reduced speed limits through active construction zones
- Increased travel times and distance travelled resulting from detour arrangements or limited Highway closures for specialized construction activities. Additional travel time and travel distance will vary dependent on the location and duration of the specific works. For example, a temporary detour/diversion at an interchange would require minimal delay, while a closure of the Tunnel for overhead works would necessitate a longer detour via an alternate crossing such as AFB.
- Increased traffic volumes and potential minor interruptions as new construction-related traffic interacts with regular flows.
- Temporary changes to transit routes, schedules, and bus stop facilities, developed in conjunction with TransLink.
- Temporary changes to local cycling and pedestrian patterns during construction of interchanges and underpasses.

The contractor will be required to maintain counter-flow operations during peak times. For peak-period traffic, current throughput rates will be maintained so that impacts on travel times and congestion-related delays will be minimal. For off-peak traffic, the lowered speeds through active construction zones are expected to have a minor impact on travel times, in the range of a one to two minute increase over a construction speed zone of approximately 5km.

While it is anticipated that traffic impacts during construction will generally be confined to minor delays within the Project corridor resulting from reduced construction speed limits and periodic diversions around active works at interchanges and underpasses, infrequent full highway closures are expected for specialized work such as bridge deck lifts over the Tunnel and approaches. Such closures would be scheduled for overnight periods and/or weekends to minimize traffic impacts. In these circumstances, traffic will be detoured via alternate routes, and additional travel time will be incurred by some Tunnel traffic. Traffic between South Surrey and Vancouver will not experience significant additional travel time to detour to Highway 91/AFB. However, traffic between Delta and Richmond will typically experience (depending on trip origin and destination) an additional travel time of 6 to 12 minutes, and additional travel distance of 9 to 18 kilometers during overnight closures.

Operation

The following steps were followed in assessing potential Project-related changes in traffic during operations:

- Consider traffic volumes, patterns, mode share, VKTs, and VHTs for three scenarios – existing, future without the Project, and future with the Project.
- Use the estimated future values to predict the incremental changes with and without the Project within the LAA.

During Project operation, transit, cycling and pedestrian infrastructure improvements, roadway upgrades, new interchanges, and the new toll bridge will align with and support current regional planning initiatives as detailed in **Section 5.3.3.2 – Project Effects** (Consistency with Land Use Plans and Designations), and highlighted below:

- Relieve congestion and improve reliability; for example, the average commuter will save 25 to 35 minutes per day when the new bridge opens in 2022. These benefits have been estimated through an analysis of:
 - current traffic throughputs at the Tunnel, by time of day and day of week – as measured through traffic counters at the Tunnel;
 - current travel times and congestion-related delay patterns, including variability – as measured by the Ministry’s Automatic Traveller Information System;
 - historic population growth patterns in relevant communities – based on census data;
 - historic traffic patterns at the Tunnel and other Fraser River crossings – based on Ministry, TransLink and municipal counters and screenline surveys;
 - future population and employment forecasts – as issued by Metro Vancouver; and,
 - future traffic volume and patterns for the new bridge - based on combining the above-mentioned sources.
- Support improved regional goods movement; for example, improving travel times and reliability will help improve scheduling and operational efficiency, and the additional capacity will better accommodate slower and merging truck traffic.
- Improve safety for all road users with a forecast decrease in crash frequencies of 35 per cent, and facilitate quicker, more reliable first responder access.
- Support provincial and regional strategies to encourage mode shift to transit and carpooling by providing continuous, dedicated transit/HOV lanes in both directions along Highway 99 between Surrey and Vancouver. Traffic model analysis based on the application of TransLink’s RTM indicates that the transit mode share across the future bridge increases in the range of 5-10% in the 2045 planning horizon, as compared to without the Project.

- Provide new active transportation options including cycling and walking to further encourage a shift away from automobile travel and support reduced GHG emissions and improved regional health.
- Reduce congestion and support more fuel-efficient travel speeds to help lower per-trip fuel consumption and GHG emissions.
- Tolling will assist in managing congestion, moderate future growth in traffic, and support more favourable mode-share choices.

These regional and local traffic benefits also enable important social and community goals and objectives of local and regional land use plans including community health and livability. Benefits of the Project are further discussed in the Business Case (MOTI 2015a) for the Project

The Project was developed to help mitigate current and anticipated traffic challenges that are resulting in adverse effects on environmental, economic, social, and health values. In this context, effects of the Project during operation are expected to be positive, and post-construction no adverse effects are anticipated. **Section 5.1.7** outlines specific traffic-related measurements that will be carried out during operation to confirm that Project performance objectives have been achieved.

5.1.4 Mitigation Measures

Mitigation measures developed to avoid or reduce potential Project-related adverse effects on traffic during construction are described in this section. A hierarchical approach was used based on avoidance of potential effects first, followed by minimization or reduction of unavoidable effects to identify strategies for mitigating potential Project-related effects.

5.1.4.1 Avoidance

As noted in **Section 5.1.3.2**, traffic management activities will meet performance requirements and maintain current highway traffic flow conditions during designated periods and events.

5.1.4.2 Minimization

Measures to minimize potential Project-related effects on traffic during Project construction, as outlined below, were identified based on mitigation applied and shown to be effective during the delivery of other major transportation developments undertaken by the Ministry including the Sea to Sky Highway Improvement Project, the Port Mann/Highway 1 Project, and the South Fraser Perimeter Road Project.

Construction

The Project will be a major multi-year construction project, which will occur on one of the busiest stretches of highway in the Lower Mainland. Careful traffic management is required to mitigate the potential effects on current traffic operations during construction work, and avoid or minimize construction-related traffic congestion, disruptions, and delays.

A detailed Construction Traffic Management Plan (CTMP) will be developed to identify and address traffic management risks and approaches for managing traffic and communicating with stakeholders and the public during the construction period. An outline of the CTMP is presented in **Section 12.0 Management Plans**. This plan will be reviewed with key stakeholders, including affected municipalities, emergency responders, and property owners and users adjacent to the Project, prior to the start of construction and following development of the final Project design and construction plan.

Key elements of the CTMP include:

- Traffic management strategies, including access routes to ensure continued movement of traffic on the Highway 99 corridor and initiatives to minimize disruption and maximize predictability for Highway 99 travellers, cycling and pedestrian network users, and nearby residents and businesses
- Safety requirements to maintain a safe corridor at all times for travellers and workers
- Communications activities in support of implementation of the CTMP
- Incident management and response measures

The CTMP will be required to meet performance objectives set by the Ministry, including those that relate to maintenance of access to existing developments and maximum wait times or delays in traffic flow.

For all construction activities that affect traffic operations, the Contractor will be required to provide a detailed description on how performance requirements for traffic management during construction will be addressed and complied with. These requirements are under development and may include, but are not limited to requirements for:

- Permitted lane closure/reduction windows
- Local detours and lane shifts
- Traffic control devices, such as construction and advisory signs, project signs and changeable message signs
- Temporary roadside barrier requirements
- Drop offs (abrupt changes in roadway elevation)

- Temporary Pavement Markings
- Location and storage of materials and equipment
- Speed Limits and Safe Passage through construction sites
- Permissible stoppages

Incident management and incident response measures will be developed as part of the CTMP to facilitate appropriate incident response and move traffic safely and expeditiously through or around the incident. The CTMP will address passage of emergency vehicles, assistance to emergency response personnel, motor vehicle crashes, emergency road repairs, disabled vehicles and debris on the road as well as provide information on the Contractor's communication system with emergency providers.

The CTMP will follow the Ministry's Traffic Management Guidelines for Work on Roads (B.C. MOTI 2001), Traffic Control Manual (B.C. MOTI 1999), and Standard Traffic Signs and Pavement Markings Manual (Ministry 2000) for temporary lane markings¹.

Communications aspects of the CTMP are of critical importance as they represent the interface between traffic management and the travelling public. Communications considerations to be addressed in the CTMP include information regarding traffic control plans, road signs and sign locations, and detour logistics. In addition, the communications sections of the CTMP will identify:

- Measures to be used to inform stakeholders of traffic management activities during construction
- Protocols to be followed in the event of an emergency
- Key stakeholders with an interest in the development and implementation of the CTMP including Ministry Operations, the contractor, municipalities, schools, emergency responders, marine users, and special traffic generators

The public will be notified of potential impacts of construction activities on traffic via a number of methods such as:

- Notices placed in the print media, Internet web pages and/or provided to the radio and television media
- Project signs, including changeable message signs
- The Ministry's online traffic information and trip planning tool (Drive BC0

¹ The documents listed here are currently being reviewed and may be updated. The CTMP will follow the updated versions as applicable.

- Direct communications, such as by mail-outs, to affected businesses and homeowners
- Brochures and other printed notices
- Public information telephone line

The Plan will take into account resident commuter travel and travel times, and commuting requirements of shift workers, local businesses and events.

Operation

As noted in **Section 5.1.1**, the rationale for the Project and key Project objectives are to address existing and anticipated traffic challenges in the Highway 99 corridor. As shown in **Section 5.1.2.4**, the Project will improve performance of the Highway 99 corridor with respect to safety, travel time and reliability, and mode share.

With respect to mitigation for temporary traffic management that may occur during the operation phase, the Project will follow the Ministry's traffic management guidelines for work on roads (Ministry 2001), Traffic Control Manual (Ministry 1999, Interim 2015), and Standard Traffic Signs and Pavement Markings Manual (Ministry 2000) for temporary lane markings.

Consistent with the Ministry's approach to Intelligent Transportation Systems (ITS) as a means to integrate communication and information technology to better manage and operate B.C.'s transportation system, the Project will include the following components to support improved operational performance on the Highway:

- Additional traffic cameras, linked to the Ministry's Drive BC online traffic information and trip planning tool
- Traffic sensors, cameras, and software to assist in providing a coordinated response to traffic accidents
- Dynamic message signs linked to traveller information systems to report delays and advise of alternate routes.

5.1.5 Residual Effects

Implementing the mitigation measures described in Section 5.1.5 will minimize potential Project-related changes on traffic during construction, although temporary, minor residual effects will be incurred.

As noted in Section 5.1.1, the rationale for the Project and key Project objectives are to address existing and anticipated traffic challenges in the Highway 99 corridor. The integration of smart transportation technologies into the Project will provide measures to manage traffic challenges

along the Highway 99 corridor and the regional road network. Additionally, integrating tolling into the Project provides a mechanism for managing future traffic demand.

5.1.5.1 Characterization of Residual Effects

Based on the Ministry's experience in managing traffic during the construction of major highway projects, the effects on traffic and the management of traffic during highway construction are well-understood. Temporary effects related to construction activities include:

- Effect #1: Change in traffic volume
 - Minor interruptions as construction-related traffic interacts with regular flows.
- Effect #2: Change in mode share
 - Temporary changes to transit routes and bus stops.
- Effect #3: Change in travel time and reliability
 - Marginal increases in off-peak travel times resulting from reduced speed limits through active construction zones.
 - Increased travel times and distance travelled during infrequent full highway closures for specialized construction activities, approximating an additional 6 to 12 minutes and 9 to 18 km for travellers between Delta and Richmond, depending on trip origin and destination

The above construction-related residual effects on traffic are characterized with respect to the direction, magnitude, extent, duration, frequency, reversibility, and likelihood of each anticipated effect. Definitions for ratings applied to residual effects criteria, developed with specific reference to Traffic are presented in **Table 5.1-5**.

Table 5.1-5 Criteria Used to Characterize Residual Effects on Traffic

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|--|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project. |
| | | Positive | Beneficial effect as a result of the Project. |
| | | Neutral | Neutral effect as a result of the Project. |
| Magnitude | Intensity of the effect relative to natural or baseline conditions | Negligible | No measurable change from baseline conditions. |
| | | Low | A measurable change of less than 5 minutes additional travel time relative to baseline conditions. |
| | | Moderate | A measurable change of 5-20 minutes additional travel time relative to baseline conditions. |
| | | High | A measurable change of greater than 20 minutes additional travel time relative to baseline conditions. |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project alignment. |
| | | Local | Effect is restricted to the LAA and connecting Highways and cross streets in Richmond, Delta & Surrey |
| | | Regional | Effect occurs beyond the LAA and connecting Highways and cross streets. |
| Duration | Length of time over which the residual effect is expected to persist | Transient term | Effect persists for less than 24 hours. |
| | | Short term | Effect persists for 24 - 72 hours. |
| | | Moderate term | Effect persists throughout Project construction. |
| | | Long term | Effect is permanent. |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Frequency | Nature of the occurrence of the residual effect | Infrequent | Effect occurs intermittently during Project construction (e.g. full-closures for specialized activities) |
| | | Frequent | Effect occurs frequently during Project construction |
| | | Continuous | Effect occurs continuously during Project construction |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Baseline conditions will be restored or improved after disturbance has ceased. |
| | | Irreversible | Baseline conditions will not be restored after disturbance has ceased. |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance. |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 25%. |
| | | Moderate | Likelihood of residual effect is between 25% and 75%. |
| | | High | Likelihood of residual effect is greater than 75%. |

Residual Effect #1: Temporary change in traffic volume during construction

During construction, temporary effects to traffic may be incurred due to incremental construction-related vehicles accessing/egressing the Project area and interacting with regular traffic flows.

Highway upgrades, reconstruction of interchanges and new bridge construction will introduce additional vehicles and equipment to the corridor. Traffic impacts associated with this incremental volume is considered low in magnitude as all construction activities that affect traffic will be conducted in accordance with the CEMP which includes measures to minimize disruption and delays associated with changes in traffic.

Effects will be of a temporary duration, occurring only during the construction phase. Post-construction, there are no adverse effects to traffic as the additional general capacity as well as the dedicated transit/HoV lanes will accommodate traffic volumes associated with future population and employment growth. A summary of criteria ratings for traffic volume effects during construction is provided in **Table 5.1-6**.

Table 5.1-6 Criteria Ratings for Construction-related Change in Traffic Volume

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|--|
| Direction | Adverse | Minor increase in traffic volumes and potential minor interruptions are expected as new construction-related traffic interacts with regular flows. |
| Magnitude | Low | Change will be within the range of natural variability and travel time impacts will be low. |
| Extent | Local | Spatial extent is local - specific to the Project alignment, and connecting Highways and cross streets. |
| Duration | Moderate Term | Minor effects will occur throughout the construction period, |
| Frequency | Frequent | Frequent occurrence for minor effects related to introduction of construction-related traffic. |
| Reversibility | Reversible | Effects eliminated on completion of construction. |
| Likelihood | High | Temporary construction-related traffic effects unavoidable. Mitigation will minimize impacts to the extent possible. |

Residual Effect #2: Temporary influence of construction on mode share

Temporary changes to transit routes, schedules and bus stops during construction will affect transit users. Such changes will occur at different locations, at different times and for different durations depending on the specific construction activity being undertaken. In particular, it is anticipated that construction of interchanges will necessitate minor changes to transit schedules and travel times due to temporary alignment shifts, diversions and/or detours at these locations. All changes affecting transit will be developed in conjunction with TransLink.

During construction, effects associated with changes to transit schedules and transit/HoV routes are generally low in magnitude, comprising minor increases in travel times resulting from reduced construction speed limits in construction zones and periodic diversions around active work sites. A moderate magnitude is expected during infrequent full-closures for specialized activities necessitating a detour via Highway 91. Effects will be of temporary duration, occurring only during the construction phase and are not anticipated to affect transit ridership levels or mode share for high-occupancy vehicles during the construction period.

Project improvements support strategies to encourage mode shift to transit and carpooling through the provision of dedicated transit/HoV lanes between Bridgeport Road in Richmond and Highway 91 in Delta. Transit-only ramps at Bridgeport Road as well as integrated transit stops at Highway 17A and Steveston Highway will further improve the accessibility, efficiency, reliability and attractiveness of transit resulting in increased transit mode share on completion of the Project. Further, tolling will assist in moderating future growth in traffic and support more favourable mode-share choices. A summary of criteria ratings for mode share is provided in **Table 5.1-7**.

Table 5.1-7 Criteria Ratings for Construction-related Change in Mode Share

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|--|
| Direction | Adverse | Expected temporary changes to bus routes and schedules will affect transit users. |
| Magnitude | Low | During construction, transit users may temporarily incur some minor increase in travel time relative to baseline conditions. |
| Extent | Local | Effects will be limited to transit users in the Project area. |
| Duration | Moderate Term | Minor, temporary effects anticipated throughout construction period at different locations and at different times dependent on prevailing construction activities. |
| Frequency | Frequent | Effect is expected to occur frequently, at different times and different locations, throughout the construction period. |
| Reversibility | Reversible | Long-term improvements to transit and HoV accessibility, efficiency, reliability and resultant mode share as a result of the Project. |
| Likelihood | High | Refinements to transit routes/schedules anticipated in concert with key construction activities such as interchanges. |

Residual Effect #3: Temporary change in travel time and reliability during construction

During construction, current levels of service will be maintained on Highway 99 and connecting interchanges during the day and early evenings. The counter-flow system will be maintained during weekdays as per the existing schedule. Nighttime lane closures will be permitted, but at least one lane of traffic will be maintained in each direction and limited full-closures of the highway will be permitted for unique circumstances such as bridge deck lifts over the Tunnel and approaches. Reduced speed limits will also be in effect through active construction zones.

Travel time and reliability effects will be incurred during Project construction. As current levels of service will be maintained during peak periods and daytimes, the magnitude of travel time and reliability effects is considered to be low. A moderate magnitude is anticipated during infrequent full-closures requiring additional travel time via a detour to Highway 91.

Effects to travel time and reliability are moderate in duration, occurring throughout the construction phase. Impacts are minor in relation to effects related to reduced construction speed zones and periodic diversions around active works at interchanges and underpasses. Infrequent highway closures for specialized activities will cause additional travel time impacts during these short-duration events, in the range of 6-12 minutes for nighttime travelers between Delta and Richmond, depending on origin and destination.

A key objective of the Project is to address congestion and improve travel time and reliability. Post-construction, both travel times and reliability will be greatly improved and there are no residual effects during operations. A summary of criteria ratings for travel time and reliability effects during construction is provided in **Table 5.1-8**.

Table 5.1-8 Criteria Ratings for Construction-related Change in Travel Time and Reliability

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|------------------------|---|
| Direction | Adverse | Temporary, minor increases in travel times are expected due to reduced speed limits through active construction zones and detours or closures for specialized activities. |
| Magnitude | Low to Moderate | Low magnitude of effect for temporary diversions/detours on Project corridor and low-moderate magnitude for infrequent full-closures necessitating detour via Highway 91. |
| Extent | Local | Effect temporary and limited to LAA and connecting Highways and cross streets. |
| Duration | Short to Moderate Term | Effect is short term during infrequent highway closures and moderate term for temporary effects related to travel through construction speed zones. |
| Frequency | Frequent | Effect is expected to occur frequently, at different times and different locations, throughout the construction period. |
| Reversibility | Reversible | Long-term travel time and reliability improvements are expected as a result of the Project. |
| Likelihood | High | Temporary, construction-related effects unavoidable. Mitigation will minimize effects to the extent possible. |

5.1.6 Cumulative Effects

The combination of Project-related changes, and changes from other certain and reasonably foreseeable projects and activities, as listed in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**, comprise the total cumulative changes in traffic. This includes TransLink's proposed Pattullo Bridge replacement, with a planned construction period between 2019 and 2023, which overlaps temporally with the Project. As the planned Pattullo replacement is a new structure, upstream of the existing bridge, traffic will be maintained on the current alignment throughout the construction period. Accordingly, there are no residual effects anticipated from the Pattullo replacement that could interact with residual construction-related effects of the Project on traffic.

No other past, present or reasonably foreseeable projects or activities with traffic-related residual effects that could overlap spatially or temporally with those of the Project and result in cumulative effects have been identified.

5.1.7 Follow-up Strategy

During construction, the TCMP will include traffic monitoring to ensure prescribed levels of service for travellers are maintained. Quality Control and auditing processes will be implemented to measure performance, ensure compliance, and identify any areas for improvement.

During operation, traffic monitoring for the Project will follow the same processes as other major highways in the Lower Mainland. In addition, specific monitoring of travel times, traffic incidents, transit, cycling and pedestrian usage, and goods movement surveys will be carried out to verify the Project performance objectives related to traffic.

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APPENDIX A

Overview of Potential Project Interactions with Traffic

Table 1 Overview of Potential Project Interactions with Traffic

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with Traffic | Nature of Potential Interaction |
|--|---------------------|--|---|
| Pre-Construction / Site Preparation | | | |
| Pre-Construction / Site Preparation | No Interaction | <ul style="list-style-type: none"> • Surveying • Acquiring property for the Project | N/A |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Clearing and grubbing within the existing Highway 99 ROW • Restoration of Green Slough to its original location • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction | <p>Nature of interaction: Works and activities adjacent to Highway 99 that could interact with highway operation.</p> <p>Rationale: May require temporary changes in highway operation including detours of existing traffic.</p> |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with Traffic | Nature of Potential Interaction |
|--|---------------------|--|--|
| Construction | | | |
| New bridge including approaches and ramp connections | No Interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: Works and activities adjacent to or above Highway 99 that could interact with highway traffic.</p> <p>Rationale: May require temporary changes in highway operation including detours of existing traffic.</p> |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with Traffic | Nature of Potential Interaction |
|---|---------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No Interaction | N/A | N/A |
| | No Effect | N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: Works and activities adjacent to Highway 99 that could interact with highway traffic.</p> <p>Rationale: May require temporary changes in highway operation, including temporary detours.</p> |
| Tunnel decommissioning | No Interaction | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches | N/A |
| | No Effect | • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | <p>Nature of interaction: Transport of recycled materials and equipment to support decommissioning</p> <p>Rationale: Will add temporary construction traffic to road network</p> |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with Traffic | Nature of Potential Interaction |
|---------------------------------------|---------------------|---|---|
| Decommissioning of Deas Slough Bridge | No Interaction | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | N/A |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • N/A | |
| Operation and Maintenance | | | |
| Highway 99 and Interchanges | No Interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | <p>Nature of interaction: Improvements in traffic flow; potential infrequent, minor lane closures during maintenance</p> <p>Rationale: May require temporary changes in traffic to support periodic maintenance activities.</p> |
| New bridge | No Interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No Effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential Effect | <ul style="list-style-type: none"> • Operating the new bridge • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: Improvements in traffic flow; potential infrequent, minor lane closures during maintenance</p> <p>Rationale: May require temporary changes in traffic to support periodic maintenance activities.</p> |

APPENDIX B

Traffic Data Overview

George Massey Tunnel Replacement Project

Traffic Data Overview

DRAFT

November 2015



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LIST OF DEFINITIONS

| | |
|-----------------|--|
| AADT | Annual Average Daily Traffic |
| AAWDT | Annual Average Weekday Traffic |
| AFB | Alex Fraser Bridge |
| EB | Eastbound |
| FHWA | Federal Highway Administration (US Department of Transportation) |
| GMT | George Massey Tunnel |
| GP | General Purpose |
| GSAM | Gateway Sub-Area Model |
| HOV | High Occupancy Vehicle |
| ICBC | Insurance Corporation of British Columbia |
| Ministry | British Columbia Ministry of Transportation and Infrastructure |
| MOTI | British Columbia Ministry of Transportation and Infrastructure |
| NB | Northbound |
| Non-Transit Bus | Includes HandyDART vehicles, school/tour/charter buses, hotel shuttles, etc. |
| OD | Origin Destination |
| Other Vehicle | Emergency Vehicles, Tow Trucks, Construction Vehicles, Recreational Vehicles |
| PMB | Port Mann Bridge |
| Project | George Massey Tunnel Replacement Project |
| RTM | Regional Transportation Model (TransLink) |
| SB | Southbound |
| SFPR | South Fraser Perimeter Road (Highway 17) |
| SOV | Single Occupancy Vehicle |
| Transit Bus | Includes all TransLink transit service on Highway 99 – buses, community shuttles, and ExpressBuses |
| Tunnel | George Massey Tunnel |
| T-W-TH | Counts performed on Tuesday, Wednesday and Thursday (Weekday Counts) |
| WB | Westbound |

1. INTRODUCTION

The purpose of this report is to provide an overview of the traffic information collected and the assessment undertaken to support the development of the George Massey Tunnel Replacement Project. It also serves as a technical reference document through the inclusion of appendices with facts, figures, and records of source documentation.

2. HISTORICAL TRAFFIC

2.1. PROBLEM IDENTIFICATION

Both the Tunnel and the parallel Alex Fraser Bridge (AFB) serve traffic demand between Surrey/Delta and Vancouver/Richmond. Combined traffic growth at these two crossings has averaged 0.64 per cent per year between 2003 and 2013. The AFB has absorbed almost all of this growth, because of the lack of available capacity at the Tunnel (see Figure 1 below).

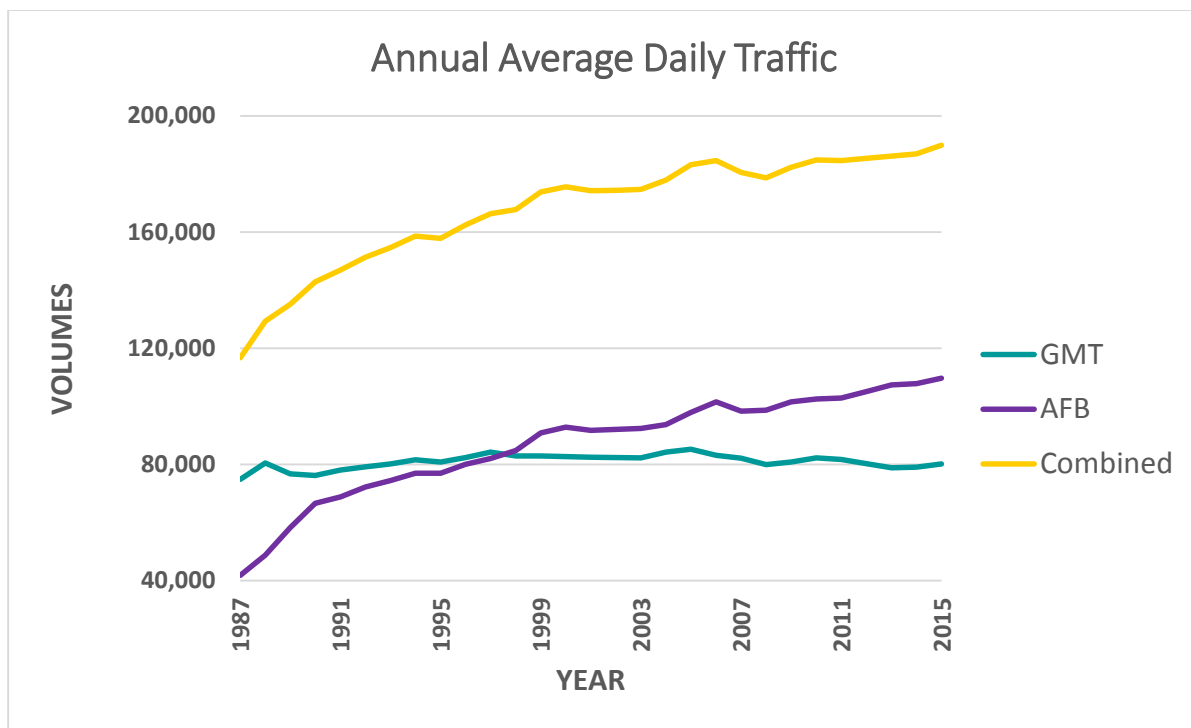


Figure 1: Annual Average Daily Traffic (AADT) – GMT vs AFB – 1987 to 2015

Source: Ministry of Transportation Traffic Data program – Note: 2015 data includes January to June

The four-lane Tunnel operates with a counter-flow system during the rush hour period, with only one lane open in the non-peak direction. Traffic volumes in the non-peak direction have grown steadily over the past 15 years. Traffic volumes outside of the rush hour period have also grown to the point where the Tunnel is close to capacity throughout the day as shown in Figure 2 below.



Figure 2: Average Hourly Two-Way Traffic Profile – George Massey Tunnel

Source (Figure 2 and Figure 3): TransLink's 2011 and 1999 Metro Vancouver Regional Screenline Survey

By comparison, traffic growth at AFB has occurred at almost all times of the day, as shown in Figure 3. AFB traffic has grown annually at 1.51 per cent (2003-2013).



Figure 3: Average Hourly Two-Way Traffic Profile – Alex Fraser Bridge

2.2. HISTORICAL TRAFFIC DATA SOURCES

The following is a list of historical traffic data sources that the Project Team used to supplement the rigorous traffic data collection program undertaken as part of Project planning:

- Permanent Count Stations (MoTI, municipal, etc.)
- TransLink Metro Vancouver Regional Screenline Surveys
- Spring 2012 Traffic Counts (Bunt and Associates)
- Cascade Gateway Data Warehouse USA / CDN Border Crossing Data (2006-2015)
- Traffic Data provided by municipalities
- Signal Data (MoTI)

Refer to APPENDIX A: HISTORICAL TRAFFIC DATA for details.

3. CURRENT TRAFFIC

3.1. DATA COLLECTION SOURCES

A traffic data collection program was implemented in 2013 to study traffic patterns at the Tunnel, along the Highway 99 corridor, and other parts of the region including Highway 91 and major routes connecting the two crossings. An expanded program was conducted in 2014 to confirm 2013 measurements and also assess the effects of the newly opened South Fraser Perimeter Road (SFPR). The following is a complete list of current traffic data collection methods:

- Permanent Count Stations
- Short Count Stations
- Tube Count Surveys
- Manual Count Surveys
- Vehicle Classification Surveys
- Vehicle Occupancy Surveys
- Origin-Destination (OD) Surveys
- Travel Time Surveys
- Queue Length Surveys
- Aerial Photograph Surveys
- Safety Assessment Surveys
- ICBC Collision Data
- MoTI Collision Information System (CIS) Data
- Traffic Signal Data Collection
- Bike Shuttle Data
- Transit Passenger Surveys

The following is a list of reports created from the data collection program:

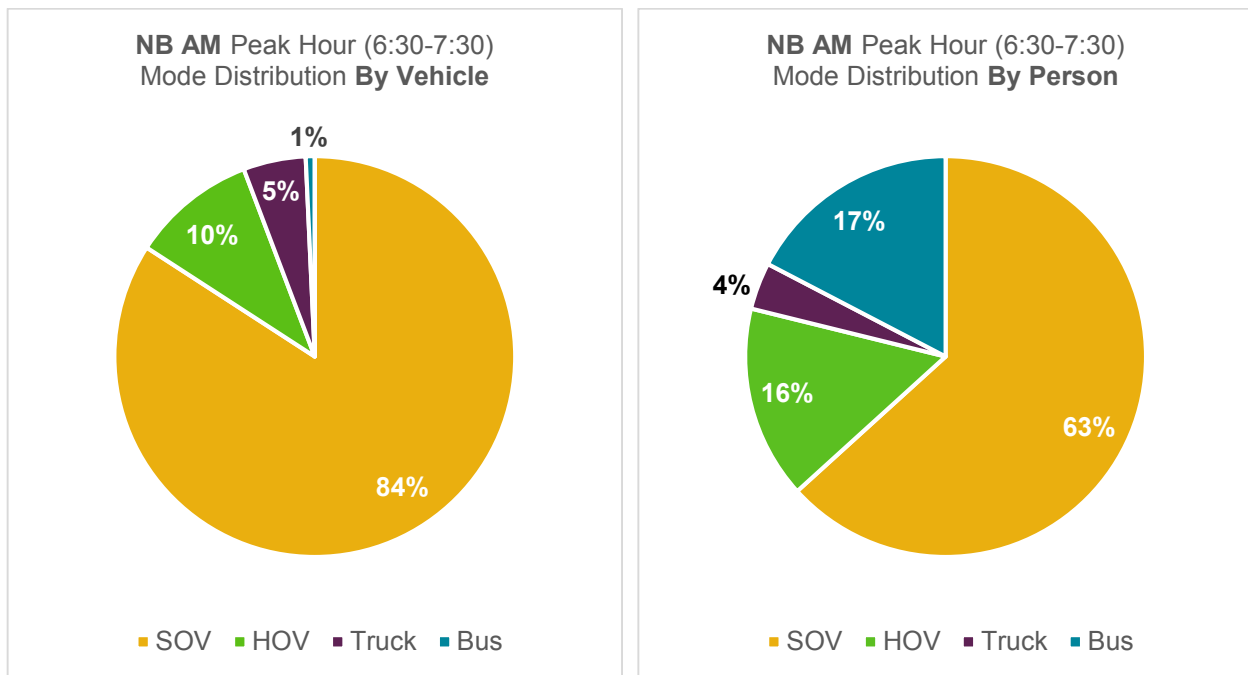
- GMTRP – Traffic Data Collection Report – Fall 2013
- GMTRP – Traffic Data Collection Report – Spring 2014
- GMTRP – Traffic Data Collection Report – Summer 2014
- GMTRP – Traffic Data Collection Report – Fall 2014
- GMTRP – Analysis of OD Survey Data – Fall 2013
- GMTRP – Analysis of OD Survey Data – Fall 2014
- GMTRP – Collision Data Analysis – 2014

The Project Team continues to collect and analyze traffic data to confirm trends identified and to validate model results.

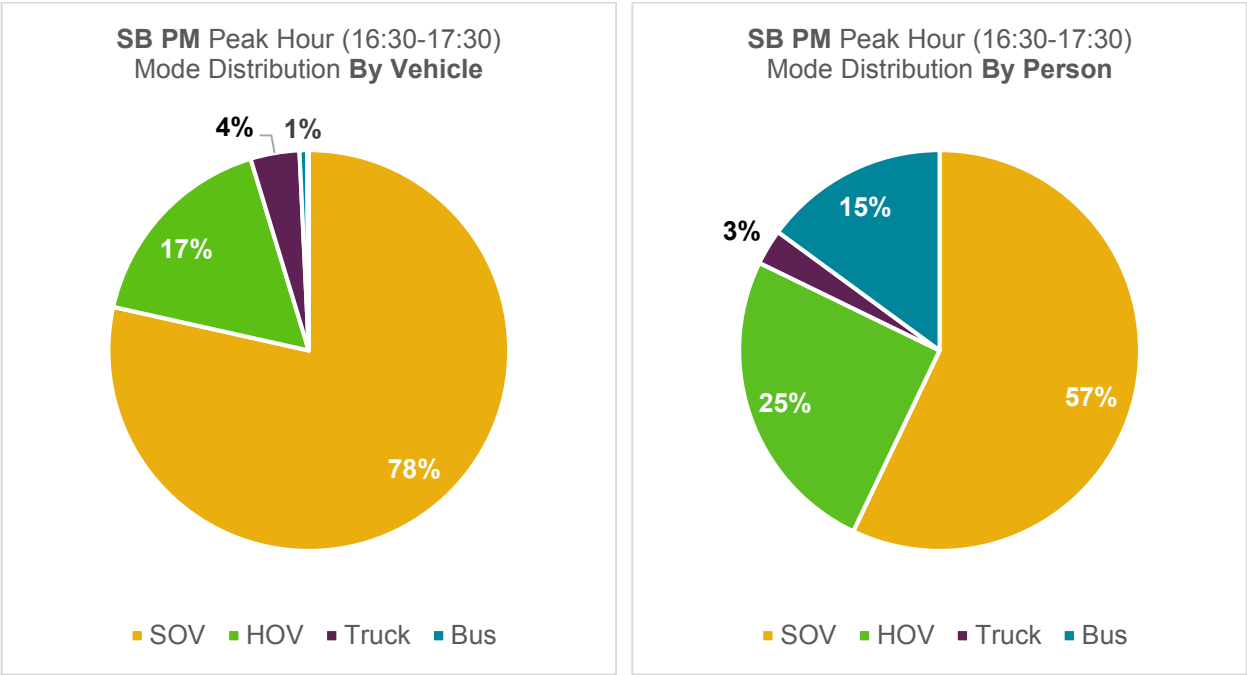
Refer to APPENDIX B: CURRENT TRAFFIC DATA for details.

3.2. GENERAL TRAFFIC

With vehicle demand at the Tunnel exceeding capacity, it is important to examine mode distribution. Figures 4 to 7 below illustrate mode distribution by vehicle type and user type. In the morning peak hour, 16% of Highway 99 travellers use HOV and 17% use buses. In the afternoon peak hour, 25% of Highway 99 travellers use HOV and 15% use buses.



Figures 4 and 5: General traffic mode percentages for vehicles and passengers (AM peak hour).



Figures 6 and 7: General traffic mode percentages for vehicles and passengers (PM peak hour).

Figures 1 to 3 illustrate that (1) the Tunnel has exceeded capacity, (2) there is no longer a viable alternative route for Tunnel users since AFB is now also congested at peak periods. Figures 4 to 7 illustrate that (3) Tunnel users already make effective use of efficient transportation modes (HOV and transit).

Refer to APPENDIX C: GENERAL TRAFFIC FACTS for details.

3.3. TRUCK TRAFFIC

Highway 99 and 91 are key components of the regional truck transportation network that supports local, provincial, and international trade. During the work week, 7000 trucks per day use the Tunnel, while 9000 trucks per day use the AFB.

Table 8 in Appendix D provides a regional context, by summarizing truck traffic volumes (counted from 7:00 to 17:30) at major South of Fraser crossings. Combined truck traffic on these crossings has increased 9.7 per cent over the past six years (2008 to 2014).

Table 9 provides further detail regarding GMT and AFB truck traffic. Table 10 provides further detail on the types and volumes of truck traffic at the Tunnel.

It is important to note that more than 50 per cent of truck traffic crosses the Fraser River at GMT and AFB during the midday. This is due in part to heavy congestion at these crossings during peak periods. Since the midday period at these crossings is becoming increasingly congested, additional capacity across the Fraser River, particularly the South Arm, to better connect East Richmond port and industrial lands, will support planned growth in local, provincial, and international trade. This additional capacity will also provide more efficient and reliable travel times beyond the midday period.

Refer to APPENDIX D: TRUCK TRAFFIC FACTS for details.

3.4. TRANSIT

During the morning rush hour approximately 60 per cent of trips to downtown Vancouver by residents of South Delta and South Surrey are made by transit (2011 TransLink Trip Diary).

The Tunnel has the highest number of buses crossing the Fraser daily. Nine northbound TransLink bus routes use the Tunnel during the morning rush period. This equates to a bus every two to three minutes (see Table 15 in Appendix E). While northbound morning rush period buses comprise only one per cent of traffic, they carry approximately 17 per cent of all Tunnel travellers.

On an average weekday, 559 buses carry 10,535 passengers through the Tunnel (see Table 10 in Appendix E). Table 13 in Appendix E contains a detailed breakdown of vehicle and passenger mode share through the Tunnel; the table splits the data by direction and period. Of note, more than 40 per cent of travellers through the Tunnel use HOV and transit; clearly indicating the importance of these options for many Highway 99 corridor users. Since these options have available capacity, it is clear that they are not a viable option for some travellers.

Refer to APPENDIX E: TRANSIT FACTS for details.

3.5. CYCLING & PEDESTRIAN TRAFFIC

Currently, cyclists and pedestrians are not permitted to use the Tunnel for safety reasons. In the absence of a viable alternate route, the Ministry operates a year-round free shuttle service through the Tunnel. In 2014 the shuttle transported an average of 910 people per month. Demand is higher in the summer, but averages 30 people per day over the year. The shuttle service does not operate on weekends during the winter months. The new bridge will include a multi-use pathway for cyclists and pedestrians, eliminating the need for the shuttle service.

Refer to APPENDIX F: CYCLING & PEDESTRIAN FACTS for details.

3.6. TOURISM

An important additional consideration is that Highway 99 carries a significant share of British Columbia's tourism traffic to destinations such as BC Ferries' Tsawwassen Terminal, the Vancouver International Airport, Whistler, the Canada–U.S. border, and Port Metro Vancouver's cruise ship terminals. For northbound afternoon traffic, delays are highest in July and August, reflecting the increase in tourism activity during these months. For example, in August 2014 the typical northbound weekday delays were 30 minutes, significantly higher than at other times of the year (refer to Figure 14 below).

3.7. ORIGIN – DESTINATION (OD)

After the Tunnel opened in 1959 it rapidly became a key commuter route to Vancouver for South of the Fraser residents. Commuter traffic to Vancouver accounts for only 40 per cent of the total traffic through the Tunnel, while almost 60 per cent of daily trips are between Richmond and communities south of the Fraser. Figures 8 and 9 illustrate daily origin – destination pairs for vehicles travelling through the Tunnel

on a typical weekday.

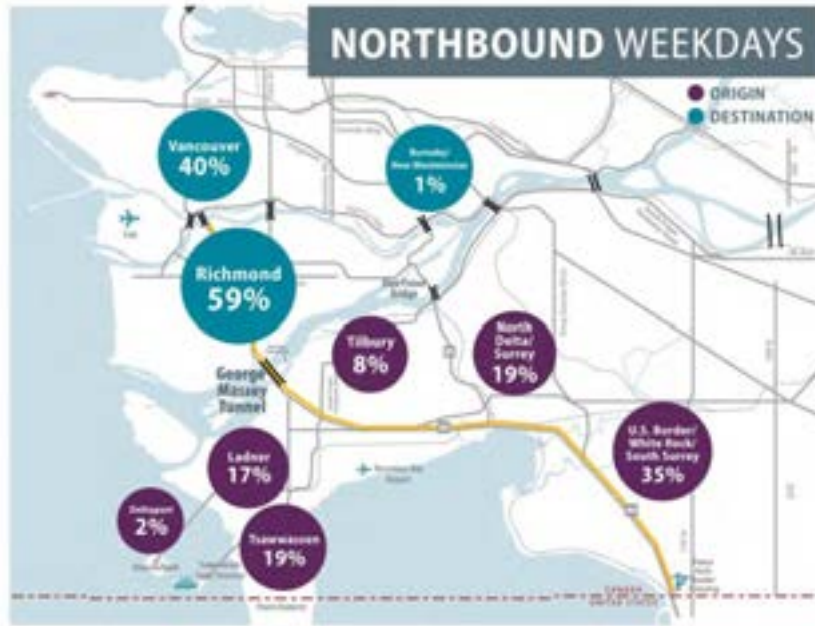


Figure 8: Origins and destinations for northbound traffic on a typical weekday in 2014

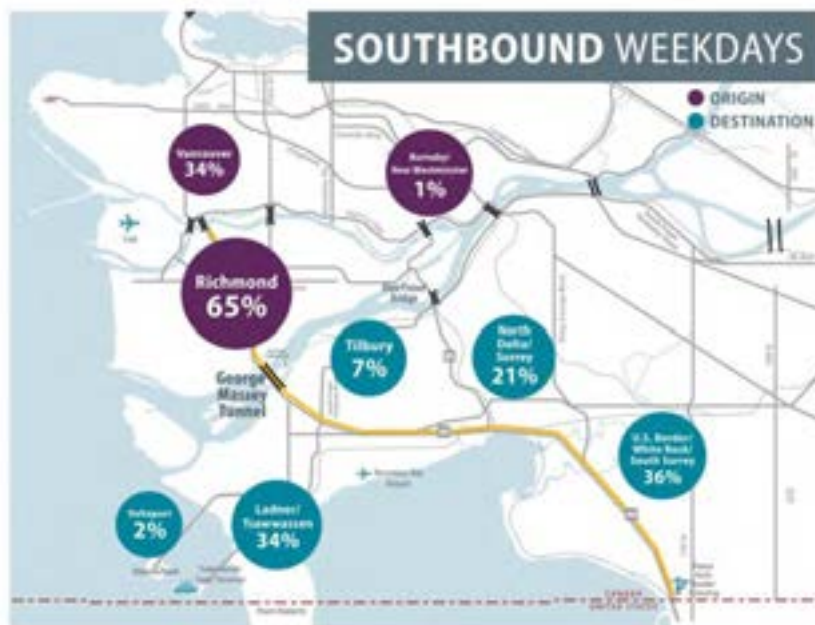


Figure 9: Origins and destinations for southbound traffic on a typical weekday in 2014

Source (Figure 8 and Figure 9): Fall 2014 – Analysis of OD Survey Data Report

Refer to APPENDIX G: ORIGIN – DESTINATION FACTS for details.

3.8. CONGESTION ANALYSIS

Tunnel congestion currently accounts for more than one million hours of vehicle delay annually.

Figure 10 displays an hourly profile based on the 2014 northbound annual average weekday traffic (AAWDT) volumes. The varying congestion zones for the Tunnel reflect the counter-flow operations. The graph shows:

- Despite the three lanes available during the morning peak, there is congestion from just after 6:00 a.m. until 10:30 a.m.
- Conditions are again congested by 3:00 p.m. until after 6:00 p.m. when the counter-flow system reduces the northbound traffic to one lane.
- AFB experiences more severe congestion during the morning peak period.

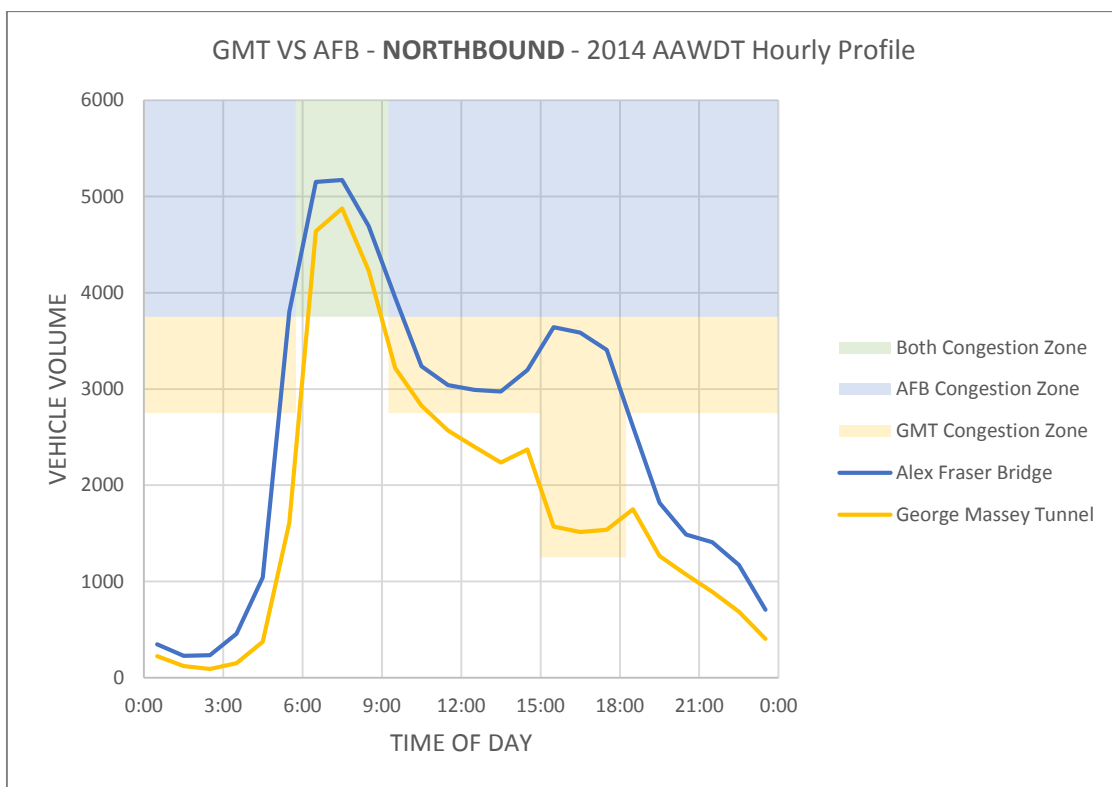


Figure 10: GMT vs AFB – Northbound – 2014 AAWDT Hourly Profile

Figure 11 displays the hourly profile based on the 2014 southbound annual average weekday traffic (AAWDT) volumes. The graph shows:

- Southbound traffic is reduced to one lane during the morning peak period, which results in heavy congestion from just after 6:00 a.m. to just after 9:00 a.m.
- Congestion resumes by 1:30 p.m. and continues until after 6:30 p.m.
- AFB experiences more severe congestion during the afternoon peak period.

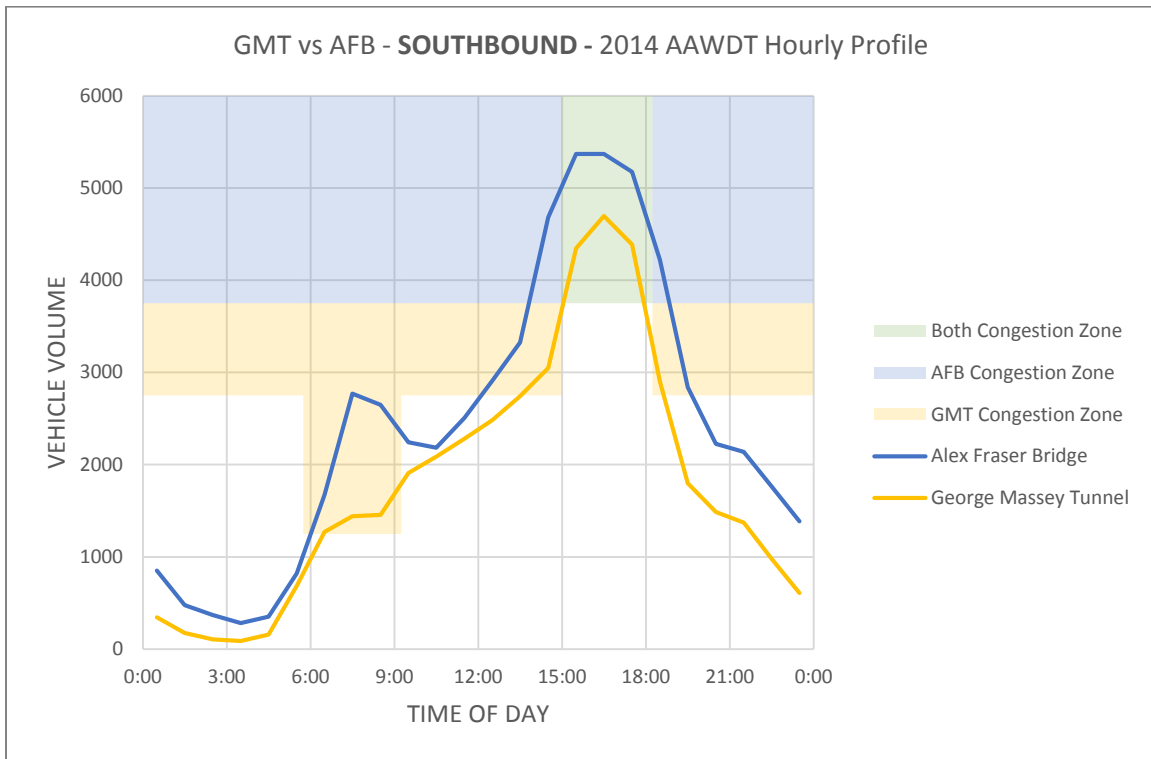


Figure 11: GMT vs AFB – Southbound – 2014 AAWDT Hourly Profile

3.9. TRAVEL TIME DELAY AND RELIABILITY

Northbound Congestion Patterns

As illustrated in Figure 12, congestion delays (additional travel time when compared to free flow travel time) are significant throughout the day, peaking during the morning and afternoon rush periods. The magnitude of the delay varies widely from day to day.

The average northbound morning delay time in October is typically five to ten minutes, but can be as high as 23 minutes during the three-lane morning rush period, and up to 15 minutes during the later-morning two-lane operation. In the afternoon, delays for the one lane of northbound traffic are far greater, averaging about 20 minutes and ranging up to 50 minutes.

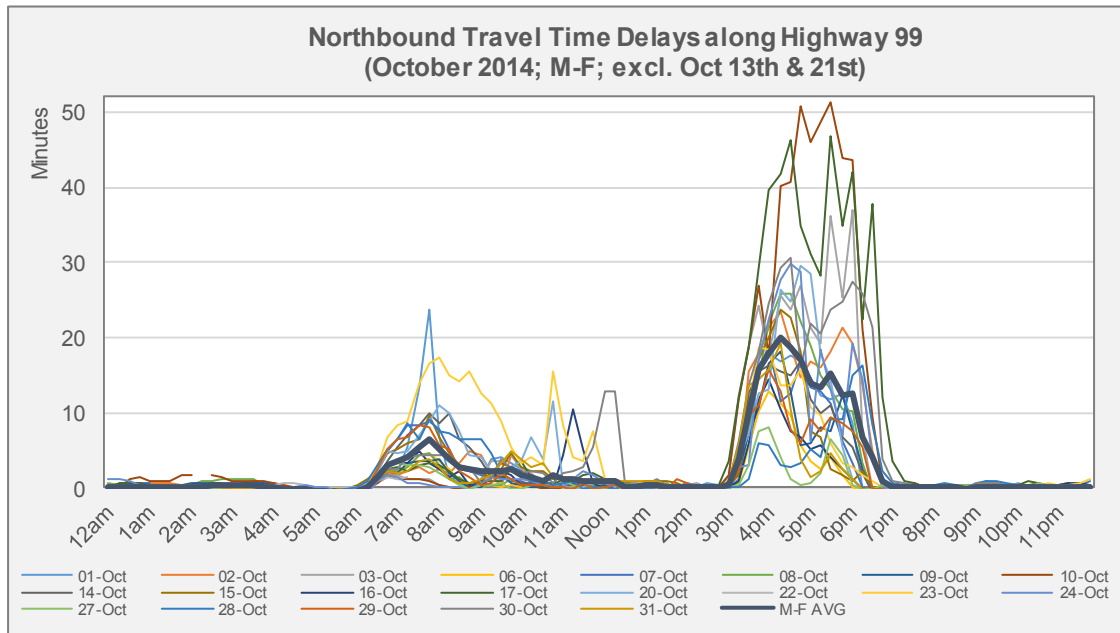


Figure 12: Northbound hourly weekday travel time delays along Highway 99

Note: October 13 (Thanksgiving) and October 21 (major incident/delay) are not included.

Note: The analysis is based on average trip times, as recorded by the Ministry's ATIS. The corridor segment analyzed is between Mud Bay (near the Highway 91 interchange) in the south and Westminster Highway in the north.

Southbound Congestion Patterns

As illustrated in Figure 13, southbound traffic delay patterns are also significant in both the morning and afternoon peak periods.

For October weekday mornings, the one lane of southbound Tunnel/Highway 99 traffic experiences an average delay of about seven minutes, ranging up to about 20 minutes.

During the early afternoon two-lane operation, delay times average six minutes and range up to 15 minutes. These delays are partly relieved by the addition of a third lane during the afternoon rush hour, but five-minute delays persist for several hours, with potential delays ranging up to 15 minutes.

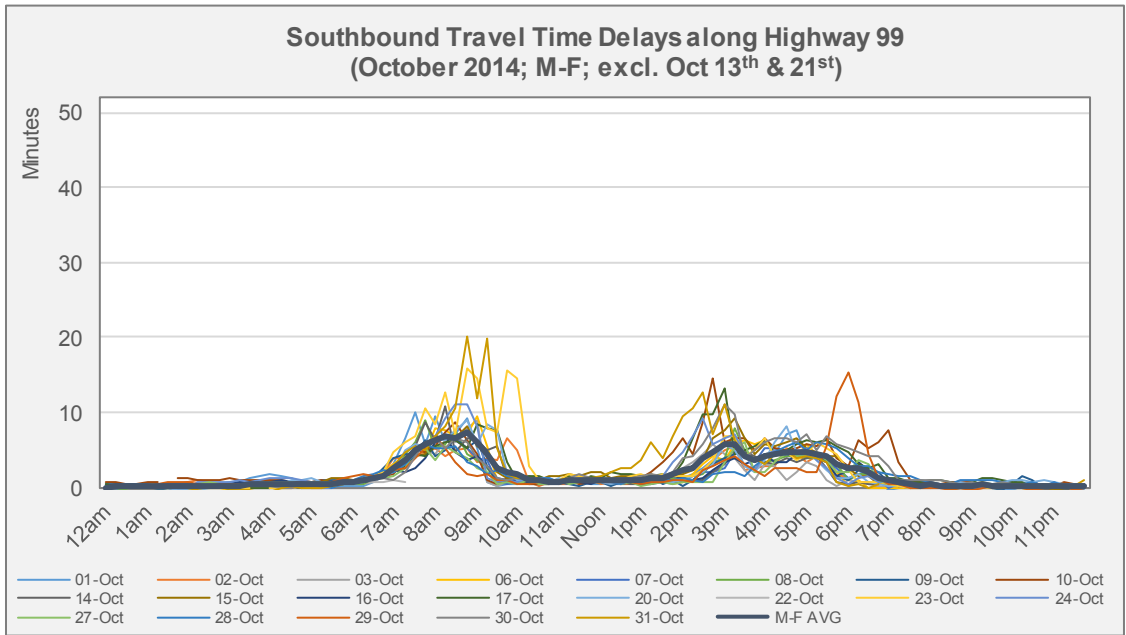


Figure 13: Southbound hourly weekday travel time delays along Highway 99

Seasonal Variations in Congestion Patterns

Congestion delays for the Tunnel / Highway 99 traffic are highest for afternoon counter-flow (northbound) traffic, especially during the summer. As illustrated in Figure 14, the average peak delay time for northbound weekday traffic in August is 30 minutes. These delays reflect the high levels of tourist, visitor, and vacation demand for the one available lane of traffic.

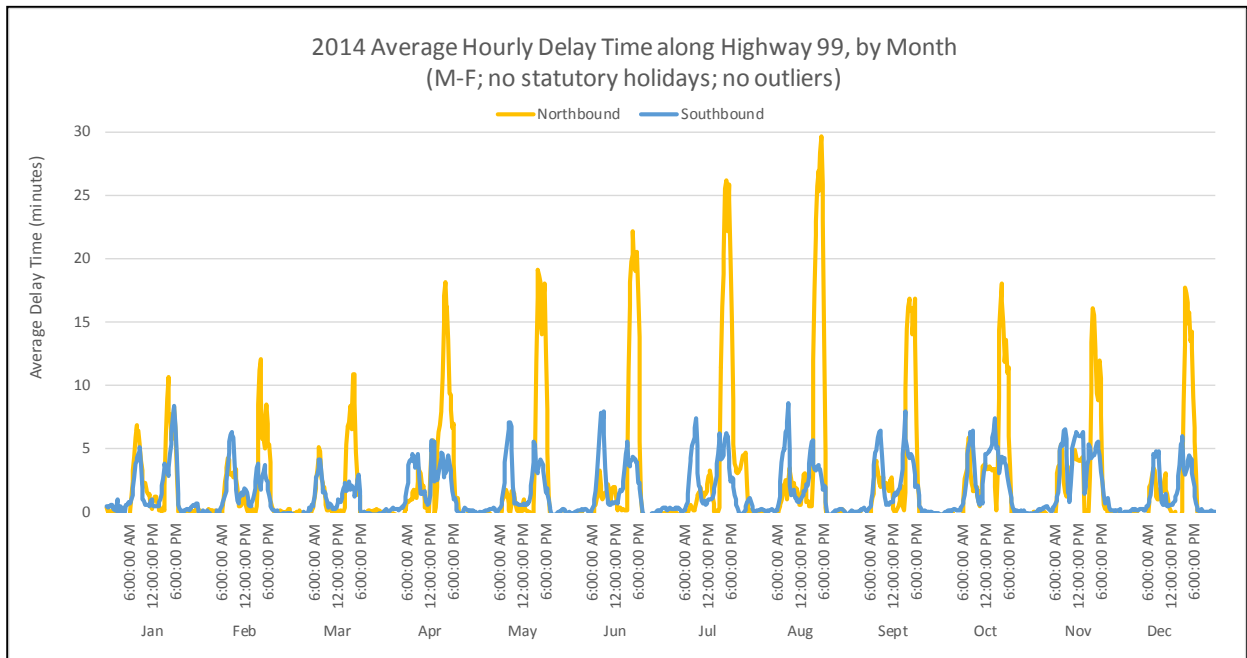


Figure 14: Seasonal variation in weekday traffic delays

Travel Time Reliability

As illustrated in Figures 12 to 14, travel time reliability is a significant issue for Tunnel users. Unreliable travel time imposes costs in many different ways:

- Earlier departures to reduce the risk of arriving late, or having the uncertainty of possibly arriving late.
- Rescheduling trips to off-peak periods.
- Traffic diverting to more circuitous routes (for example, northbound afternoon traffic diverting to the AFB / Highway 91 corridor).
- Choosing alternate destinations to avoid using the Tunnel.
- Cancelling or postponing trips that would otherwise be taken.

During the Phase 1 and 2 stakeholder and community consultation process, many Tunnel users indicated that the unpredictability of travel time delays represents as large a cost to them as the delay times themselves.

The new bridge will provide significant benefits in terms of travel time savings and improved reliability. Upon bridge opening, peak period round-trip commuters will save as much as 25 to 35 minutes daily in travel time, along with much greater reliability.

4. TRAFFIC FORECASTING

Understanding future traffic demand is essential to designing an efficient transportation network that will serve all user groups for decades. Traffic forecasting begins with the collection of current traffic data and then applying growth factors for known traffic demand generators such as population and employment growth, travel costs, and regional land use and developments planned to take place during the planning horizon. The traffic model is iteratively calibrated and validated.

Two traffic models have been used for the Project.

Gateway Sub Area Model

The first model used was the Gateway Sub Area Model (GSAM). The GSAM was used for Gateway Program projects between 2003 and 2009. The horizon year of the model is 2031; the model predicts traffic volumes in 2031.

For the purposes of the GMT Project, the GSAM model required refinement, including updates to the road and transit network, truck traffic generators, major future developments, and U.S. border traffic. These updates were made in 2012 and 2013.

Regional Transportation Model

The second model used was the Regional Transportation Model (RTM). The RTM is the most current model developed by TransLink, and has a horizon year of 2045. The RTM uses a sophisticated architecture that allows for much more detailed parameters.

The Project Team tailored the RTM for use with the GMT Project by updating the output values to match the morning and afternoon peak hours at the Tunnel. The truck traffic generators and the highway network also required updating.

Model Comparison

There are many differences between the models. The RTM uses a more advanced modelling architecture that allows for a sophisticated set of assumptions. However, to be effective, traffic models require rigorous iterative calibration and validation. The GSAM model has the advantage of years of additional testing. The different models also provide forecast values for different horizon years, 2031 and 2045.

Both models were used, to assure development of the most complete and comprehensive forecasts.

Critical Assessment

Even the most effective model does not attempt to perfectly predict the future. Rather, it will provide an estimation while identifying the potential for variations, as well as any limitations of the model. Further, the models are designed to forecast at a corridor and regional level, and thus present less reliable volumes at a granular level, such as a turning movement at an interchange. These reasons were kept in mind, when developing forecast volumes. The Project Team developed the GMT forecast volumes as follows:

Step 1: Gather measured and forecast volumes for each traffic movement.

Volumes gathered included 2013 measured volumes, 2014 measured volumes, 2031 GSAM forecast volumes, 2045 RTM forecast volumes, and 2031 & 2045 volumes estimated using 2013/14 measured volumes as a baseline and applying a one percent annual growth rate, based on historical trends.

Step 2: Apply engineering judgment to evaluate and modify Step 1 volumes.

This included: [1] examining the change in traffic volumes between years, both measured (2013 and 2014) and forecast (GSAM 2031 and RTM 2045), [2] checking the forecast volumes against the estimated volumes for the same year, [3] for each of the measured and forecast years, reviewing the volumes for the specific movement and comparing with volumes at surrounding interchanges, highways, intersections, and roadways (reconciling as necessary), and [4] iteratively balancing volumes along the entire Highway 99 corridor.

Modelling results, based on forecast population and employment growth, and considering planned regional road and transit improvements, predict that by 2045 traffic through the existing Tunnel will grow to approximately 100,000 vehicles per day and that traffic over a new 10-lane bridge will be approximately 115,000 vehicles per day. Future traffic volumes are influenced by a number of factors including infrastructure development across the region over the next 30 years.

5. LANING REQUIREMENTS

The laning assessment for the new GMT replacement bridge considered current traffic data, forecast volumes, and experience gained at AFB and PMB. It was determined that a 10-lane bridge (eight lanes for general traffic and two for transit/HOV) would best meet Project requirements for 2045.

Figure 17 in Appendix H illustrates current conditions at GMT and AFB. The current throughput traffic per lane in the morning rush hour is 1600 to 1800 vehicles at GMT, and 1600 to 1900 at AFB. Both crossings are congested during the morning rush hour today.

Figure 18 compares conditions between an eight-lane and a 10-lane bridge in 2022 (opening day). With an eight-lane bridge, conditions remain congested with a demand for 1730 vehicles per general-purpose lane. With a 10-lane bridge, drivers experience free-flow conditions with 1425 vehicles per general-purpose lane.

Figure 19 compares conditions between an eight-lane and a 10-lane bridge in 2045 (design year). With an eight-lane bridge conditions become heavily congested with a demand for 2030 vehicles per general-purpose lane. With a 10-lane bridge, drivers experience significantly reduced congestion, with 1700 vehicles per general-purpose lane.

Further, the additional lane on each side of the 10-lane bridge (as compared to an eight-lane bridge), provides larger vehicles, like container trucks, more time to climb the vertical grade and to safely merge with traffic.

Refer to APPENDIX H: LANING REQUIREMENTS for details.

APPENDIX A: HISTORICAL TRAFFIC DATA

Permanent Count Stations:

- Traffic volumes are collected in 15 minute intervals, 24 hours a day, 365 days a year.
- Many of the permanent count stations were installed in 2004.
- Some collect length bin data for partial vehicle classification.
- SFPR permanent count stations also collect FHWA13 classification data.

TransLink Metro Vancouver Regional Screenline Surveys:

- Data collected at 123 stations along 32 regional screenlines.
- Vehicle volume, classification, and occupancy were collected.
- The project used Screenline Surveys dating back to 1999.

Spring 2012 Traffic Counts:

- Intersection movement counts at 60 Street and 62B Street.
- Interchange movement counts at Highway 17A and Highway 99.
- Traffic volumes through the Tunnel.

Cascade Gateway Data Warehouse USA / CDN Border Crossing Data (2006-2015):

- Volumes
- Delay Times
- Service Rates
- Vehicles in Queue
- Queue Lengths

City of Richmond Traffic Data:

- Traffic volumes automatically counted at all Richmond traffic signals.
- Richmond traffic signals use 1,650 induction loop detectors.
- Traffic is monitored in five minute increments, 24 hours per day, 365 days per year.
- Data is available since 2003.

City of Surrey Traffic Data:

- Hourly volume data dating back to 2010 at 16 permanent traffic volume count stations along arterial roads.
- Daily roadway traffic volumes on a typical weekday through arterial roads based on intersection induction loops.
- Data is collected from 120 traffic cameras.

Ministry of Transportation and Infrastructure:

- Traffic signal data.

Note: The Project Team continues to collect and analyze data from the sources discussed.

APPENDIX B: CURRENT TRAFFIC DATA

DATA SOURCES

Permanent Count Stations: Automated counter recording traffic volumes and vehicle characteristics 24 hours a day, 7 days a week. Typical characteristics collected are length, number of axles, classification and speed.

Short Count Stations: Similar to permanent count stations but implemented for a short time on a temporary basis (48 hours minimum period).

Tube Count Surveys: Air filled tubes laid across the road to capture axle counts and sometimes other vehicle characteristics. Tubes are typically deployed on a temporary basis.

Manual Count Surveys: Vehicle movements and volumes are recorded in the field or with a video camera. Once analysed manual counts can provide accurate data for turning movements at intersections.

Vehicle Classification Surveys: Survey performed to determine the composition of traffic based on vehicle characteristics (e.g. Truck vs. Motorcycle). Up to 13 different vehicle classes can be determined. Can be automated or manual data collection.

Vehicle Occupancy Surveys: Vehicle classification survey performed while recording passenger volumes. This method produces data to determine proportion of trips carried by each mode of travel (e.g. Number of HOV passengers and Bus passengers).

Origin-Destination (OD) Surveys: Survey providing detailed picture of trip patterns and route selection made by vehicles. In this case the survey was conducted using Bluetooth signal analysis. Temporary Bluetooth sensors were deployed along the highway 99 and 91 corridor to gather origin, route and destinations of individual Bluetooth devices.

Travel Time Surveys: Permanent Bluetooth readers are positioned along the highway to gather signatures and determine travel time between locations. Collected by the Ministry ATIS (Advanced Traveller Information System), this travel time information can then be shown on dynamic message boards.

Queue Length Surveys: Field surveys conducted to record how many vehicles are queued at a particular location during set time intervals.

Aerial Photograph Surveys: Photographs taken from an airplane or helicopter that are later analysed to determine queue lengths at key locations.

Safety Assessment Surveys: Collection and review of average collision rates on segments of the study corridor and alternative routes.

ICBC Collision Data: Crash data gathered from reports made to ICBC by insured registered vehicle owners, drivers, pedestrians, and cyclists.

MoTI Collision Information System (CIS) Data: BC MoTI traffic collision data for provincial jurisdiction highways only. The CIS database of collisions is based on motor vehicle accident reports that are generated by police-attended collisions. As such, the database underreports the actual number of collisions because not all collisions are police-attended.

Traffic Signal Data Collection: Vehicle movements and volume data collected by traffic signal controllers at various intersections. Data collected cannot provide classification or turning volumes for lanes with shared movements.

Bike Shuttle Data: Records maintained by Mainroad Lower Mainland Contracting of the number of passengers using the free bicycle shuttle service at the Tunnel.

Transit Passenger Surveys: Field surveys conducted to confirm the bus ridership statistics collected by the vehicle occupancy surveys. Surveyors observed boarding and alighting passengers at established transit facilities.

KEY REPORTS

GMTRP – Traffic Data Collection Report – Fall 2013: A summary of data collected in August and October 2013 for the Project.

GMTRP – Traffic Data Collection Report – Spring 2014: A summary of data collected in April 2014. This report builds on, and complements the data collected in the *Fall 2013 – Traffic Data Collection Report*.

GMTRP – Traffic Data Collection Report – Summer 2014: A summary of data collected in August 2014. This report builds on, and complements the data collected in previous reports.

GMTRP – Traffic Data Collection Report – Fall 2014: A summary of data collected in October 2014. This report builds on, and complements the data collected in previous reports.

GMTRP – Analysis of OD Survey Data – Fall 2013: A summary of the findings of the October and November 2013 origin – destination survey.

GMTRP – Analysis of OD Survey Data – Fall 2014: A summary of the findings of the October and November 2014 origin – destination survey. This report builds on and complements the *Fall 2013 – Analysis of OD Survey Data Report*.

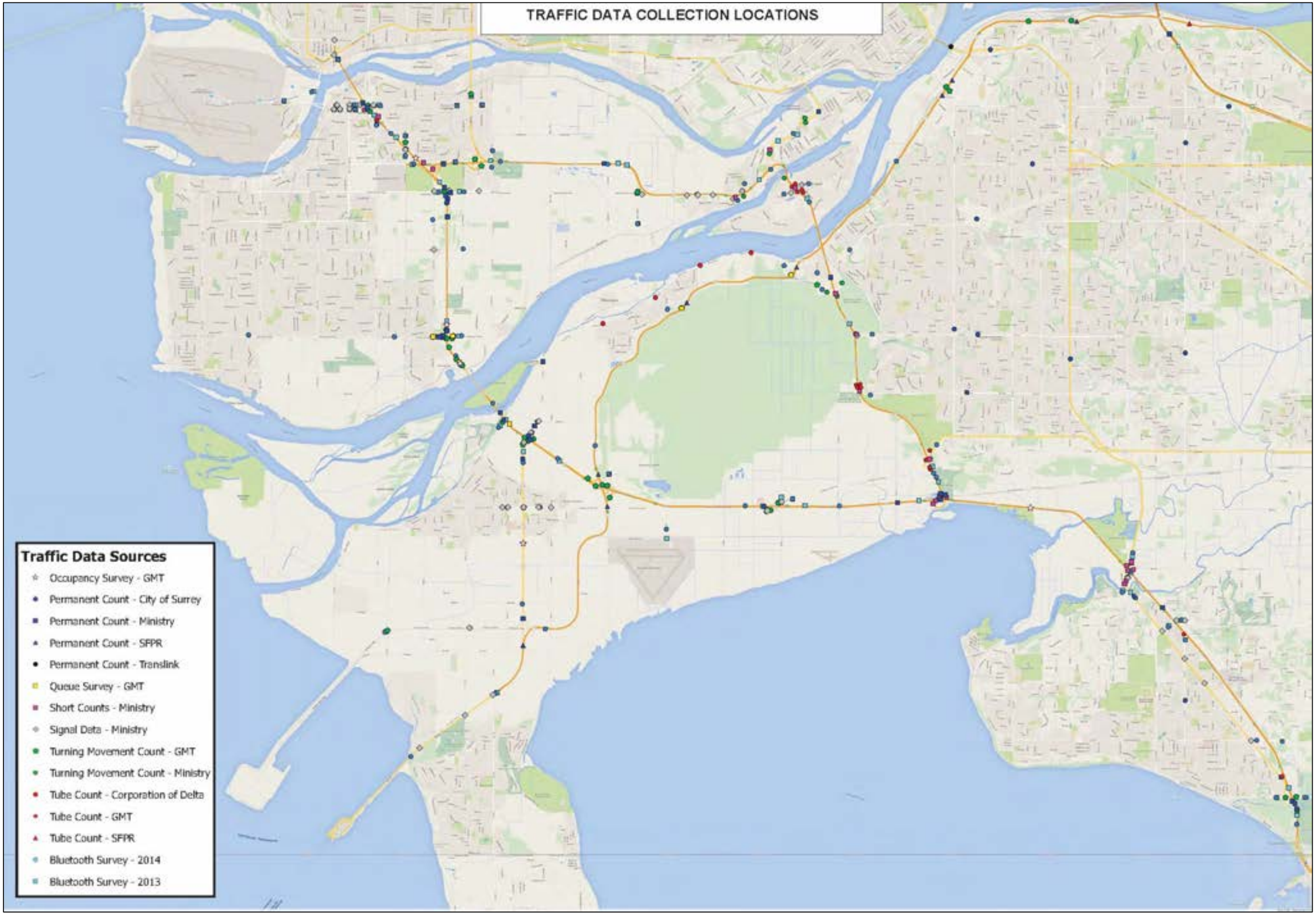
GMTRP – Collision Data Analysis – 2014: Collision data is collected and analyzed to determine average collision rates, trends, and patterns.

TRAFFIC DATA COLLECTION LOCATIONS

See attached map.

TRAFFIC DATA COLLECTION LOCATIONS

- Traffic Data Sources**
- ☆ Occupancy Survey - GMT
 - Permanent Count - City of Surrey
 - Permanent Count - Ministry
 - ▲ Permanent Count - SFPR
 - Permanent Count - Translink
 - Queue Survey - GMT
 - Short Counts - Ministry
 - ◇ Signal Data - Ministry
 - Turning Movement Count - GMT
 - Turning Movement Count - Ministry
 - Tube Count - Corporation of Delta
 - Tube Count - GMT
 - ▲ Tube Count - SFPR
 - Bluetooth Survey - 2014
 - Bluetooth Survey - 2013



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APPENDIX C: GENERAL TRAFFIC FACTS

REGIONAL CONTEXT

Table 1: Annual Average Daily Traffic

| Crossing | 2003 AADT | 2014 AADT | % Annual Growth |
|----------------------|-----------|-----------|-----------------|
| George Massey Tunnel | 82,297 | 79,105 | -0.36% |
| Alex Fraser Bridge | 92,373 | 107,785 | 1.41% |
| Combined | 174,670 | 186,890 | 0.62% |

Note: Data taken from Ministry of Transportation Traffic Data Program: Annual Volume Reports (2003-2014)

GEORGE MASSEY TUNNEL

Table 2: Traffic Mode Split by Vehicle Type – Daily (2014)

| | SOV | HOV | Light Truck | Heavy Truck | Motor cycles | Taxi & Limo | Transit Bus | Other Bus | Other Vehicle |
|---------|-------|-------|-------------|-------------|--------------|-------------|-------------|-----------|---------------|
| NB | 74.8% | 16.0% | 3.4% | 4.3% | 0.1% | 0.5% | 0.6% | 0.2% | 0.1% |
| SB | 72.1% | 17.2% | 3.5% | 5.5% | 0.1% | 0.4% | 0.7% | 0.2% | 0.2% |
| Roadway | 73.5% | 16.6% | 3.4% | 4.9% | 0.1% | 0.5% | 0.7% | 0.2% | 0.1% |

Table 3: Traffic Mode Split by Vehicle Type – Peak Period (2014)

| | SOV | HOV | Light Truck | Heavy Truck | Motor cycles | Taxi & Limo | Transit Bus | Other Bus | Other Vehicle |
|---------------------------------|-------|-------|-------------|-------------|--------------|-------------|-------------|-----------|---------------|
| NB AM Peak Period (6:00-9:00) | 83.5% | 10.4% | 2.6% | 2.2% | 0.1% | 0.4% | 0.6% | 0.1% | 0.0% |
| NB PM Peak Period (15:00-18:00) | 63.3% | 28.0% | 2.0% | 4.0% | 0.1% | 0.9% | 1.1% | 0.4% | 0.2% |
| SB AM Peak Period (6:00-9:00) | 70.8% | 14.2% | 3.4% | 8.2% | 0.3% | 0.5% | 2.0% | 0.7% | 0.1% |
| SB PM Peak Period (15:00-18:00) | 77.4% | 16.7% | 2.1% | 2.6% | 0.1% | 0.3% | 0.5% | 0.1% | 0.1% |

Note: Data from the October 23, 2014 Vehicle Occupancy performed by TransTech as part of the GMT Data Collection Program Fall 2014.

Table 4: Traffic Mode Split by Vehicle Type – Peak Hour (2014)

| | SOV | HOV | Light Truck | Heavy Truck | Motor cycles | Taxi & Limo | Transit Bus | Other Bus | Other Vehicle |
|-------------------------------|-------|-------|-------------|-------------|--------------|-------------|-------------|-----------|---------------|
| NB AM Peak Hour (6:30-7:30) | 84.0% | 9.7% | 2.5% | 2.5% | 0.2% | 0.4% | 0.6% | 0.1% | 0.0% |
| NB PM Peak Hour (16:30-17:30) | 64.4% | 28.8% | 1.7% | 2.2% | 0.2% | 0.8% | 1.3% | 0.6% | 0.1% |
| SB AM Peak Hour (6:30-7:30) | 74.9% | 10.6% | 2.8% | 8.8% | 0.3% | 0.2% | 2.0% | 0.3% | 0.0% |
| SB PM Peak Hour (16:30-17:30) | 78.4% | 16.5% | 1.7% | 2.3% | 0.1% | 0.3% | 0.5% | 0.1% | 0.1% |

Note: Data from the October 23, 2014 Vehicle Occupancy performed by TransTech as part of the GMT Data Collection Program Fall 2014.

Table 5: Northbound Peak Hour (6:30-7:30) Traffic Composition

| | October 2013 | | October 2014 | |
|--------------------------|--------------|--------------|--------------|--------------|
| | Volume | % of Traffic | Volume | % of Traffic |
| Passenger Vehicle | 4,732 | 93.4% | 4,752 | 93.6% |
| Cars | 4,712 | 93.0% | 4,749 | 93.5% |
| Motorcycles | 20 | 0.4% | 3 | 0.1% |
| Buses | 40 | 0.8% | 31 | 0.6% |
| Trucks | 295 | 5.8% | 294 | 5.8% |
| Light Trucks | 162 | 3.2% | 157 | 3.1% |
| Heavy Trucks | 133 | 2.6% | 114 | 2.2% |
| Container Trucks | N/A | N/A | 23 | 0.5% |
| Total | 5,067 | 100% | 5,077 | 100% |

Note: Data taken from 2013 and 2014 Manual Counts performed at the George Massey Tunnel. Values are the results of a Tuesday count performed in October of each given year.

Table 6: Southbound Peak Hour (16:30-17:30) Traffic Composition

| | October 2013 | | October 2014 | |
|--------------------------|--------------|--------------|--------------|--------------|
| | Volume | % of Traffic | Volume | % of Traffic |
| Passenger Vehicle | 4,601 | 96.2% | 4,627 | 96.5% |
| Cars | 4,581 | 95.8% | 4,622 | 96.4% |
| Motorcycles | 20 | 0.4% | 5 | 0.1% |
| Buses | 31 | 0.7% | 27 | 0.5% |
| Trucks | 149 | 3.1% | 143 | 3.0% |
| Light Trucks | 78 | 1.6% | 77 | 1.6% |
| Heavy Trucks | 71 | 1.5% | 39 | 0.8% |
| Container Trucks | N/A | N/A | 27 | 0.6% |
| Total | 4,781 | 100% | 4,797 | 100% |

Note: Data taken from 2013 and 2014 Manual Counts performed at the George Massey Tunnel. Values are the results of a Tuesday count performed in October of each given year.

APPENDIX D: TRUCK TRAFFIC FACTS

REGIONAL CONTEXT

Table 7: Total Truck Volumes at Major River Crossings – Daily (7:00 to 17:30)

| Crossing | 2008 Truck Volume | 2014 Truck Volume | Growth |
|------------------------------|-------------------|-------------------|-------------|
| George Massey Tunnel | 5,270 | 5,740 | 9.0% |
| Alex Fraser Bridge | 6,500 | 6,850 | 5.4% |
| Pattullo Bridge | 3,340 | 3,840 | 15.1% |
| Port Mann/Golden Ears Bridge | 6,980 | 7,760 | 11.2% |
| Pitt River Bridge | 3,090 | 3,420 | 10.6% |
| All Crossings | 25,170 | 27,600 | 9.7% |

Note: Data taken from the 2008 and 2014 Metro Vancouver Truck Classification and Dangerous Goods Surveys.

CORRIDOR CONDITIONS – HIGHWAY 99 & HIGHWAY 91

Table 8: Truck (Light & Heavy) Volumes at GMT & AFB – AM Peak, Midday, PM Peak

| | George Massey Tunnel | | | | Alex Fraser Bridge | | | |
|-------------------------------------|----------------------|--------------|--------------|--------------|--------------------|--------------|--------------|--------------|
| | 2008 | | 2011 | | 2008 | | 2011 | |
| | Vol. | % | Vol. | % | Vol. | % | Vol. | % |
| Morning Peak (06:00-09:00) | 999 | 5.4% | 1,207 | 6.9% | 1,561 | 6.9% | 1,508 | 7.0% |
| Light Truck | 307 | 1.7% | 260 | 1.5% | 617 | 2.7% | 519 | 2.4% |
| Heavy Truck | 692 | 3.7% | 947 | 5.4% | 944 | 4.2% | 989 | 4.6% |
| Midday (09:00-15:00) | 3,501 | 12.3% | 4,151 | 14.5% | 3,922 | 11.5% | 3,978 | 11.3% |
| Light Truck | 1,046 | 3.7% | 911 | 3.2% | 1,791 | 5.2% | 1,564 | 4.4% |
| Heavy Truck | 2,455 | 8.7% | 3,240 | 11.3% | 2,131 | 6.3% | 2,414 | 6.8% |
| Afternoon Peak (15:00-19:00) | 930 | 4.0% | 950 | 4.1% | 1,583 | 4.9% | 2,013 | 5.8% |
| Light Truck | 286 | 1.2% | 316 | 1.4% | 695 | 2.1% | 798 | 2.3% |
| Heavy Truck | 644 | 2.8% | 634 | 2.7% | 888 | 2.8% | 1,215 | 3.5% |

Note: Data from 2008 and 2011 TransLink Screenline Surveys.

Note: The % column shows truck traffic volume as a percentage of total traffic volume.

GEORGE MASSEY TUNNEL

Table 9: Truck (Light, Heavy, & Container) Volumes at GMT – AM Peak, Midday, PM Peak

| | October 2013 | | | | | | October 2014 | | | | | |
|-----------------------|--------------|------------|------------|------------|-------------|------------|--------------|------------|------------|------------|-------------|------------|
| | SB | | NB | | Total | | SB | | NB | | Total | |
| | # | % | # | % | # | % | # | % | # | % | # | % |
| AM Period | 555 | 14% | 829 | 6% | 1384 | 8% | 435 | 11% | 791 | 5% | 1226 | 7% |
| Light Truck | 165 | 4% | 405 | 3% | 570 | 3% | 171 | 4% | 418 | 3% | 589 | 3% |
| Heavy Truck | 390 | 10% | 424 | 3% | 814 | 5% | 204 | 5% | 294 | 2% | 498 | 3% |
| Container Truck | - | - | - | - | - | - | 60 | 2% | 79 | 1% | 139 | 1% |
| Mid-Day Period | 1083 | 17% | 986 | 14% | 2069 | 15% | 1006 | 16% | 859 | 12% | 1865 | 14% |
| Light Truck | 435 | 7% | 417 | 6% | 852 | 6% | 441 | 7% | 372 | 5% | 813 | 6% |
| Heavy Truck | 648 | 10% | 569 | 8% | 1217 | 9% | 435 | 7% | 365 | 5% | 800 | 6% |
| Container Truck | - | - | - | - | - | - | 130 | 2% | 122 | 2% | 252 | 2% |
| PM Period | 943 | 6% | 569 | 8% | 1512 | 6% | 897 | 5% | 413 | 6% | 1310 | 6% |
| Light Truck | 427 | 3% | 195 | 3% | 622 | 3% | 405 | 2% | 163 | 2% | 568 | 2% |
| Heavy Truck | 516 | 3% | 374 | 5% | 890 | 4% | 316 | 2% | 131 | 2% | 447 | 2% |
| Container Truck | - | - | - | - | - | - | 176 | 1% | 119 | 2% | 295 | 2% |

Note: Data taken from *October 2013 and October 2014 Manual Count Surveys*. Container trucks were not distinguished in the October 2013 counts. AM period 6:00 – 9:00, MD period 10:00 – 13:00, PM period 14:00 – 18:00.

APPENDIX E: TRANSIT FACTS

REGIONAL CONTEXT

Table 10: South Arm Bridges – Average Weekday Bus Volumes and Ridership

| Crossing | Number of Bus routes | Bus Volume | Passenger Volume |
|----------------------|----------------------|----------------------|------------------|
| George Massey Tunnel | 9 | 559 | 10,535 |
| Alex Fraser Bridge | 3 | 250 | 3,853 |
| Pattullo Bridge | 1 | 11* | 350* |
| Port Mann Bridge | 1 | 137* | 2,500* |
| Golden Ears Bridge | 1 | 75 | 735 |
| SkyBridge | N/A | 230 trains per day** | 51,000** |

Note: Data taken from the 2011 TransLink Screenline Survey, except as noted:
 * Data taken from TransLink 2014 Bus Service Performance Review (no PMB or PB buses in 2011).
 ** Based on 2015 Transit Schedule.

Table 11: Peak Hour Transit Ridership

| Crossing | Peak Hour Volume |
|----------------------|------------------|
| SkyBridge | 6,500 |
| Canada Line | 5,000 |
| George Massey Tunnel | 1,350 |
| Alex Fraser Bridge | 425 |
| Port Mann Bridge | 240* |

Note: Data taken from 2011 Metro Vancouver Screenline Report.
 * Based on 6 buses/hour and average peak passenger load of 40 (2014 TransLink Bus Service Performance Review).

GEORGE MASSEY TUNNEL

Table 12: GMT Vehicle and Passenger Mode Share (Direction and Period Split)

| | | SOV | 2 Pax HOV | 3+ Pax HOV | LT | HT | MC | TL | Bus | OB | Other | Total |
|-------|------|--------|-----------|------------|-----|-----|----|-----|-------|-----|-------|--------|
| NB AM | Veh | 10,408 | 1,257 | 43 | 324 | 277 | 16 | 44 | 78 | 13 | 1 | 12,461 |
| NB AM | Pass | 10,408 | 2,514 | 140 | 324 | 277 | 16 | 88 | 2,512 | 91 | 4 | 16,374 |
| NB MD | Veh | 5,977 | 1,456 | 72 | 458 | 645 | 1 | 57 | 32 | 22 | 17 | 8,737 |
| NB MD | Pass | 5,977 | 2,912 | 234 | 458 | 645 | 1 | 114 | 765 | 155 | 19 | 11,280 |
| NB PM | Veh | 2,947 | 1,221 | 82 | 94 | 185 | 5 | 40 | 53 | 20 | 7 | 4,654 |
| NB PM | Pass | 2,947 | 2,442 | 267 | 94 | 185 | 5 | 80 | 970 | 140 | 10 | 7,139 |

| | | SOV | 2 Pax HOV | 3+ Pax HOV | LT | HT | MC | TL | Bus | OB | Other | Total |
|-------------|---------------|--------|-----------|------------|-------|-------|------|------|-------|------|-------|--------|
| NB | Veh | 19,332 | 3,934 | 197 | 876 | 1,107 | 22 | 141 | 163 | 55 | 25 | 25,852 |
| NB | Pass | 19,332 | 7,868 | 640 | 876 | 1,107 | 22 | 282 | 4,247 | 386 | 33 | 34,793 |
| SB AM | Veh | 2,643 | 491 | 38 | 126 | 306 | 10 | 18 | 73 | 25 | 5 | 3,735 |
| SB AM | Pass | 2,643 | 982 | 124 | 126 | 306 | 10 | 36 | 432 | 177 | 6 | 4,841 |
| SB MD | Veh | 4,126 | 1,269 | 78 | 441 | 697 | 2 | 45 | 30 | 20 | 17 | 6,725 |
| SB MD | Pass | 4,126 | 2,538 | 254 | 441 | 697 | 2 | 90 | 405 | 141 | 22 | 8,715 |
| SB PM | Veh | 11,281 | 2,286 | 145 | 307 | 381 | 16 | 46 | 72 | 16 | 18 | 14,568 |
| SB PM | Pass | 11,281 | 4,572 | 471 | 307 | 381 | 16 | 92 | 2,488 | 113 | 20 | 19,741 |
| SB | Veh | 18,050 | 4,046 | 261 | 874 | 1,384 | 28 | 109 | 175 | 61 | 40 | 25,028 |
| SB | Pass | 18,050 | 8,092 | 848 | 874 | 1,384 | 28 | 218 | 3,325 | 431 | 47 | 33,297 |
| Road | Veh | 37,382 | 7,980 | 458 | 1,750 | 2,491 | 50 | 250 | 338 | 116 | 65 | 50,880 |
| Road | Pass | 37,382 | 15,960 | 1,489 | 1,750 | 2,491 | 50 | 500 | 7,572 | 817 | 80 | 68,090 |
| Road | Veh % | 73.5% | 15.7% | 0.9% | 3.4% | 4.9% | 0.1% | 0.5% | 0.7% | 0.2% | 0.1% | 100.0% |
| Road | Pass % | 54.9% | 23.4% | 2.2% | 2.6% | 3.7% | 0.1% | 0.7% | 11.1% | 1.2% | 0.1% | 100.0% |

Source: Fall 2014 Occupancy Survey.

Note: LT: Light Truck, HT: Heavy Truck, MC: Motorcycle, TL: Taxi & Limo, OB: Non-transit Bus.

AM: 6:00 – 9:00, MD: 10:00 – 13:00, PM: 15:00 – 18:00

Table 13: GMT Vehicle and Passenger Mode Share – Bi-directional AM Peak Period (6:00-9:00 a.m.)

| | SOV | 2OV | 3OV+ | LT | HT | MC | TL | Bus | OB | Other | Total |
|-------------|-------|-------|------|------|------|------|------|-------|------|-------|--------|
| Veh | 80.6% | 10.8% | 0.5% | 2.8% | 3.6% | 0.2% | 0.4% | 0.9% | 0.2% | 0.0% | 100.0% |
| Pass | 61.5% | 16.5% | 1.2% | 2.1% | 2.7% | 0.1% | 0.6% | 13.9% | 1.3% | 0.0% | 100.0% |

Source: Fall 2014 Occupancy Survey.

Table 14: GMT Northbound Transit User Origin

| Origin | Percent Use |
|--------------|-------------|
| South Surrey | 65% |
| South Delta | 35% |

Note: Data from the 2013 Bus Passenger Survey.

Table 15: GMT Bus Frequency

| Bus Route # | 311 | 351 | 352 | 354 | 601 | 602 | 603 | 604 | 620 | All |
|------------------------------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Bus Frequency Per Hour (6:00-9:00) | 2 | 6 | 3 | 4 | 5 | 2 | 2 | 2 | 2 | 28 |

Note: There is a northbound bus every 2-3 minutes through the Tunnel in morning peak period (6:00-9:00).

Source: TransLink 2014 Bus Service Performance Review.

APPENDIX F: CYCLING & PEDESTRIAN FACTS

GEORGE MASSEY TUNNEL

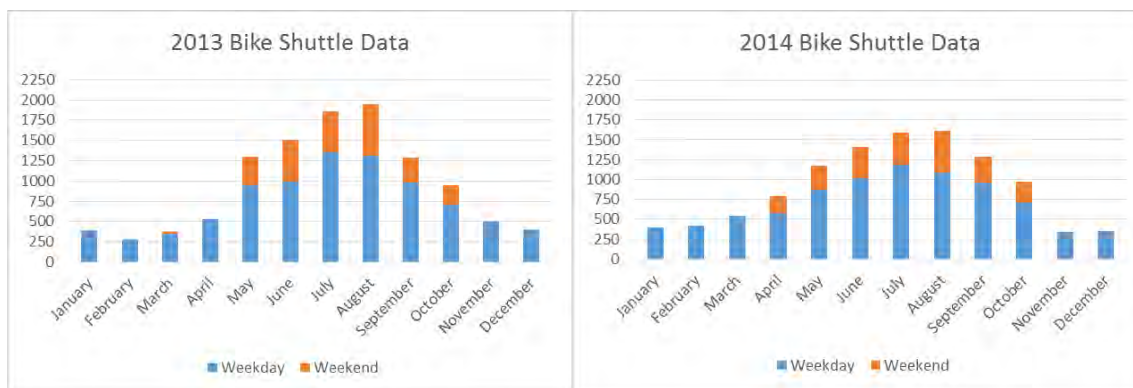
Table 16: Daily Average Bike Shuttle Volume by Month

| Month | 2013 | 2014 |
|-----------|------|------|
| January | 12 | 13 |
| February | 10 | 15 |
| March | 12 | 17 |
| April | 18 | 26 |
| May | 42 | 38 |
| June | 50 | 47 |
| July | 60 | 51 |
| August | 63 | 52 |
| September | 43 | 43 |
| October | 31 | 31 |
| November | 17 | 11 |
| December | 13 | 11 |

Note: Data for Tables 17 and 18 obtained from Mainroad Lower Mainland Contracting LP – 2013, 2014 reports.

Table 17: Daily Average Bike Shuttle Volume by Weekday

| Weekday | 2013 | 2014 |
|-----------|------|------|
| Monday | 32 | 31 |
| Tuesday | 32 | 31 |
| Wednesday | 35 | 34 |
| Thursday | 34 | 32 |
| Friday | 35 | 33 |
| Saturday | 27 | 24 |
| Sunday | 23 | 23 |
| Weekdays | 33 | 32 |
| Weekends | 25 | 24 |



Figures 15 and 16: Bike Shuttle Totals by Month (2013, 2014)

APPENDIX G: ORIGIN – DESTINATION FACTS

Table 18: Origin-Destination Facts – Northbound Trips through the Tunnel (2014)

| Sub Area | Weekday | | | Weekend | | Total |
|-----------------------------|---------|--------|-----------|---------|--------|-------|
| | Morning | Midday | Afternoon | Morning | Midday | |
| ORIGIN | | | | | | |
| Ladner | 16% | 17% | 17% | 17% | 17% | 18% |
| Deltaport | 1% | 3% | 3% | 2% | 2% | 1% |
| Tsawwassen | 14% | 17% | 16% | 11% | 15% | 17% |
| Tsawwassen Ferries | 1% | 4% | 8% | 9% | 4% | 6% |
| Industrial Delta (Tilbury) | 5% | 11% | 15% | 5% | 8% | 4% |
| North Delta | 15% | 9% | 7% | 12% | 10% | 11% |
| SFPR - Nordel | 11% | 9% | 6% | 7% | 9% | 6% |
| Rural Delta | 2% | 3% | 4% | 4% | 3% | 2% |
| South Surrey | 27% | 19% | 14% | 19% | 23% | 22% |
| White Rock | 8% | 8% | 10% | 14% | 9% | 13% |
| DESTINATION | | | | | | |
| Vancouver | 43% | 38% | 41% | 35% | 40% | 43% |
| YVR | 6% | 5% | 4% | 10% | 6% | 5% |
| Richmond West of Highway 99 | 19% | 17% | 15% | 17% | 18% | 17% |
| Richmond East of Highway 99 | 14% | 11% | 7% | 6% | 11% | 7% |
| Richmond Fraser | 2% | 3% | 2% | 3% | 2% | 2% |
| Steveston | 15% | 25% | 30% | 28% | 22% | 25% |
| Burnaby / Westminster | 1% | 1% | 1% | 1% | 1% | 1% |

Table 19: Origin-Destination Facts – Southbound Trips through the Tunnel (2014)

| Sub Area | Weekday | | | | Total | Weekend Total |
|-----------------------------|---------|--------|-----------|---------|-------|---------------|
| | Morning | Midday | Afternoon | Evening | | |
| ORIGIN | | | | | | |
| Vancouver | 35% | 33% | 35% | 35% | 34% | 36% |
| YVR | 4% | 6% | 7% | 11% | 7% | 6% |
| Richmond West of Highway 99 | 10% | 17% | 23% | 20% | 19% | 18% |
| Richmond East of Highway 99 | 9% | 12% | 12% | 6% | 11% | 9% |
| Richmond Fraser | 3% | 3% | 1% | 1% | 2% | 1% |
| Steveston | 38% | 28% | 21% | 26% | 26% | 28% |
| Burnaby / Westminster | 1% | 1% | 1% | 1% | 1% | 2% |
| DESTINATION | | | | | | |
| Ladner | 12% | 15% | 16% | 17% | 15% | 16% |
| Deltaport | 7% | 3% | 1% | 1% | 2% | 2% |
| Tsawwassen | 12% | 16% | 15% | 16% | 15% | 16% |
| Tsawwassen Ferries | 8% | 5% | 2% | 3% | 4% | 7% |
| Industrial Delta (Tilbury) | 17% | 9% | 3% | 3% | 7% | 3% |
| North Delta | 10% | 9% | 16% | 14% | 13% | 12% |
| SFPR - Nordel | 7% | 10% | 8% | 6% | 8% | 5% |
| Rural Delta | 5% | 4% | 2% | 4% | 3% | 3% |
| South Surrey | 10% | 17% | 27% | 26% | 22% | 22% |
| White Rock | 12% | 12% | 10% | 10% | 11% | 14% |

Source: Tables 19 and 20: Fall 2014 – Analysis of OD Survey Data Report.

Note: Morning – 5:30 to 9:30, Midday – 9:30 to 14:30, Afternoon – 14:30 to 18:30, Evening – 18:30 to 5:30

APPENDIX H: LANING REQUIREMENTS

10 Lanes

A 10-lane bridge would have one dedicated transit/HOV lane in each direction located adjacent to the median of the highway. The four remaining lanes in each direction would be for general purpose (GP) traffic for a total of five lanes in each direction.

This option would provide a lane on the right hand side of the highway for trucks and other slower moving traffic as they navigate the grade of the new bridge (similar to the Alex Fraser Bridge). This lane would also be utilized by traffic merging to/from the Highway 17A and Steveston Highway Interchanges. By providing an additional lane over the eight-lane option; the effect of weaving across all highway lanes will be reduced.

The 10-lane bridge option provides increased capacity over existing conditions, with the addition of a dedicated transit/HOV lane and a general purpose lane.

8 Lanes

An eight-lane bridge would also have a dedicated transit/HOV lane in each direction located adjacent to the median of the highway. The three remaining lanes would be for GP traffic for a total of four lanes in each direction.

This option would not provide an additional lane for trucks and other slower moving traffic as they navigate the grade of the new bridge (similar to the Alex Fraser Bridge). With only three GP traffic lanes, vehicles merging to/from the Highway 17A and Steveston Highway Interchanges will weave into and mix with through traffic. The absence of an additional lane for slow moving and weaving traffic would lead to heavier congestion; compromising travel times for the faster moving through traffic.

The eight-lane bridge option does not provide for increased capacity other than the addition of a transit/HOV lane. An eight-lane bridge would result in peak-period congestion on opening day.

Discussion

The following diagram demonstrates existing conditions at the George Massey Tunnel and the Alex Fraser Bridge.

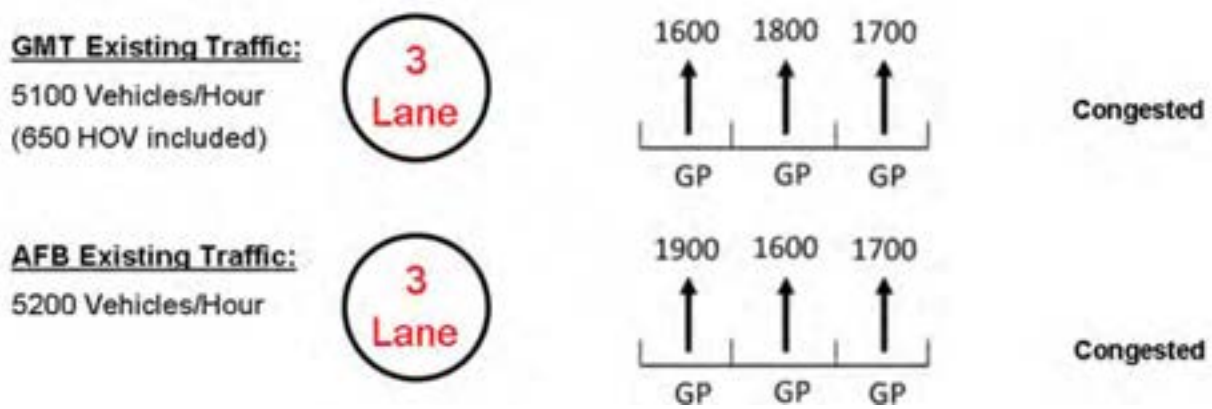


Figure 17: Laning Diagram – NB 2014 AM Rush Hour – GMT vs AFB

The following diagram demonstrates 2022 forecast conditions at the George Massey Tunnel under the 10 and 8 lane bridge scenarios.

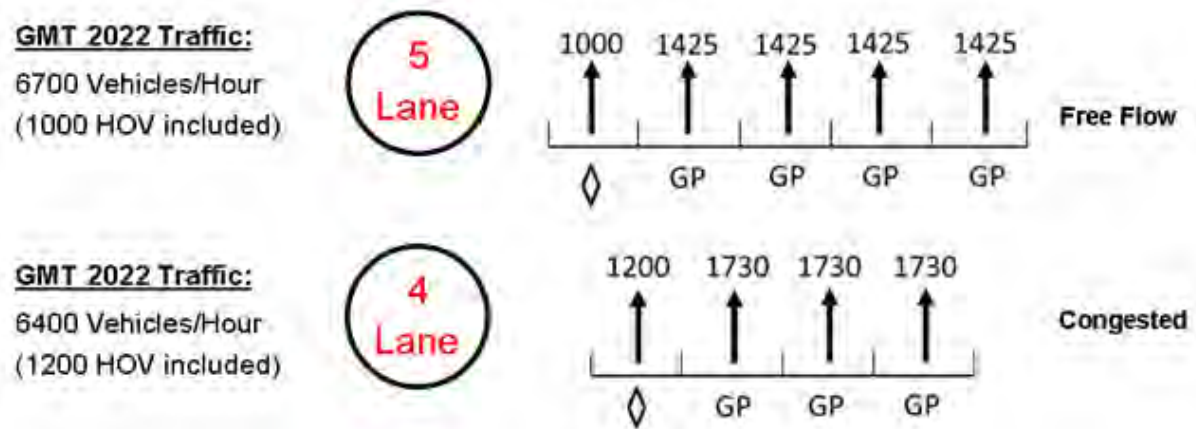


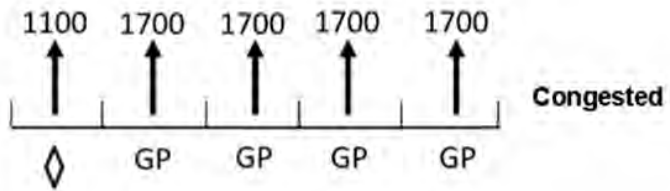
Figure 18: Laning Diagram – NB 2022 AM Rush Hour – Eight vs Ten Lanes

On opening day during the AM rush hour a 10-lane bridge would operate under free flow conditions. On opening day during the AM rush hour an eight-lane bridge would be in a congested state similar to today.

There is a significant difference in rush hour volume when comparing existing traffic in 2014 to anticipated traffic at the new bridge in 2022 (5100 to 6700 vehicles per hour) due to additional capacity. Increased capacity allows traffic to leave at their desired travel time rather than staggering their trip to avoid congestion related delays. This is empirically evident based on the Port Mann Bridge experience. The Port Mann Bridge opened on December 1, 2012 and the increase in rush hour volume is evident in the 2013 data. This is illustrated in Figure 20 and 21 in Appendix I below.

The following diagram demonstrates 2045 forecast conditions at the George Massey Tunnel under the 10- and eight-lane bridge scenarios.

GMT 2045 Traffic:
7900 Vehicles/Hour
(1100 HOV included)



GMT 2045 Traffic:
7500 Vehicles/Hour
(1400 HOV included)

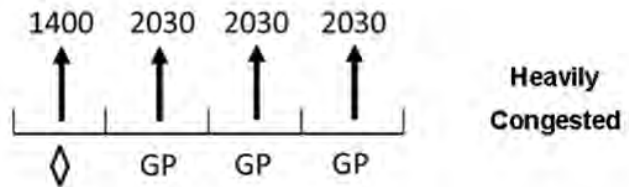


Figure 19: Laning Diagram – NB 2045 AM Rush Hour – Eight vs Ten Lanes

In the 10-lane option, vehicles per lane are returning to levels similar to current conditions at the existing tunnel. The level of congestion will be mitigated to a degree by the improved ramps and interchanges connecting to the bridge.

In the eight-lane option the bridge is experiencing heavy congestion during rush hour beyond what is currently occurring at the tunnel.

APPENDIX I: PORT MANN BRIDGE WEEKDAY TRAFFIC PROFILE

As illustrated in the following graphs, the Port Mann Bridge is experiencing a three-year trend of increased use in the peak direction during peak periods and an overall decreased use during the remainder of the day. Toll diversion appears to have peaked in 2014.

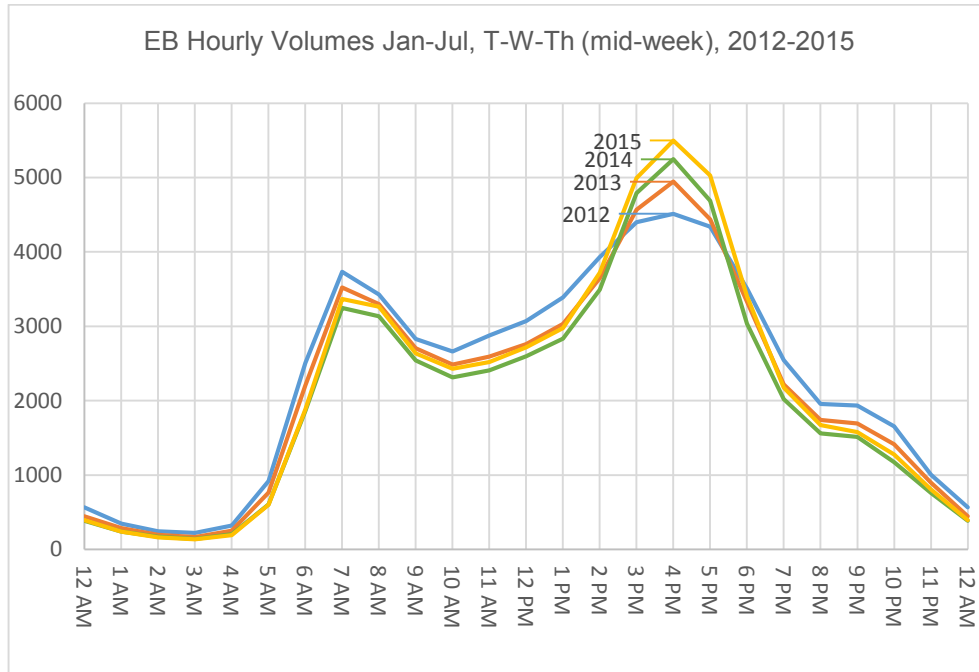


Figure 20: PMB EB weekday traffic profile.

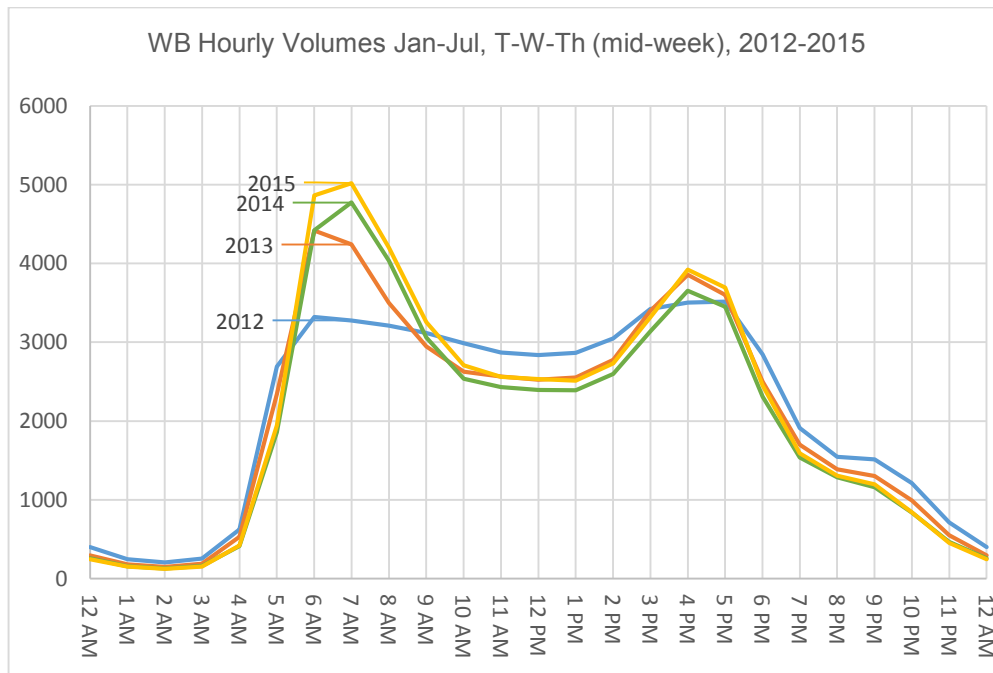


Figure 21: PMB WB weekday traffic profile.

APPENDIX C

Traffic Forecasts



George Massey Tunnel
Replacement Traffic
Forecasts

Report
November 2015

George Massey Tunnel
Replacement Project

Our ref: 22882501





George Massey Tunnel
Replacement Traffic
Forecasts

Report
November 2015

George Massey Tunnel
Replacement Project

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Appendices

A Traffic Forecasts

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1 Introduction

Background

Steer Davies Gleave was appointed by the Massey Tunnel Replacement Project (the Client) to develop an independent analysis of traffic forecasts for the Project to validate the traffic forecasts developed internally by the Client.

The work carried out includes:

- Analysis of historical traffic patterns
- Review of socio-economic development in the region
- Development of a spreadsheet-based forecast model, including:
 - Econometric facility model (peak/off-peak split into car and trucks)
 - Estimation of tolling and capacity increase impacts
 - Development of traffic forecasts to December 2045

The Project

The Massey Tunnel opened in 1959 and is a key component of Metro Vancouver's transportation system. In 1981 counter-flow measures were introduced, using a reversible lane system to increase traffic flow during peak periods in the peak direction, and this continues to this day. The tunnel carried around 80,000 daily vehicles in 2014. Figure 1.1 shows the location of the tunnel.

Figure 1.1: Massey Tunnel location



Source: Massey Tunnel Replacement Project

In response to growing concerns about the impact of congestion, and recognizing that the existing tunnel has about 10 years of useful life remaining, the Province of British Columbia has committed to constructing a bridge replacement. Construction of the new bridge on the existing Highway 99 corridor is scheduled to begin in 2017 and the new crossing could be operational by 2021.

2 Traffic Analysis

Massey Tunnel and Alex Fraser Bridge data has been analyzed, as both facilities offer a similar option to travel between Richmond and Delta, Surrey and the US border. Future construction and/or tolls on the Massey Tunnel will clearly influence the traffic on the Alex Fraser Bridge.

Data Availability

Traffic data for the Massey Tunnel and Alex Fraser Bridge was collected from BC Ministry of Transportation and Infrastructure (MoTI) data¹ or provided by the Massey Tunnel Replacement Project office. Table 2.1 summarizes the data available for this study.

Table 2.1: Traffic data availability

| Crossing | Traffic volumes | Vehicle classification | Time of day | Source |
|----------------------|--|--|--|--------------|
| George Massey Tunnel | Jan 2004 - Jun 2015 | Partially available | Jan 2004 - Jun 2015 | MoTI, client |
| Alex Fraser Bridge | Jan 2004 - Jun 2015 | Jan 2004 - Jun 2015 | Jan 2004 - Jun 2015 | MoTI, client |
| Port Mann Bridge | Jan 2004 - Mar 2012 Nov 2012 - Jul 2015 | Jan 2004 - Mar 2012 Nov 2012 - Jul 2015 | Jan 2004 - Mar 2012 Nov 2012 - Jul 2015 | Client |

The data listed in the table represents an extensive dataset. Note the following regarding the data reviewed:

- There is no complete historical vehicle classification data available for the Massey Tunnel.
- There are some data gaps for Massey Tunnel and Alex Fraser (identified later in this section).

Traffic Data

Historical traffic data for the Massey Tunnel and Alex Fraser Bridge is presented in Figure 2.1.

¹ <http://www.th.gov.bc.ca/trafficdata/index.html>

Figure 2.1: Massey Tunnel (MT) and Alex Fraser (AF) Daily Traffic



Source: MoTI Traffic Data Program

Figure 2.1 shows the monthly daily traffic for the Massey Tunnel is consistently lower than Alex Fraser by around 18% (average between 2004 and 2015).

Note that no traffic data was available for the Massey Tunnel for the following periods:

- October 2004 – March 2005
- May 2007
- July 2011 – August 2011
- August 2012 – November 2012
- January 2013

For Alex Fraser Bridge the following data was missing:

- February 2011 to April 2011
- May 2013.

Data in Figure 2.1 has missing values replaced with traffic based on traffic growth, historical information and monthly profile data. The figure shows a decrease in traffic for Massey Tunnel in the period analyzed. This is confirmed with the traffic presented in Table 2.2 where annual traffic growth shows a reduction of -0.7% between 2005 and 2014. Alex Fraser Bridge traffic shows permanent AADT for 2014 of about 108,000, 10% more than the AADT for 2005 (98,000).

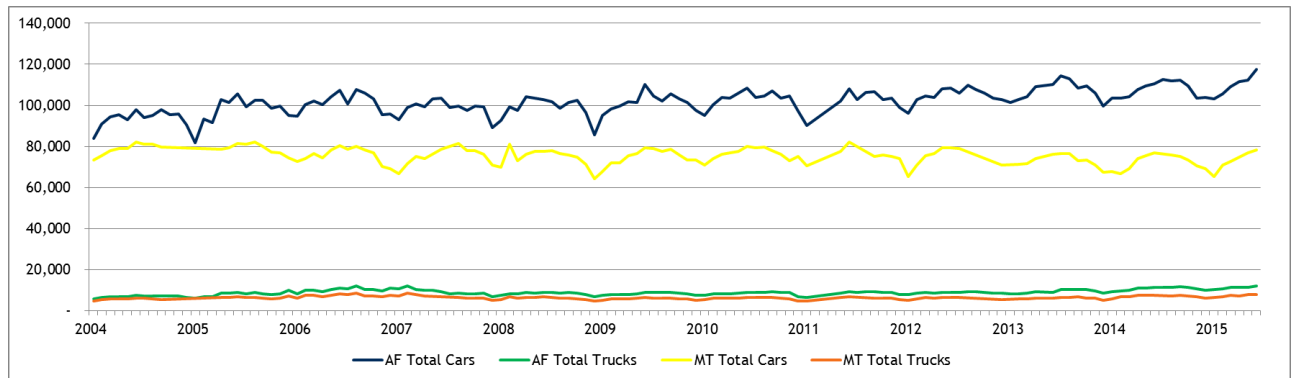
Table 2.2: Massey Tunnel and Alex Fraser Bridge annual traffic

| | George Massey Tunnel | | | Alex Fraser Bridge | | |
|---------------------------|----------------------|--------|--------|--------------------|---------|---------|
| | AADT | AAWDT | AAWET | AADT | AAWDT | AAWET |
| 2005 | 85,000 | 90,000 | 72,000 | 98,000 | 108,000 | 72,000 |
| 2006 | 83,000 | 87,000 | 69,000 | 102,000 | 111,000 | 75,000 |
| 2007 | 82,000 | 87,000 | 68,000 | 98,000 | 107,000 | 73,000 |
| 2008 | 80,000 | 84,000 | 67,000 | 99,000 | 108,000 | 73,000 |
| 2009 | 81,000 | 85,000 | 68,000 | 102,000 | 111,000 | 77,000 |
| 2010 | 82,000 | 87,000 | 69,000 | 103,000 | 112,000 | 77,000 |
| 2011 | 82,000 | 86,000 | 68,000 | 103,000 | 112,000 | 77,000 |
| 2012 | - | 86,000 | - | 105,000 | 114,000 | 80,000 |
| 2013 | 79,000 | 82,000 | 68,000 | 107,000 | 116,000 | 84,000 |
| 2014 | 79,000 | 84,000 | 66,000 | 108,000 | 116,000 | 85,000 |
| Difference (2005 to 2014) | -6,000 | -6,000 | -6,000 | +10,000 | +8,000 | +13,000 |
| Annual growth | -0.7% | -0.7% | -0.9% | +1.0% | +0.7% | +1.7% |

Source: MoTI Traffic Data Program²

As indicated previously there is limited historical vehicle classification data for the Massey Tunnel. Therefore, we estimated the vehicle classification data for the tunnel based on a combination of localised traffic counts and a permanent counter (site P67-13) located on Highway 99 north of the Massey Tunnel. Traffic is shown in Figure 2.2.

Figure 2.2: Massey Tunnel and Alex Fraser Bridge classified monthly traffic



Source: MoTI Traffic Data Program. Massey Tunnel truck percentages estimated.

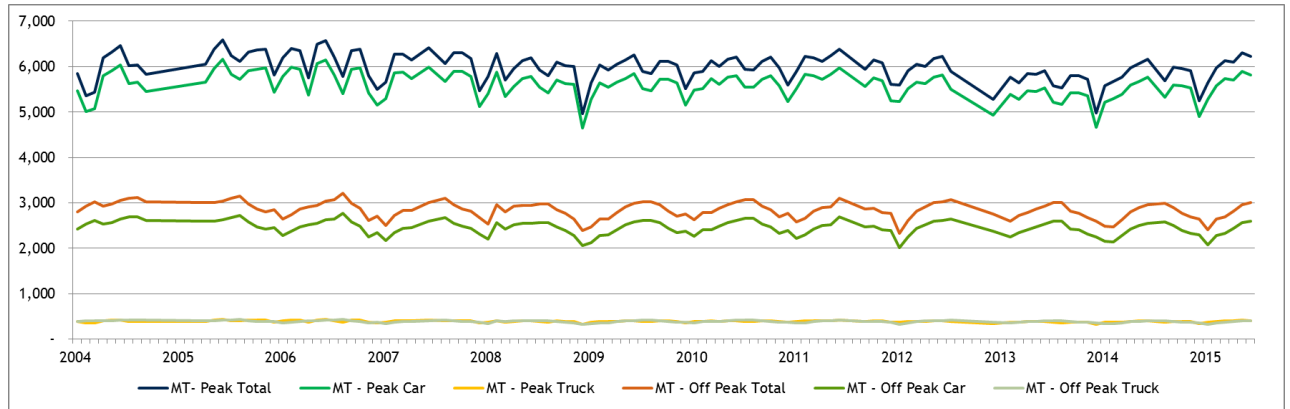
Between 2004 and 2015, the vehicle split for the Massey Tunnel is about 92% for cars and 8% for trucks, whereas for Alex Fraser Bridge it is 91% for cars and 9% for trucks. Overall traffic growth on the Massey Tunnel and the Alex Fraser Bridge is determined by car traffic.

² AADT = Annual Average Daily Traffic, AAWDT = Annual Average Weekday Traffic, AAWET = Annual Average Weekend Total

Traffic Demand Analysis

Figure 2.3 shows a slight reduction in Massey Tunnel traffic during the peak hours³ (from 6,300 vehicles/hr in 2005 to 5,800 vehicles/hr in 2014). The average traffic for trucks during peak and off peak hours is about the same (around 375 vehicles).

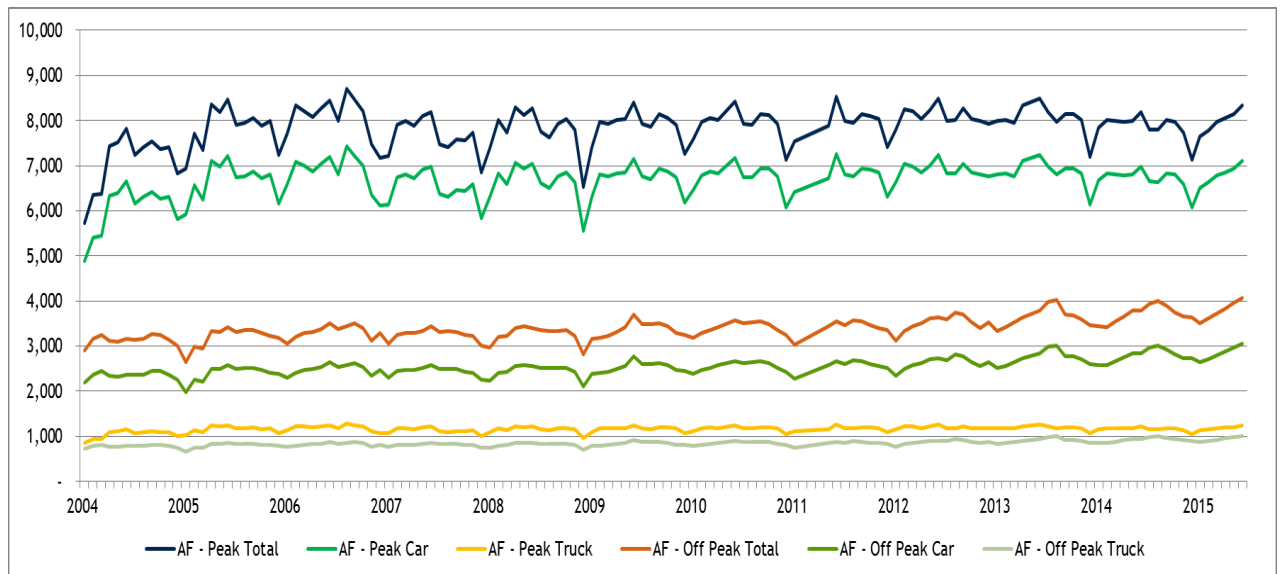
Figure 2.3: Massey Tunnel classified average hourly Peak and Off Peak traffic



Source: MoTI Traffic Data Program

There is a higher truck traffic on Alex Fraser Bridge compared to Massey Tunnel as shown in Figure 2.4 with the peak period showing higher flows than the off peak.

Figure 2.4: Alex Fraser classified average hourly Peak and Off Peak traffic



Source: MoTI Traffic Data Program

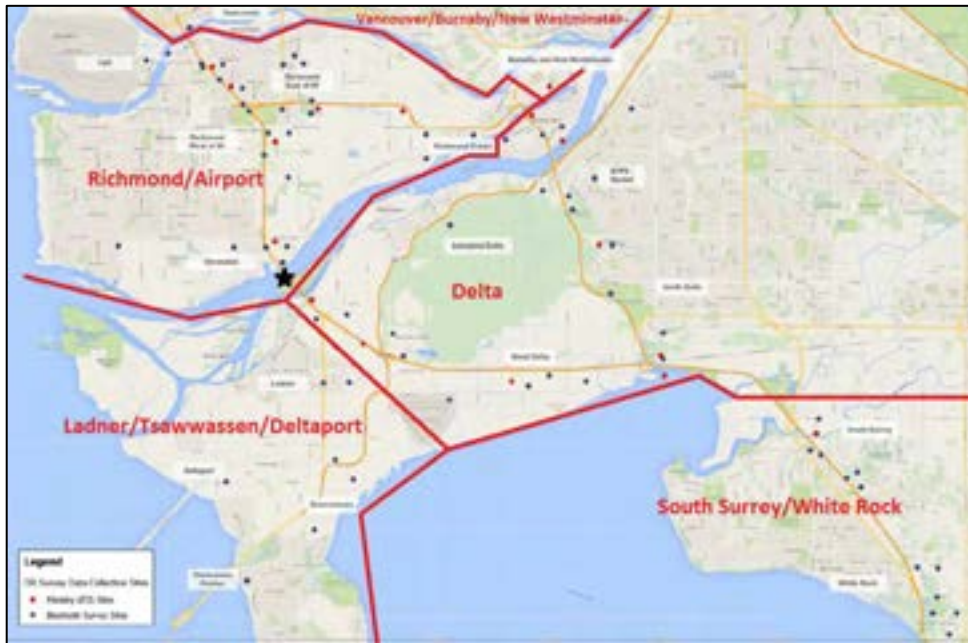
The hourly average peak traffic for the Alex Fraser Bridge is 7,800 vehicles/hr, where 85% is made up by car traffic.

³ Peak hours = 6:00am to 9:00am and 3:00pm to 6:00pm on weekdays

Origin-Destination Data

Latest OD survey data is available for fall 2014. The survey was conducted with Bluetooth readers at 70 locations over a two-week period in late October/early November. Bluetooth readers were grouped into five geographic areas as shown in Figure 2.5.

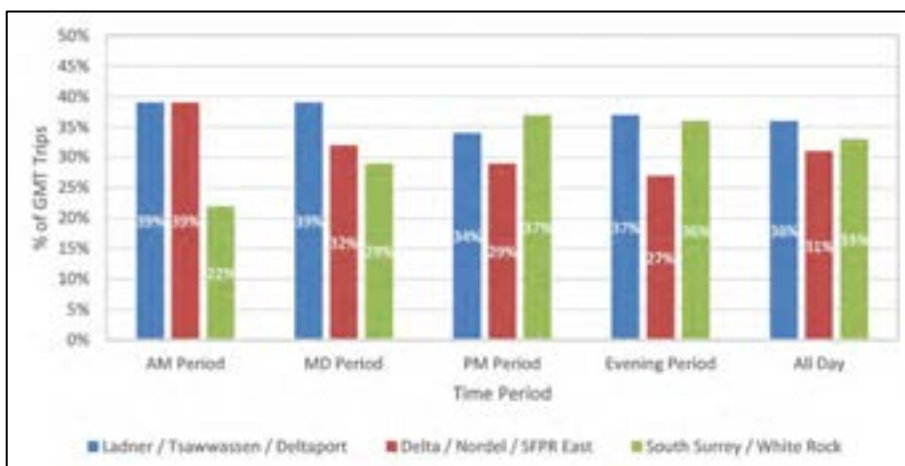
Figure 2.5: OD survey analysis areas



Source: Analysis of OD Survey Data, Fall 2014 (Parsons)

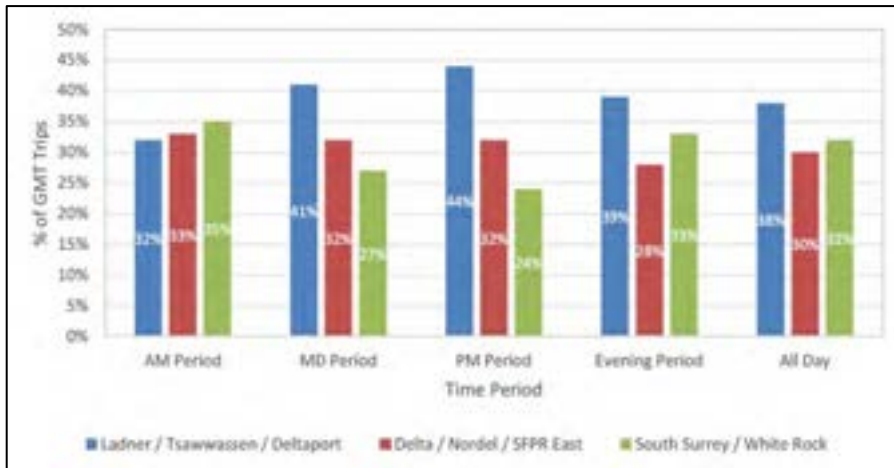
Two of the readers are located to the north of the Fraser River and three to the south (Massey Tunnel is identified as the star in the figure) and 507,000 trips were detected during the two week period. Figure 2.6: and Figure 2.7 present the distribution of southbound and northbound trips for trips recorded South of the Fraser.

Figure 2.6: Time of day distribution of SB weekday trip destinations (South of the Fraser)



Source: Analysis of OD Survey Data, Fall 2014 (Parsons)

Figure 2.7: Time of day distribution of NB weekday trip origins (South of the Fraser)

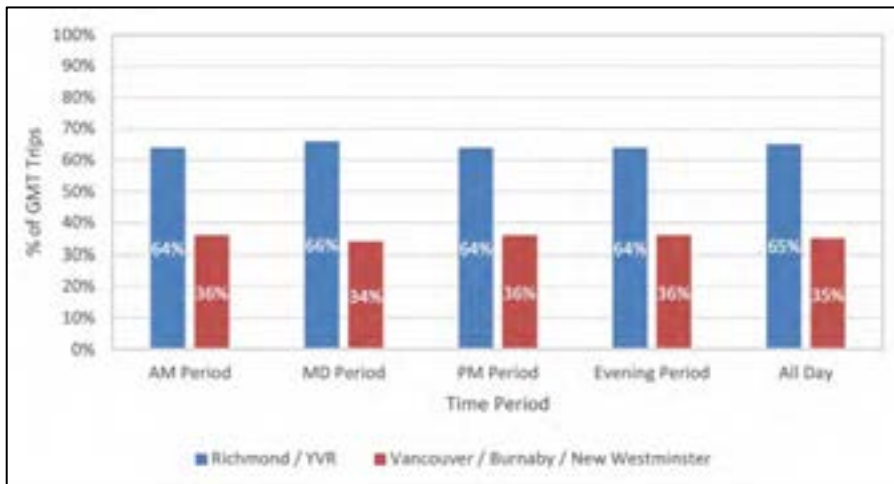


Source: Analysis of OD Survey Data, Fall 2014 (Parsons)

In the AM period traffic destined to South Surrey/White Rock represent 22% of trips while in the PM peak this increases to 37% suggesting a heavy commuter flow. In the northbound direction the proportions from South Surrey/White Rock are reversed i.e. 35% of the trips originate from there in the AM period while only 24% in the PM peak. Lardner/Tsawwassen/Deltaport area generally represents the highest proportions of trips.

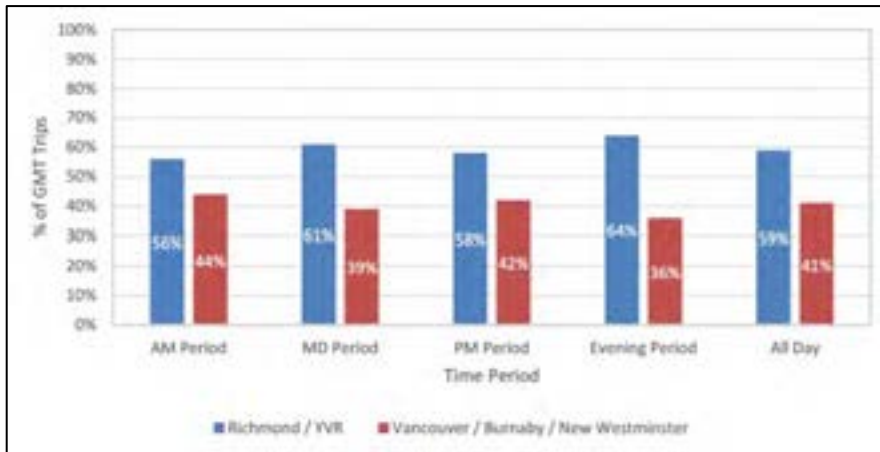
Figure 2.8 and Figure 2.9 present the distribution of southbound and northbound trips for trips recorded North of the Fraser.

Figure 2.8: Time of day distribution of SB weekday trip origins (North of the Fraser)



Source: Analysis of OD Survey Data, Fall 2014 (Parsons)

Figure 2.9: Time of day distribution of NB weekday trip destinations (North of the Fraser)



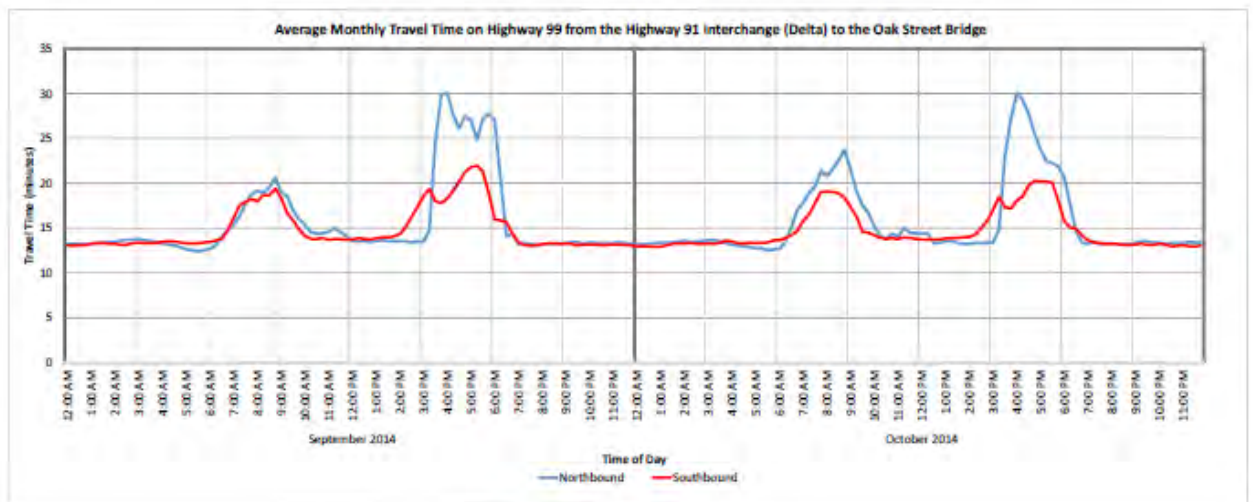
Source: Analysis of OD Survey Data, Fall 2014 (Parsons)

Trips north of the Fraser show a consistent geographical pattern throughout the day. Around 65% of southbound trip origins are from Richmond/YVR while 60% of the northbound trips destinate there. The one ‘outlier’ are northbound trips in the evening period (64%) where the airport appears to increase the proportion slightly.

Travel Times

Travel time data is collected by the Ministry’s Advanced Traveller Information System (ATIS) and Highway 99 travel times are summarised in Figure 2.10. It shows the impact of peak traffic on travel times, particularly in the northbound direction where travel times can double compared to free flow conditions. This is likely caused by traffic flow volumes and fact that only 1 lane operates in the northbound direction in the PM peak.

Figure 2.10: Highway 99 travel times



Source: Traffic Data Collection Report, Fall 2014 (Parsons)

3 Model Development

Data Inputs

Econometric models estimate the relationship between socio-economic factors (such as GDP, employment, income, etc.) as well as prices (such as fuel or tolls) on traffic. Given detailed data, one can develop robust estimates of the various elasticities influencing demand. The estimated models can also be used, in turn, to simulate the impacts of future economic growth on traffic demand.

Traffic Data

Section 2 presented Massey Tunnel and Alex Fraser historical traffic data split into cars and trucks.

Socio Economic Parameters

Historical national, provincial and metropolitan economic data from Statistics Canada was reviewed to develop the econometric models. This included a wide range of data sources ranging from GDP to border crossings. All the variables are potential variables for the econometric models according to economic theory, and in order to select the best predictors of traffic a series of statistical analyses were run.

Model Development

An extensive number of model estimations were made as part of this work. This involved the following parameters:

- Gas and diesel prices
- Canada, BC and Metro Vancouver employment (total and 6 different employment sectors)
- Canada, BC and Metro Vancouver population
- Canada and BC GDP
- Canada, BC and Metro Vancouver retail trade
- Canada, BC and Metro Vancouver building permits
- BC manufacturing sales
- Canada and BC weekly earnings
- Canada and BC travel accommodation
- Exchange rates
- Border crossings

The specifications for each model developed are detailed below. These are the models showing the variables found to have the highest explanatory power in the model. The variables are converted to natural logarithms (denoted as ln) which means that estimated coefficients are equal to elasticities. These measures detail the effect of a % increase in the variable in terms of a resulting % change in traffic.

Peak Model - Passenger vehicles

The summary results for the peak model developed for passenger vehicles are shown in **Table 3.1**. Note that this model was based on Alex Fraser peak car traffic only as Massey Tunnel shows effectively no peak growth since 2004. Specific coefficients for seasonal variations and special events (Stanley cup finals in 2011, weather conditions in Dec 2008) are not shown but were also included in the analysis.

Table 3.1: Peak model: Passenger vehicles

| | Coefficient | P value |
|---------------------------------------|-------------|---------|
| ln(British Columbia Total Employment) | 0.308*** | 0.00 |
| Constant | 8.261*** | 0.00 |

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ where p is the probability that the observation was not statically significant. The lower the p , the higher the statistical significance.

Peak Model - Commercial vehicles

The summary results for the peak model developed for commercial vehicles are shown in **Table 3.2**. The model considers peak truck traffic for the Massey Tunnel and Alex Fraser bridge. While detailed coefficients are not shown, the models included controls for monthly seasonal variations, heavy snow in December 2008 and large increase in month to month truck traffic observed in 2014 and 2015 for construction impacts in the area.

Table 3.2: Peak model: Commercial vehicles

| | Coefficient | P value |
|---------------------|-------------|---------|
| ln(Real GDP Canada) | 0.602*** | 0.000 |
| Constant | 0.0787 | 0.48 |

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ where p is the probability that the observation was not statically significant. The lower the p , the higher the statistical significance.

Off Peak Model - Passenger vehicles

The summary results for the off peak model developed for passenger vehicles are shown in **Table 3.3**. The model considers growth in total off-peak vehicles for Massey Tunnel and Alex Fraser Bridge. Gas prices are not statistically significant but do have the correct sign (increase in gas prices will result in reduction in traffic) while British Columbia total employment and the constant are strongly significant.

Table 3.3: Off Peak model: Passenger vehicle

| | Coefficient | P value |
|---|-------------|---------|
| ln(Real British Columbia gas prices) ⁴ | -0.0213 | 0.732 |
| ln(British Columbia Employment) | 0.796*** | 0.000 |
| Constant | 5.522*** | 0.000 |

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ where p is the probability that the observation was not statically significant. The lower the p , the higher the statistical significance.

⁴ Model uses the 3 month moving average for fuel prices

Off Peak Model - Commercial vehicles

The summary results for the off peak model developed for commercial vehicles are shown in **Table 3.4**. The model considers off-peak truck traffic for the Massey Tunnel and Alex Fraser Bridge. Whilst detailed coefficients are not shown the models included controls for seasonal variations, controls for the heavy snow in 2008 and large increase in month to month truck traffic observed in 2014 and 2015 for construction impacts in the area.

Table 3.4: Off Peak model: Commercial vehicle

| | Coefficient | P value |
|---------------------|-------------|---------|
| ln(Real GDP Canada) | 1.009*** | 0.00 |
| Constant | 5.291*** | 0.01 |

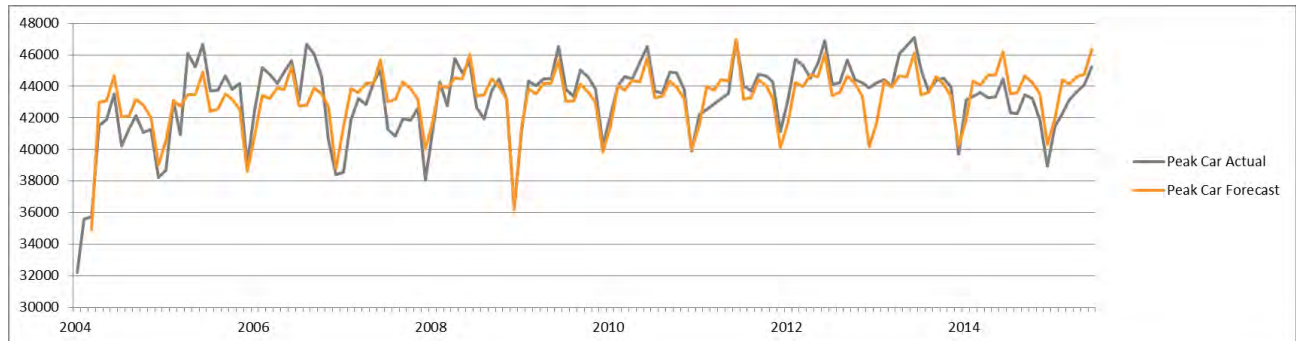
*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ where p is the probability that the observation was not statically significant. The lower the p , the higher the statistical significance.

Forecast Comparison

Each of these variables is theoretically sound, and together form a comprehensive model to forecast traffic. Gas prices increase the price of travel and reduce the number of trips, employment is a driver of both trips and demand and GDP (economic activity) is closely linked to travel demand.

Figures below compare the modelled flows against observed traffic flows for the various models developed.

Figure 3.1: Peak Model: Passenger vehicles



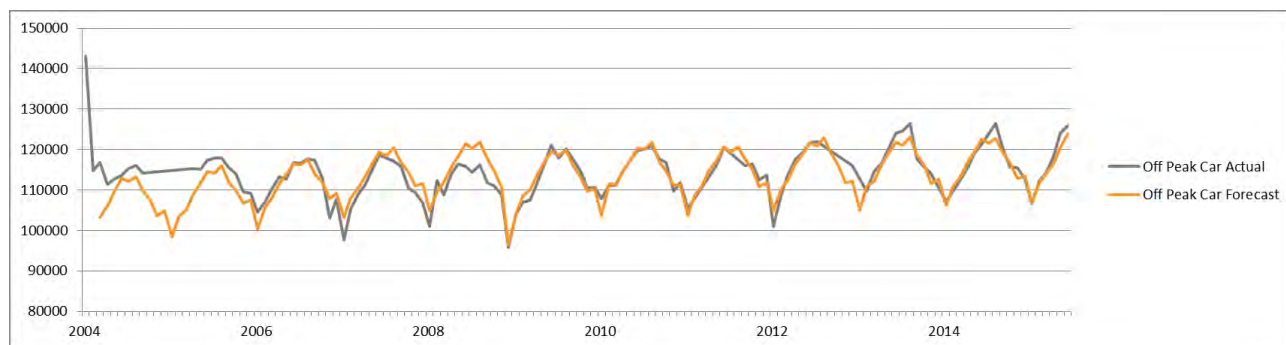
Source: Steer Davies Gleave

Figure 3.2: Peak Model: Commercial vehicles



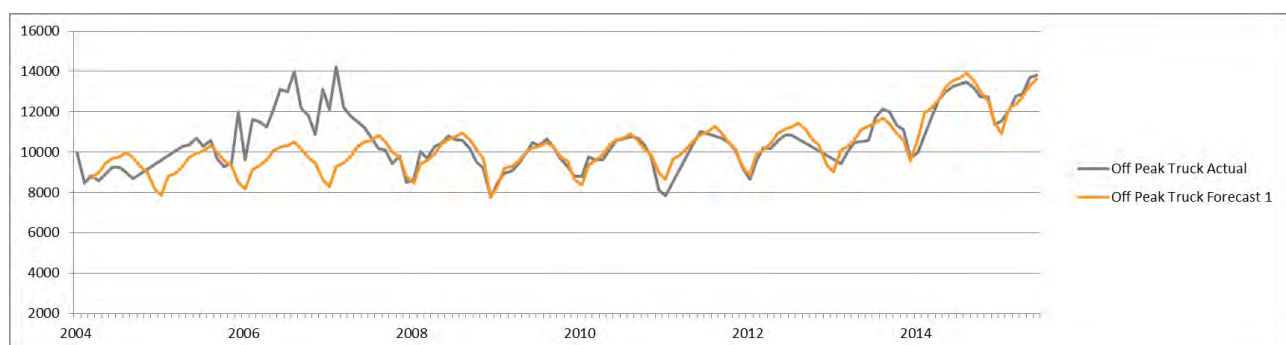
Source: Steer Davies Gleave

Figure 3.3: Off Peak Model: Passenger vehicles



Source: Steer Davies Gleave

Figure 3.4: Off Peak Model: Commercial vehicles



Source: Steer Davies Gleave

The models reflect past traffic patterns accurately and generally show a robust forecasting tool has been developed. Note the following:

- Peak model based on Alex Fraser traffic data, as Massey Tunnel shows negative peak traffic growth since 2004 (see Figure 2.1) and this makes the development of an econometric growth model challenging.
- There was very high truck traffic growth between 2006 and 2008. This made calibration of econometric models in that period challenging as observed data completely outside the trend growth observed between 2004 to 2006 and 2008 to 2014.

4 Traffic Forecasts

Forecasting Inputs

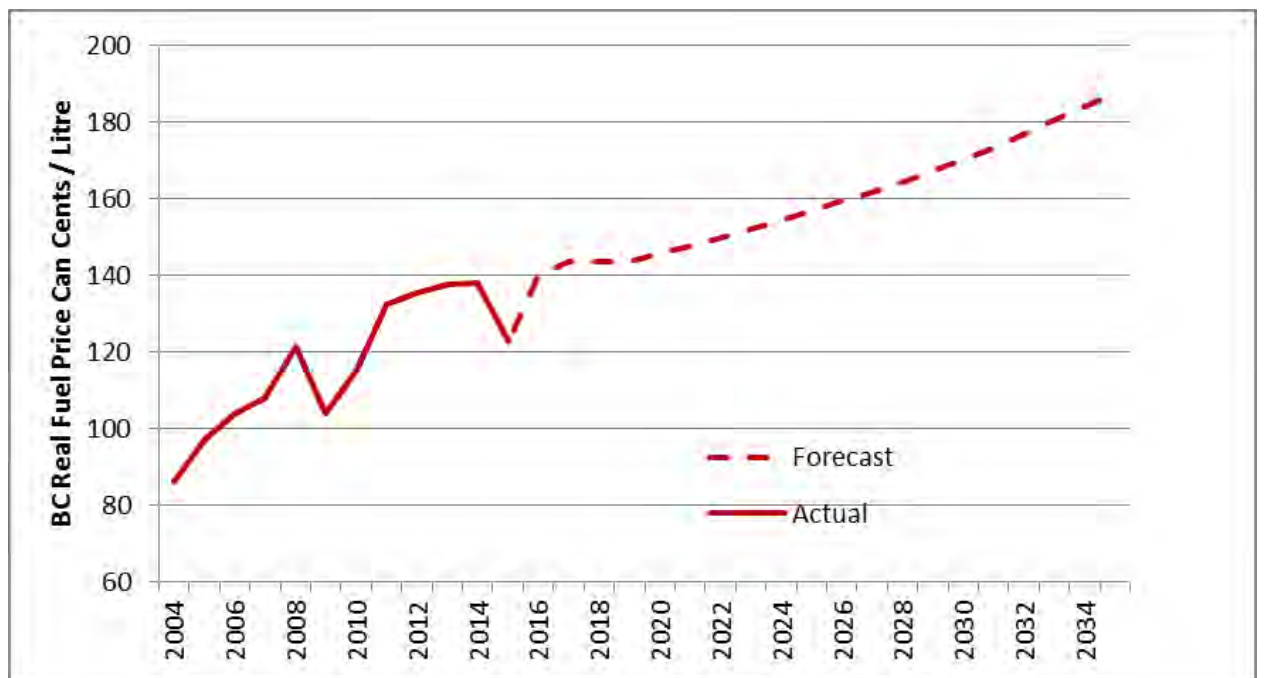
Socio Economic Forecasts

Chapter 3 identified the socioeconomic variables which derive traffic growth and these are detailed below.

Gas Prices

For gasoline prices we used United States Energy Information Agency (EIA) forecasts for the Northwest region. While gas prices are lower in the US, we consider that the forecast captures the overall growth and fluctuations expected. Note that they have been adjusted to the average British Columbia market price to reflect the different gas tax rates. Figure 4.1 shows historical and forecast British Columbia gas prices, adjusted for inflation. It shows the high gas prices in the summers of 2008 and 2012 and the decline in 2015. EIA suggests price recovery in the near future to 2016 and gradually increasing afterwards.

Figure 4.1: British Columbia Gas Prices

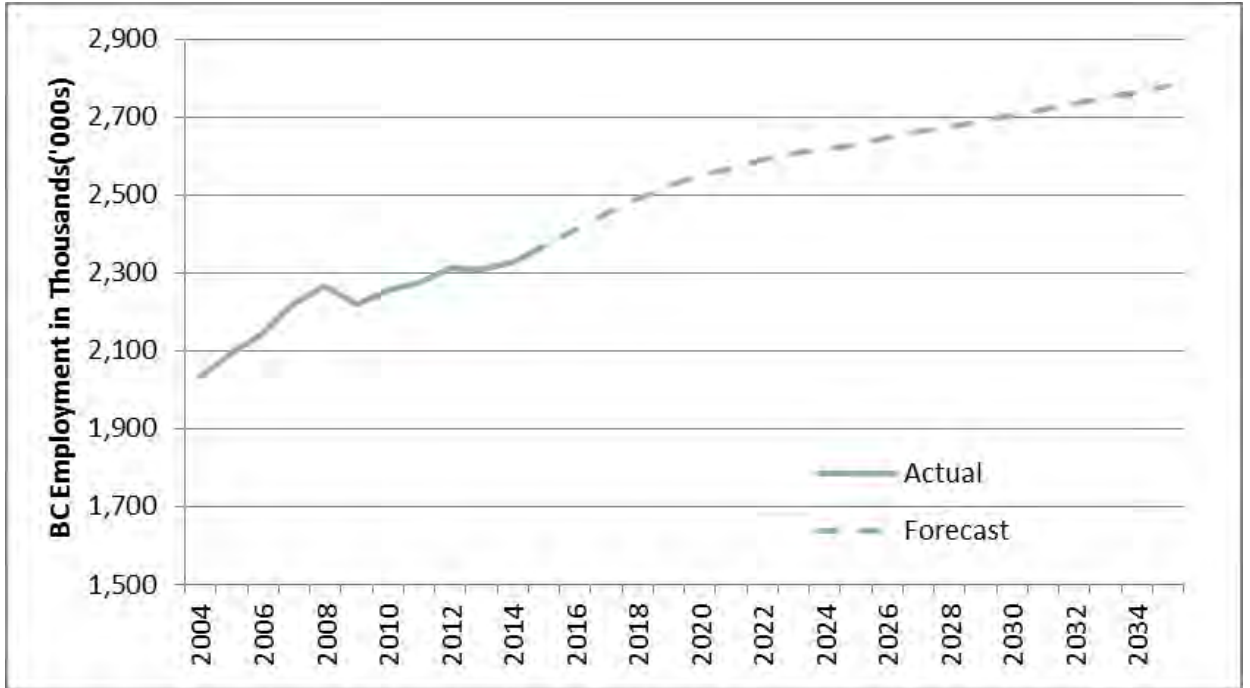


Source: Statistics Canada (historical), Energy Information Agency (forecast)

BC Employment

Figure 4.2 details the historical and forecast growth for BC employment. In the near term there is reasonable growth in employment expected at 1.5-2.0% per year but this slows down to less than 1.5% after 2018. Employment growth is expected to slow down below 1% beyond 2020.

Figure 4.2: BC Employment

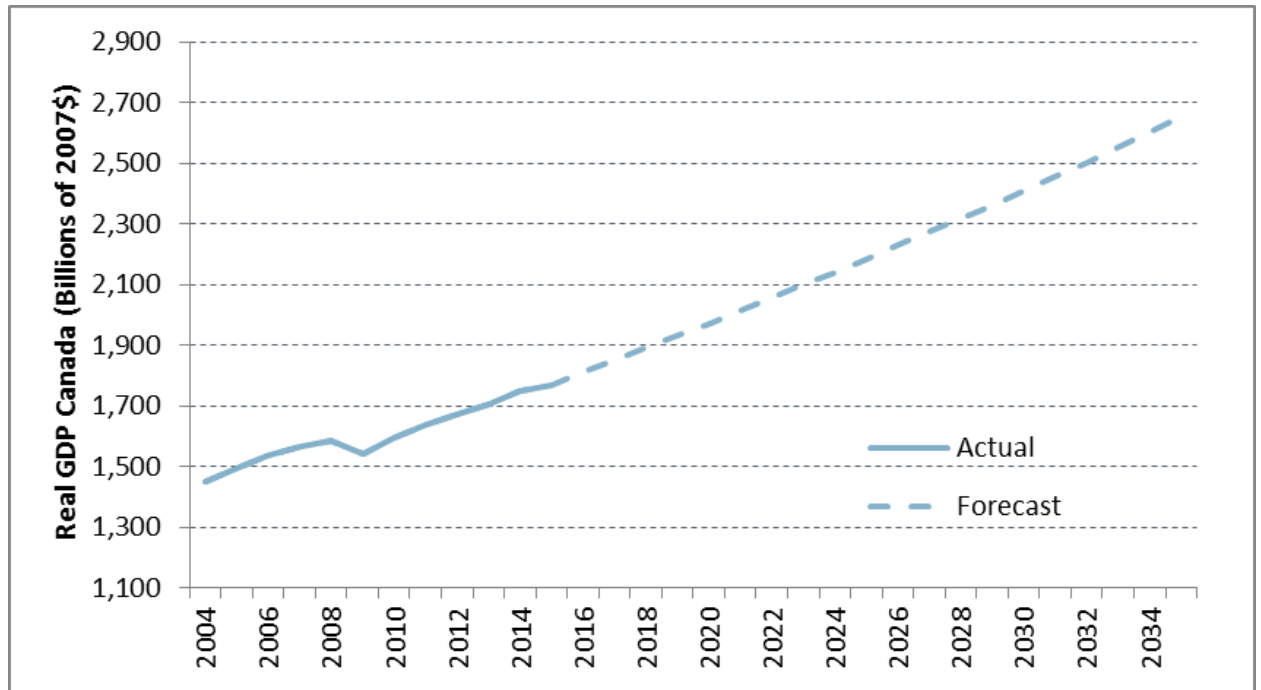


Source: Statistics Canada (historical), Conference Board of Canada (forecast)

Canada GDP

Figure 4.3 presents the historical and forecast growth for Canadian GDP. It shows growth of around 2.3% in the near term and this slows down to around 2% in the longer term.

Figure 4.3: Canada GDP



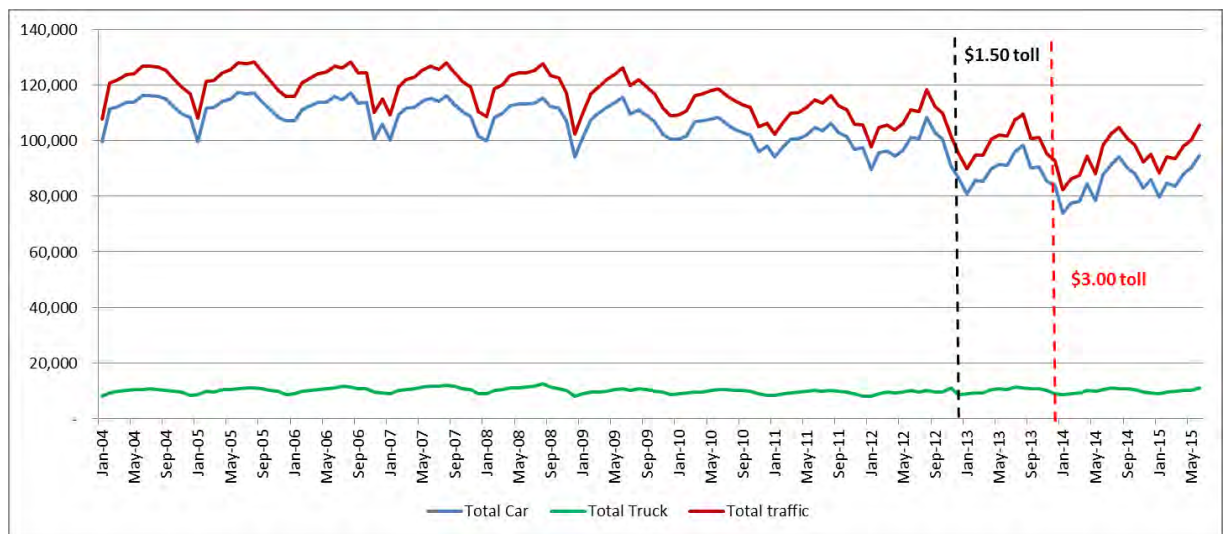
Source: Statistics Canada (historical), Conference Board of Canada (forecast)

New Bridge Impact

Econometric models provide a robust method to estimate underlying traffic growth driven by the parameters presented in Section 3. However we need to estimate the impact of the crossing capacity expansion (from 4 lanes to 10 lanes when completed) and the introduction of tolls.

For the development of traffic forecasts for the Massey Tunnel, we have reviewed Port Mann Bridge traffic data as a proxy for capacity improvements and inclusion of a toll. Figure 4.4 shows bridge traffic since 2004 (note that traffic data between April and October 2012 was missing and estimated for the purposes of this analysis).

Figure 4.4: Monthly Average Daily Traffic (MADT) – Port Mann Bridge

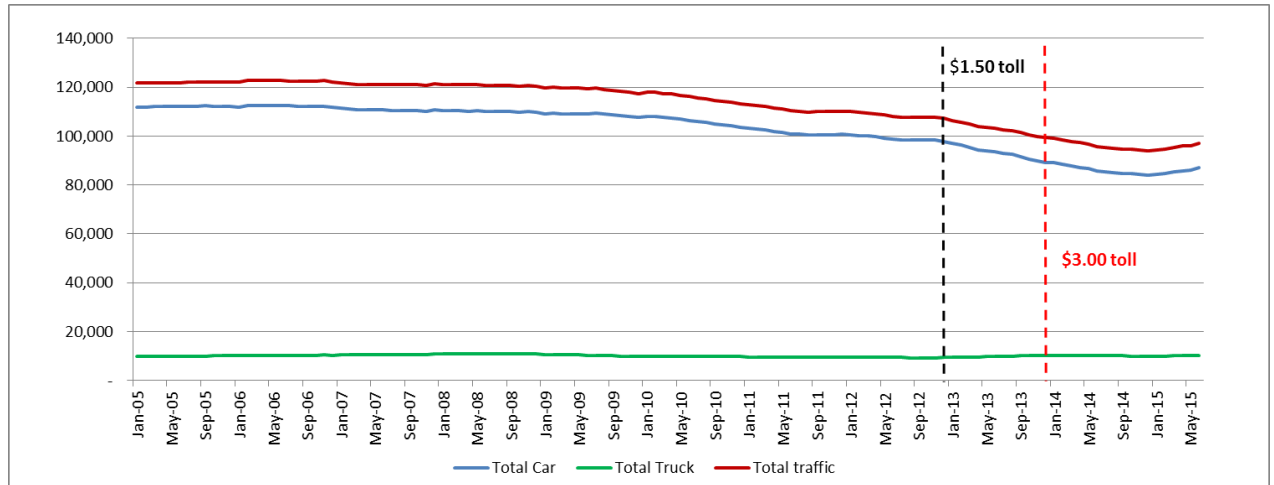


Source: Massey Tunnel Replacement Project

The figure shows traffic decreasing since 2009, with economic recession and construction impacts likely to be the main factors. A reduction in traffic can be observed once the tolls were introduced in December 2012 (\$1.50 toll per car). A further reduction can be observed when the toll was increased to \$3.00 in December 2013 as the introductory toll rate ended.

Figure 4.5 presents the 12 month traffic moving average. The figure shows a negative growth trend in car traffic (which is over 90% of the total traffic) since mid-2009, from around 120,000 vehicles/day to 94,000 vehicles/day in January 2015.

Figure 4.5: 12 month average daily traffic – Port Mann Bridge



Source: Massey Tunnel Replacement Project

Compared to car traffic, truck traffic at Port Mann Bridge has not been affected to such a degree. In fact, the truck MADT since the opening of the new bridge has increased from 9,300 trucks/day to around 10,000 trucks/day.

The Port Mann traffic impacts are summarized in Table 4.1. It suggests that the impact of the introduction of a \$3.00 toll (similar level envisaged for the new Massey Tunnel replacement) is a 13% reduction in car traffic and a 4.8% increase in truck traffic.

Table 4.1: Port Mann Bridge traffic impact

| Port Mann Bridge | Car | Total Truck | Total Traffic |
|---|--------|-------------|---------------|
| First year traffic impact (2012 vs 2013) | | | |
| Car toll = \$1.5 | -8.2% | +7.4% | -6.8% |
| Light Truck toll = \$4.5 | | | |
| Heavy Truck toll = \$9.0 | | | |
| Second year traffic impact (2012 vs 2014) | | | |
| Car toll = \$3.0 | -13.0% | +4.8% | -11.4% |
| Light Truck toll = \$6.0 | | | |
| Heavy truck toll = \$9.0 | | | |

Source: Steer Davies Gleave calculations of Massey Tunnel Replacement Project data

The project toll values were provided by the project office. Note that we are assuming that tolls will be increasing in line with inflation i.e. no increase in tolls in real terms.

Induced Demand

Induced traffic refers to trips that are generated as a result of new road infrastructure, such as the new bridge and associated works. Trips will be generated as new travel or existing corridor users travel more frequently due to the convenience and time savings created by the new bridge. Furthermore current trips that do not involve a crossing of the Fraser may divert across the river due to the easier access associated with the bridge.

The Massey Tunnel replacement is providing additional capacity (and reliability) across the Fraser River with significant travel time savings in a number of origin-destination movements both sides of the river.

While induced demand has long been recognized as a result of the introduction of new transportation infrastructure, there is uncertainty in estimating induced traffic due to the length of the impact and the extent of it. We have based our induced traffic estimate on an elasticity function whereby the number of new trips is derived from the forecast travel cost with and without the new facility and applying an elasticity of 0.5 i.e. a 10% reduction in travel costs results in a 5% increase in traffic demand.

Based on the travel cost saving estimate we have calculated an induced demand estimate of 3%. Note the following:

- Applied to peak cars only - off peak travel times are equivalent to free flow travel times already (see Figure 2.10) and truck traffic is non-discretionary
- Induced traffic might take some time to materialize after the new infrastructure is in place. We have phased its full impact and assumed the following rates of induced traffic in the first years following the completion of the project (1% in 2021, 2% in 2022 and 3% by 2023)

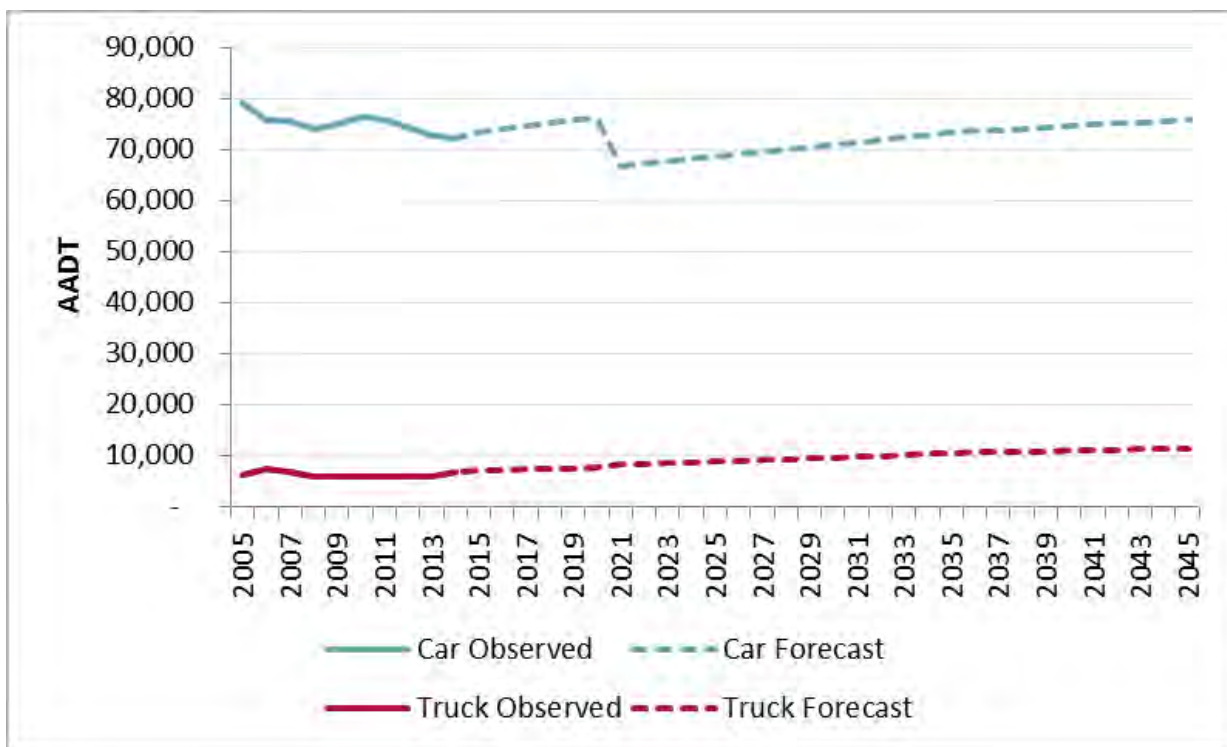
Post 2035 Growth

Forecast socioeconomic information extends to 2035. This is in line with forecasts generally as a result of issues with very long term forecasting and the high level of risk and uncertainty for such timescales. For the purposes of this study we have assumed that growth is reduced by half to 2045.

Traffic Forecasts

The resulting traffic forecasts are shown in Figure 4.6.

Figure 4.6: Massey Tunnel Replacement traffic forecasts



Source: Steer Davies Gleave

The forecasts show the following:

- Slight increase in car traffic from 2014 to 2020 as off peak growth assumed (0.9% annual growth). Trucks grow considerably higher at 1.8% in line with historical growth patterns
- Toll impact represented in 2021 with car traffic reduction and based on local experience from the Port Mann Bridge
- Growth from 2022 to 2035 based on econometric growth and induced demand generated (0.7% annual growth for cars). Truck growth continues at a faster rate (1.8%)

Forecasts split into car, Light Truck and Heavy Truck and included in Appendix B.

A Traffic Forecasts

Table A.1: Massey Tunnel Replacement Traffic Forecasts

| Year | Car | Light truck | Heavy truck | Total truck | Total traffic |
|------|--------|-------------|-------------|-------------|---------------|
| 2005 | 79,030 | 3,740 | 2,520 | 6,260 | 85,280 |
| 2006 | 75,820 | 4,480 | 2,820 | 7,300 | 83,120 |
| 2007 | 75,480 | 3,930 | 2,810 | 6,730 | 82,220 |
| 2008 | 73,980 | 3,540 | 2,400 | 5,940 | 79,930 |
| 2009 | 75,030 | 3,480 | 2,290 | 5,780 | 80,800 |
| 2010 | 76,300 | 3,590 | 2,370 | 5,960 | 82,260 |
| 2011 | 75,730 | 3,580 | 2,420 | 6,000 | 81,730 |
| 2012 | 74,240 | 3,580 | 2,330 | 5,910 | 80,150 |
| 2013 | 72,840 | 3,610 | 2,390 | 5,990 | 78,840 |
| 2014 | 72,190 | 4,130 | 2,790 | 6,920 | 79,110 |
| 2015 | 73,310 | 4,170 | 2,820 | 6,990 | 80,300 |
| 2016 | 73,930 | 4,260 | 2,870 | 7,130 | 81,060 |
| 2017 | 74,530 | 4,340 | 2,930 | 7,270 | 81,800 |
| 2018 | 75,140 | 4,430 | 2,990 | 7,410 | 82,560 |
| 2019 | 75,680 | 4,510 | 3,040 | 7,550 | 83,230 |
| 2020 | 76,110 | 4,590 | 3,100 | 7,690 | 83,800 |
| 2021 | 66,760 | 4,900 | 3,310 | 8,210 | 74,970 |
| 2022 | 67,290 | 4,990 | 3,370 | 8,370 | 75,650 |
| 2023 | 67,780 | 5,090 | 3,430 | 8,520 | 76,300 |
| 2024 | 68,160 | 5,180 | 3,490 | 8,670 | 76,840 |
| 2025 | 68,600 | 5,270 | 3,560 | 8,830 | 77,430 |
| 2026 | 69,080 | 5,370 | 3,620 | 8,990 | 78,070 |
| 2027 | 69,540 | 5,460 | 3,690 | 9,150 | 78,690 |
| 2028 | 69,990 | 5,560 | 3,750 | 9,310 | 79,300 |
| 2029 | 70,440 | 5,660 | 3,820 | 9,470 | 79,910 |
| 2030 | 70,930 | 5,750 | 3,880 | 9,640 | 80,570 |
| 2031 | 71,410 | 5,860 | 3,950 | 9,810 | 81,220 |
| 2032 | 71,870 | 5,960 | 4,020 | 9,980 | 81,850 |
| 2033 | 72,340 | 6,060 | 4,090 | 10,150 | 82,500 |
| 2034 | 72,810 | 6,170 | 4,160 | 10,330 | 83,140 |
| 2035 | 73,310 | 6,280 | 4,240 | 10,520 | 83,820 |
| 2036 | 73,560 | 6,340 | 4,280 | 10,610 | 84,170 |
| 2037 | 73,810 | 6,390 | 4,310 | 10,700 | 84,510 |
| 2038 | 74,060 | 6,450 | 4,350 | 10,800 | 84,860 |
| 2039 | 74,320 | 6,510 | 4,390 | 10,900 | 85,210 |
| 2040 | 74,570 | 6,560 | 4,430 | 10,990 | 85,560 |
| 2041 | 74,830 | 6,620 | 4,470 | 11,090 | 85,910 |
| 2042 | 75,080 | 6,680 | 4,510 | 11,190 | 86,270 |
| 2043 | 75,340 | 6,740 | 4,550 | 11,290 | 86,630 |
| 2044 | 75,600 | 6,800 | 4,590 | 11,390 | 86,980 |
| 2045 | 75,850 | 6,860 | 4,630 | 11,490 | 87,340 |

Note that Light Trucks includes transit buses



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| Version control/issue number | Date |
| V2.0 | 5-November-2015 |
| V3.0 | 24-June-2016 |



APPENDIX D

Design Hourly Volumes



George Massey Tunnel Replacement Project



DESIGN HOURLY VOLUMES

DRAFT - JUNE 2016





George Massey Tunnel Replacement Project



ALL VEHICLE VOLUMES

DRAFT - JUNE 2016



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

BRIDGEPORT ROAD / SEA ISLAND WAY

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| A1 Highway 99 SB to Sea Island WB | | |
|-----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 235 | 300 |
| PM | 770 | 1,000 |

| A2 Sea Island EB to Highway 99 SB | | |
|-----------------------------------|-------|-------|
| | 2014 | DHV |
| AM | 401 | 900 |
| PM | 1,079 | 1,600 |

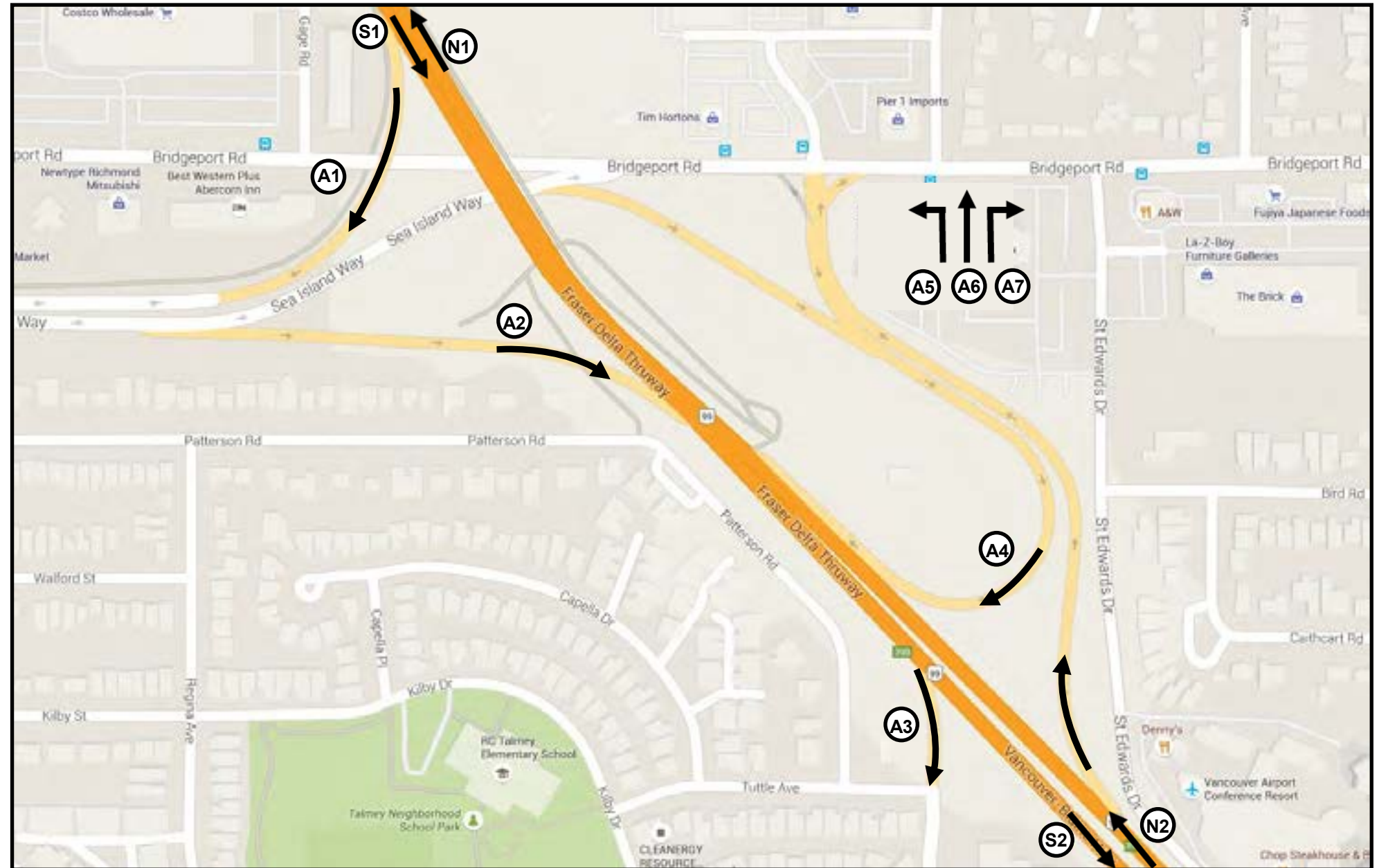
| A3 Highway 99 SB to No.4 Road | | |
|-------------------------------|------|-----|
| | 2014 | DHV |
| AM | 104 | 200 |
| PM | 480 | 500 |

| A4 Sea Island EB to Highway 99 NB | | |
|-----------------------------------|-------|-------|
| | 2014 | DHV |
| AM | 390 | 550 |
| PM | 1,031 | 1,300 |

| A5 Highway 99 NB to Bridgeport WB | | |
|-----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 977 | 1,400 |
| PM | 474 | 800 |

| A6 Highway 99 NB to Mall Entrance | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 94 | 200 |
| PM | 33 | 150 |

| A7 Highway 99 NB to Bridgeport EB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 58 | 100 |
| PM | 110 | 150 |



| S1 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,369 | 1,660 |
| PM | 3,078 | 3,550 |

| S2 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,431 | 2,060 |
| PM | 2,907 | 3,650 |

| N1 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 2,958 | 3,680 |
| PM | 3,372 | 3,345 |

| N2 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,697 | 4,830 |
| PM | 2,958 | 3,145 |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

SHELL ROAD

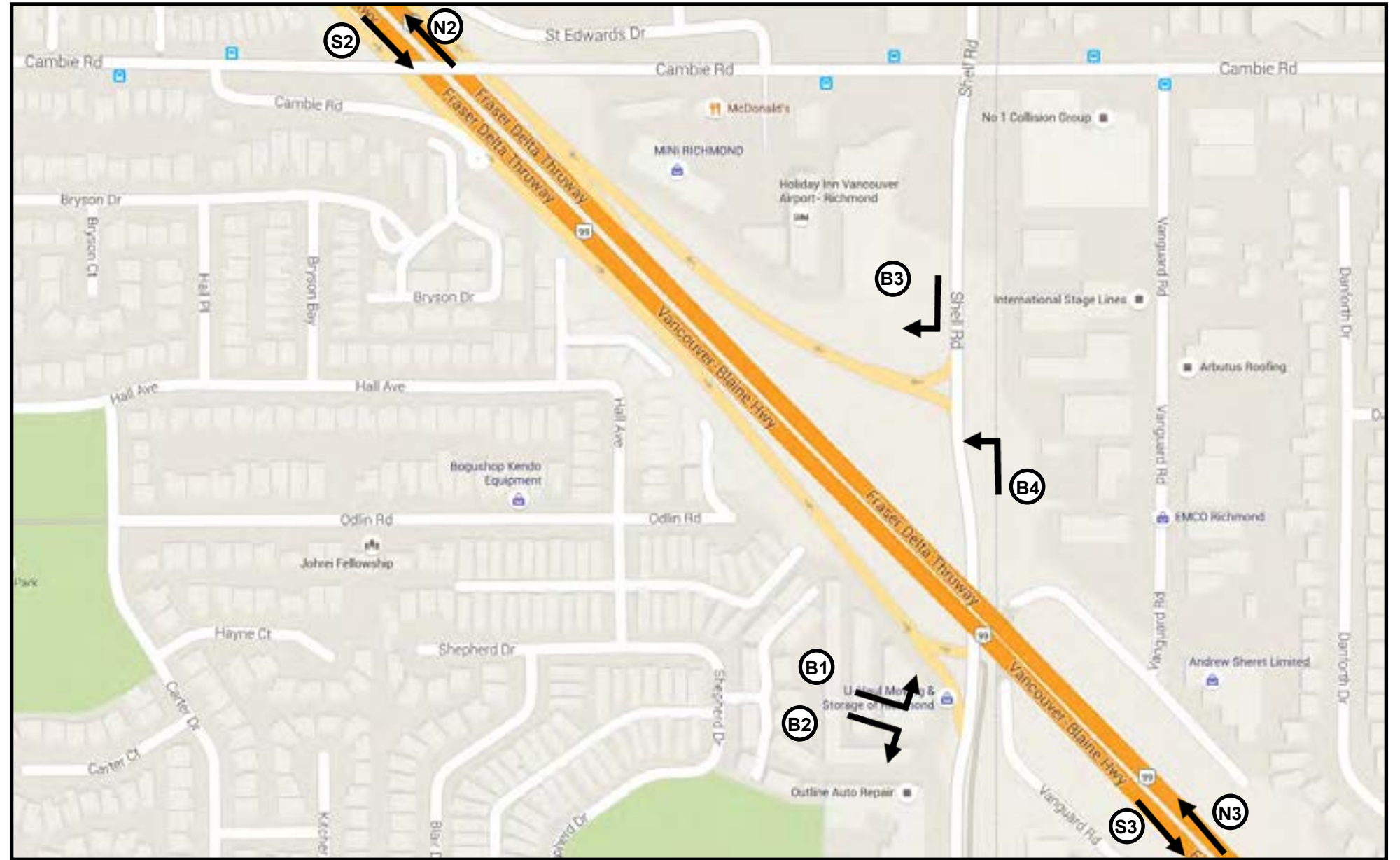
Historical and Forecast Hourly Traffic Volumes - All Vehicles

| B1 Highway 99 SB to Shell Road EB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 98 | 150 |
| PM | 162 | 200 |

| B2 Highway 99 SB to Shell Road WB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 54 | 100 |
| PM | 191 | 250 |

| B3 Shell Road WB to Highway 99 NB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 142 | 225 |
| PM | 506 | 900 |

| B4 Shell Road EB to Highway 99 NB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 265 | 325 |
| PM | 257 | 350 |



| S2 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,431 | 2,060 |
| PM | 2,907 | 3,650 |

| S3 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,279 | 1,810 |
| PM | 2,554 | 3,200 |

| N2 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,697 | 4,830 |
| PM | 2,958 | 3,145 |

| N3 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,290 | 4,280 |
| PM | 2,195 | 1,895 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

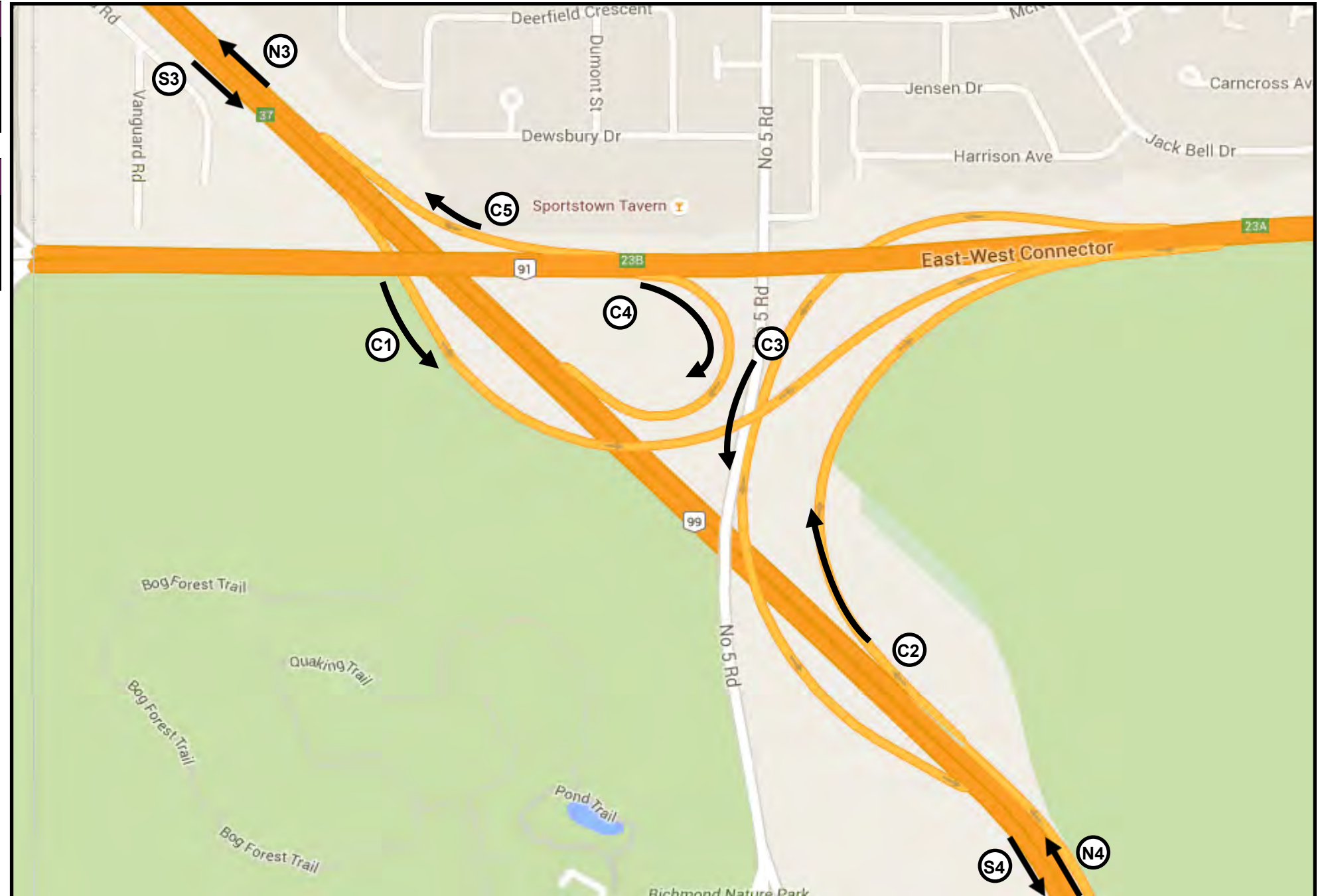
| C1 Highway 99 SB to Highway 91 EB | | |
|-----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 824 | 1,150 |
| PM | 845 | 950 |

| C2 Highway 99 NB to Highway 91 EB | | |
|-----------------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,165 | 1,800 |
| PM | 402 | 550 |

| C3 Highway 91 WB to Highway 99 SB | | |
|-----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 642 | 1,000 |
| PM | 745 | 1,600 |

| C4 Alderbridge Way EB to Highway 99 NB | | |
|--|------|-----|
| | 2014 | DHV |
| AM | 14 | 50 |
| PM | 63 | 100 |

| C5 Highway 91 WB to Highway 99 NB | | |
|-----------------------------------|-------|-------|
| | 2014 | DHV |
| AM | 928 | 500 |
| PM | 1,248 | 1,200 |



| S3 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,279 | 1,810 |
| PM | 2,554 | 3,200 |

| S4 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,097 | 1,660 |
| PM | 2,454 | 3,850 |

| N3 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,290 | 4,280 |
| PM | 2,195 | 1,895 |

| N4 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,513 | 5,530 |
| PM | 1,286 | 1,145 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| D1 Westminster Highway EB Thru | | |
|--------------------------------|------|-------|
| | 2014 | DHV |
| AM | 718 | 1,000 |
| PM | 832 | 1,100 |

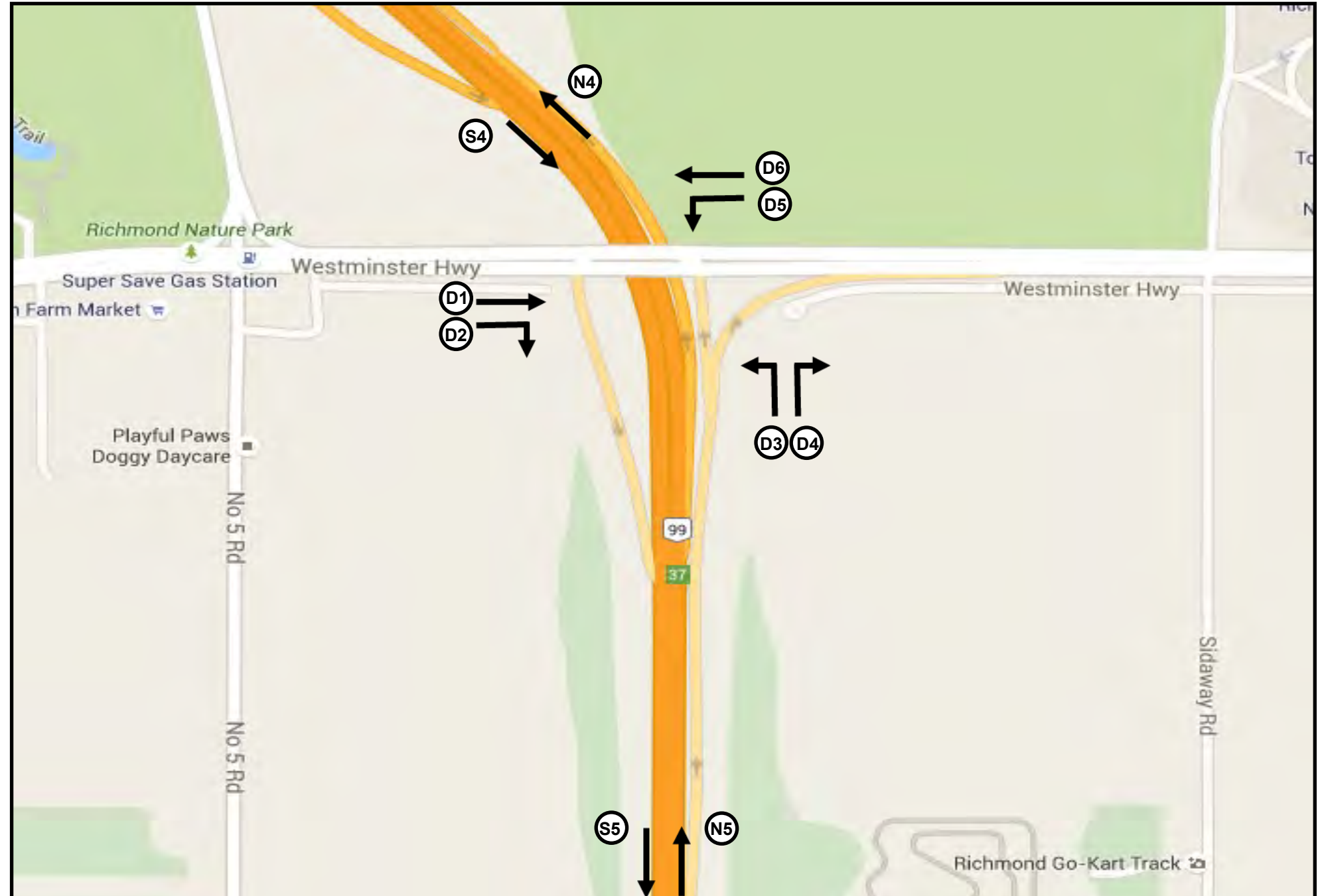
| D2 Westminster EB to Highway 99 SB | | |
|------------------------------------|------|-------|
| | 2014 | DHV |
| AM | 96 | 350 |
| PM | 869 | 1,800 |

| D3 Highway 99 NB to Westminster WB | | |
|------------------------------------|------|-------|
| | 2014 | DHV |
| AM | 758 | 1,200 |
| PM | 174 | 450 |

| D4 Highway 99 NB to Westminster EB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 503 | 800 |
| PM | 130 | 450 |

| D5 Westminster WB to Highway 99 SB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 38 | 300 |
| PM | 423 | 800 |

| D6 Westminster Highway WB Thru | | |
|--------------------------------|-------|-------|
| | 2014 | DHV |
| AM | 330 | 450 |
| PM | 1,489 | 2,000 |



| S4 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,097 | 1,660 |
| PM | 2,454 | 3,850 |

| S5 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,231 | 2,310 |
| PM | 3,746 | 6,450 |

| N4 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,513 | 5,530 |
| PM | 1,286 | 1,145 |

| N5 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 4,774 | 7,530 |
| PM | 1,590 | 2,045 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| E1 Highway 99 SB to Steveston EB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 24 | 200 |
| PM | 34 | 200 |

| E2 Highway 99 SB to Steveston WB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 446 | 750 |
| PM | 121 | 350 |

| E3 Steveston EB to Highway 99 NB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 508 | 675 |
| PM | 554 | 850 |

| E4 Steveston Highway EB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 109 | 200 |
| PM | 250 | 350 |

| E5 Steveston EB to Highway 99 SB | | |
|----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 585 | 950 |
| PM | 852 | 1,600 |

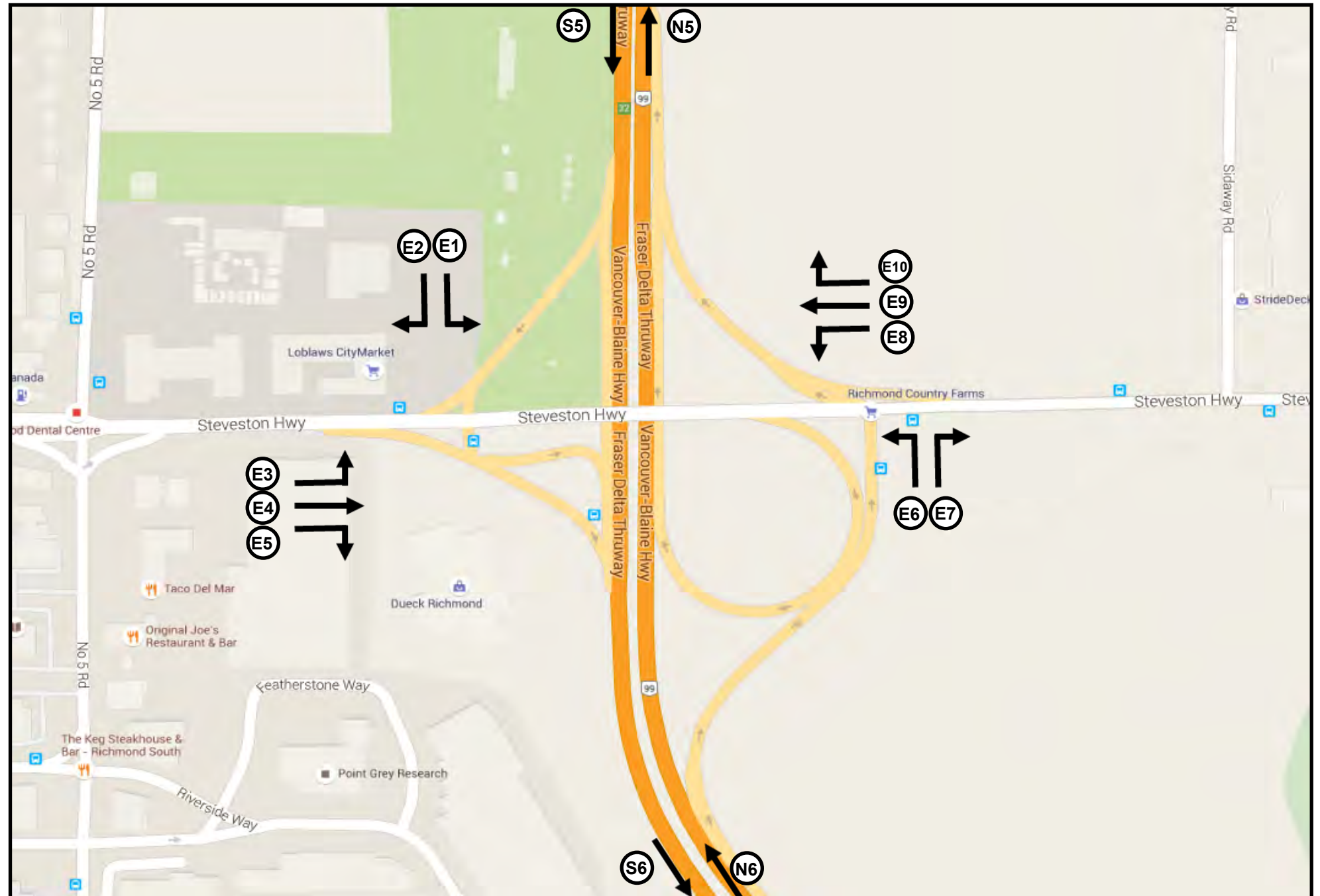
| E6 Highway 99 NB to Steveston WB | | |
|----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 747 | 1,000 |
| PM | 359 | 950 |

| E7 Highway 99 NB to Steveston EB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 100 | 300 |
| PM | 89 | 200 |

| E8 Steveston WB to Highway 99 SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 65 | 100 |
| PM | 354 | 500 |

| E9 Steveston Highway WB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 85 | 200 |
| PM | 277 | 400 |

| E10 Steveston WB to Highway 99 NB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 36 | 100 |
| PM | 62 | 100 |



| S5 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,231 | 2,310 |
| PM | 3,746 | 6,450 |

| S6 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,411 | 2,410 |
| PM | 4,797 | 8,000 |

| N5 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 4,774 | 7,530 |
| PM | 1,590 | 2,045 |

| N6 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 5,077 | 8,055 |
| PM | 1,422 | 2,245 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| F1 River Road Off-Ramp | | |
|------------------------|------|-----|
| | 2014 | DHV |
| AM | 91 | 300 |
| PM | 612 | 900 |

| F2 Highway 99 SB to Highway 17A EB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 345 | 400 |
| PM | 123 | 250 |

| F3 Highway 99 SB to Highway 17A WB | | |
|------------------------------------|-------|--------------|
| | 2014 | DHV |
| AM | 338 | 500 |
| PM | 1,029 | 1,750 (+300) |

| F4 Highway 17A EB to Highway 99 NB HOV | | |
|--|------|-----|
| | 2014 | DHV |
| AM | 398 | 250 |
| PM | 227 | 150 |

| F5 Highway 17A EB to Highway 99 NB | | |
|------------------------------------|------|-------|
| | 2014 | DHV |
| AM | 780 | 1,775 |
| PM | 422 | 650 |

| F6 Highway 17A EB Thru | | |
|------------------------|------|-----|
| | 2014 | DHV |
| AM | 549 | 400 |
| PM | 113 | 200 |

| F7 Highway 17A EB to Highway 99 SB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 58 | 200 |
| PM | 311 | 400 |

| F8 Highway 99 NB to Highway 17A WB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 135 | 400 |
| PM | 258 | 350 |

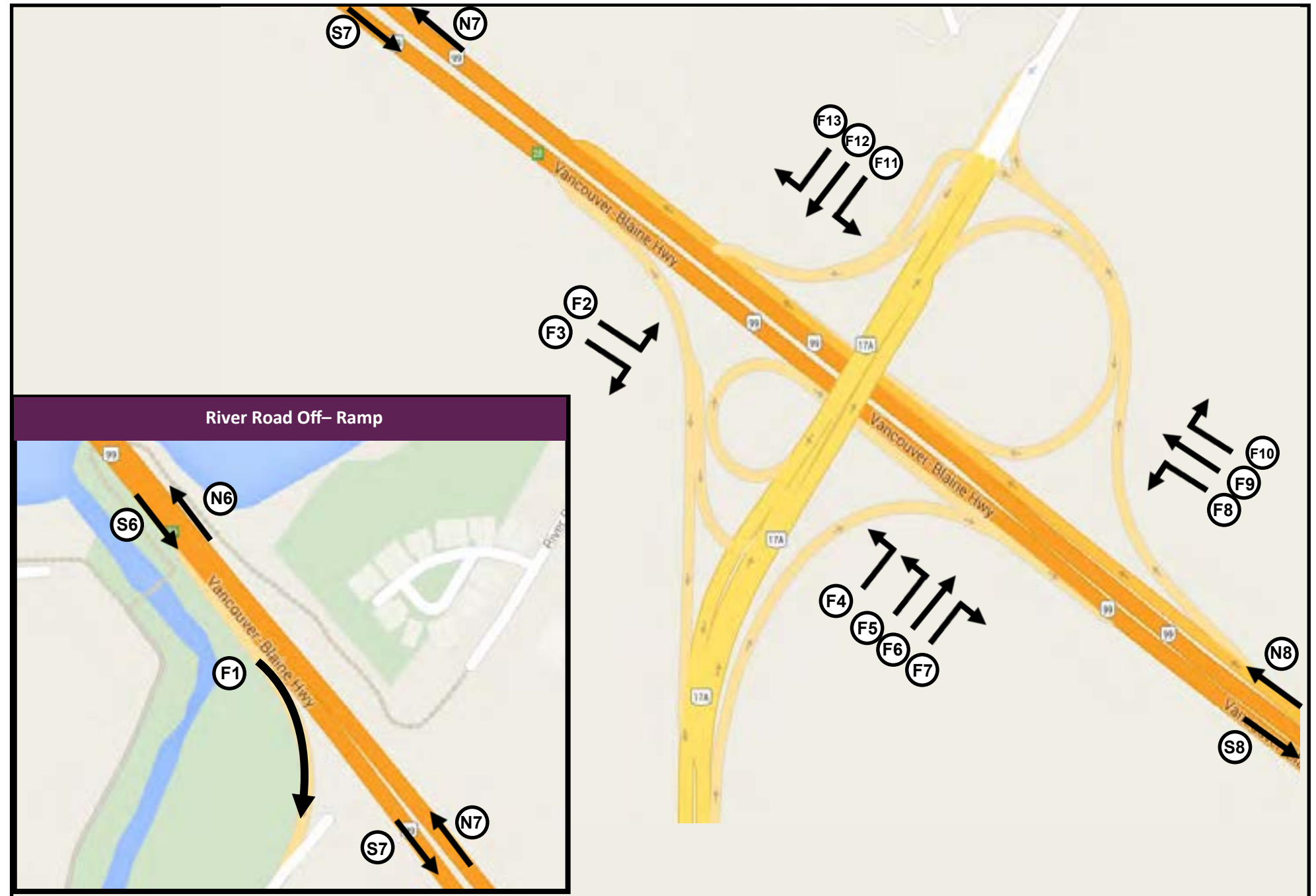
| F9 Highway 99 NB to Highway 99 NB HOV | | |
|---------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 254 | N/A |
| PM | 131 | N/A |

| F10 Highway 99 NB to Highway 17A EB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 267 | 400 |
| PM | 39 | 150 |

| F11 Highway 17A WB to Highway 99 SB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 51 | 50 |
| PM | 156 | 250 |

| F12 Highway 17A WB Thru | | |
|-------------------------|------|-----|
| | 2014 | DHV |
| AM | 31 | 200 |
| PM | 273 | 500 |

| F13 Highway 17A WB to Highway 99 NB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 520 | 800 |
| PM | 221 | 800 |



| S7 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,320 | 2,110 |
| PM | 4,185 | 7,100 |

| S8 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 746 | 1,460 |
| PM | 3,500 | 5,450 |

| N7 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 5,077 | 8,055 |
| PM | 1,422 | 2,245 |

| N8 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,781 | 6,030 |
| PM | 849 | 1,145 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| G1 Highway 99 SB to Highway 17 EB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 189 | 200 |
| PM | 488 | 950 |

| G2 Highway 99 SB to Highway 17 WB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 72 | 250 |
| PM | 119 | 300 |

| G3 Highway 17 EB Thru | | |
|-----------------------|------|-----|
| | 2014 | DHV |
| AM | 227 | 300 |
| PM | 308 | 400 |

| G4 Highway 17 EB to Highway 99 NB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 394 | 750 |
| PM | 86 | 350 |

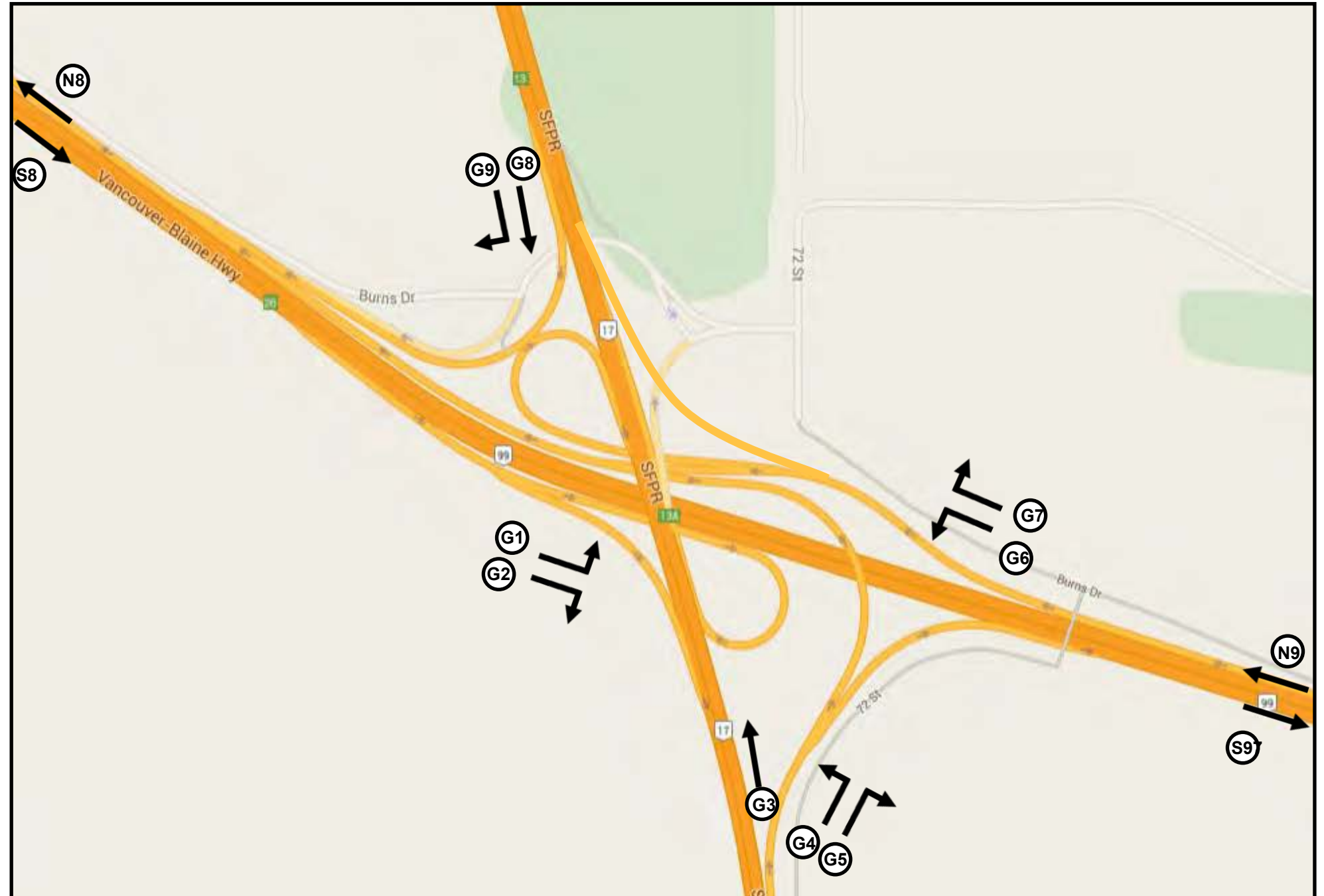
| G5 Highway 17 EB to Highway 99 SB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 163 | 250 |
| PM | 343 | 450 |

| G6 Highway 99 NB to Highway 17 WB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 324 | 450 |
| PM | 219 | 450 |

| G7 Highway 99 NB to Highway 17 EB (Future) | | |
|--|------|-----|
| | 2014 | DHV |
| AM | N/A | 400 |
| PM | N/A | 150 |

| G8 Highway 17 WB Thru | | |
|-----------------------|------|-----|
| | 2014 | DHV |
| AM | 189 | 250 |
| PM | 268 | 300 |

| G9 Hwy 17 WB + Burns Dr. to Hwy 99 NB | | |
|---------------------------------------|------|-------|
| | 2014 | DHV |
| AM | 535 | 1,150 |
| PM | 243 | 350 |



| S8 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 746 | 1,460 |
| PM | 3,500 | 5,450 |

| S9 Highway 99 Mainline SB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 648 | 1,260 |
| PM | 3,236 | 4,650 |

| N8 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,781 | 6,030 |
| PM | 849 | 1,145 |

| N9 Highway 99 Mainline NB | | |
|---------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,176 | 4,980 |
| PM | 739 | 1,045 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| H1 80th Street Off-Ramp | | |
|-------------------------|------|-----|
| | 2015 | DHV |
| AM | 43 | 100 |
| PM | 60 | 100 |

| H2 Highway 99 SB to Ladner Trunk Rd | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 68 | 100 |
| PM | 502 | 650 |

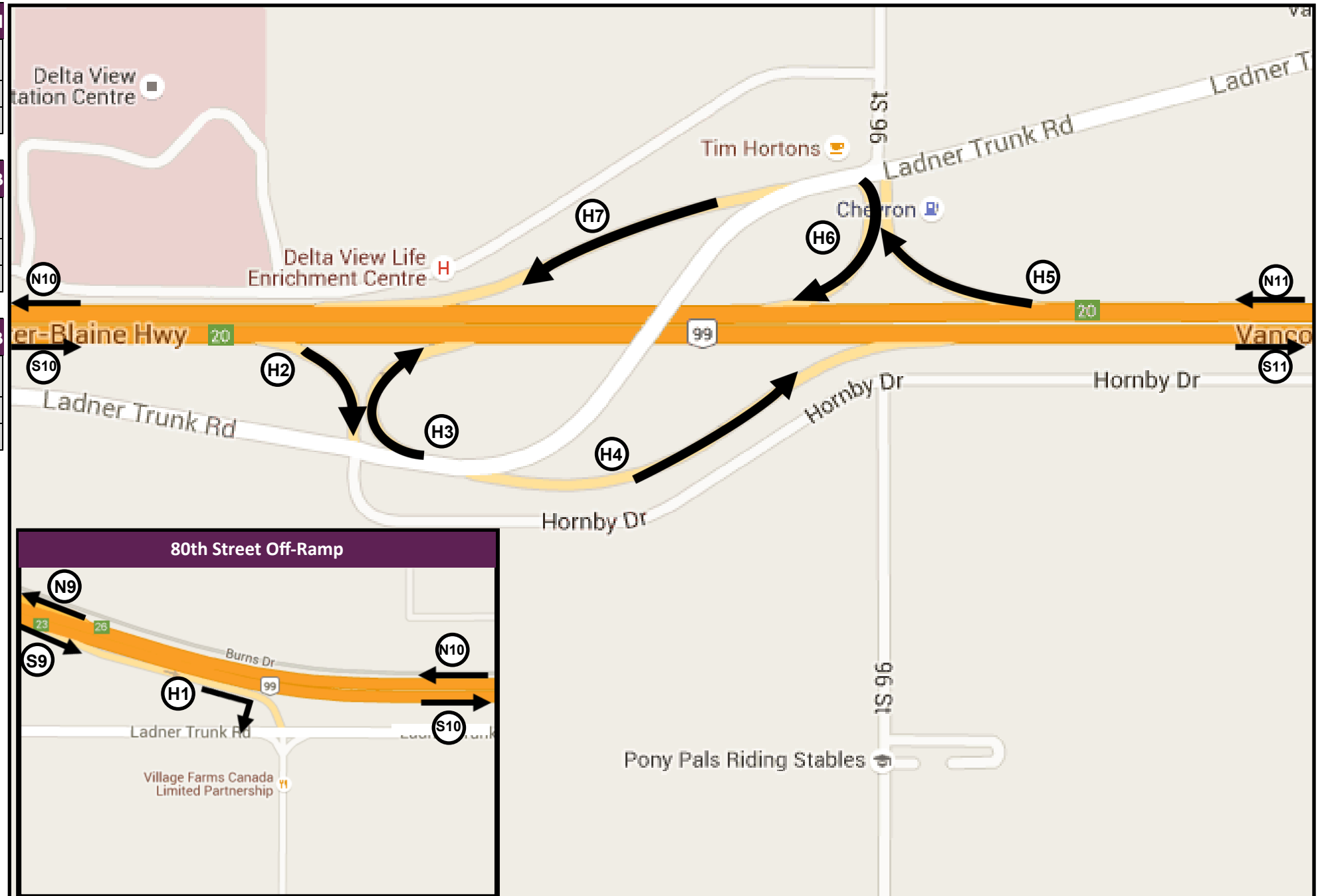
| H3 Ladner Trunk WB to Highway 99 SB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 2 | 50 |
| PM | 16 | 50 |

| H4 Ladner Trunk EB to Highway 99 SB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 70 | 100 |
| PM | 130 | 200 |

| H5 Highway 99 NB to Ladner Trunk Rd. | | |
|--------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 198 | 300 |
| PM | 114 | 200 |

| H6 Ladner Trunk EB to Highway 99 NB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 11 | 50 |
| PM | 4 | 50 |

| H7 Ladner Trunk WB to Highway 99 NB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 722 | 950 |
| PM | 167 | 250 |



| S10 Highway 99 Mainline SB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 605 | 1,160 |
| PM | 3,176 | 4,550 |

| S11 Highway 99 Mainline SB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 609 | 1,210 |
| PM | 2,820 | 4,150 |

| N10 Highway 99 Mainline NB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 3,176 | 4,980 |
| PM | 739 | 1,045 |

| N11 Highway 99 Mainline NB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 2,641 | 4,280 |
| PM | 682 | 945 |

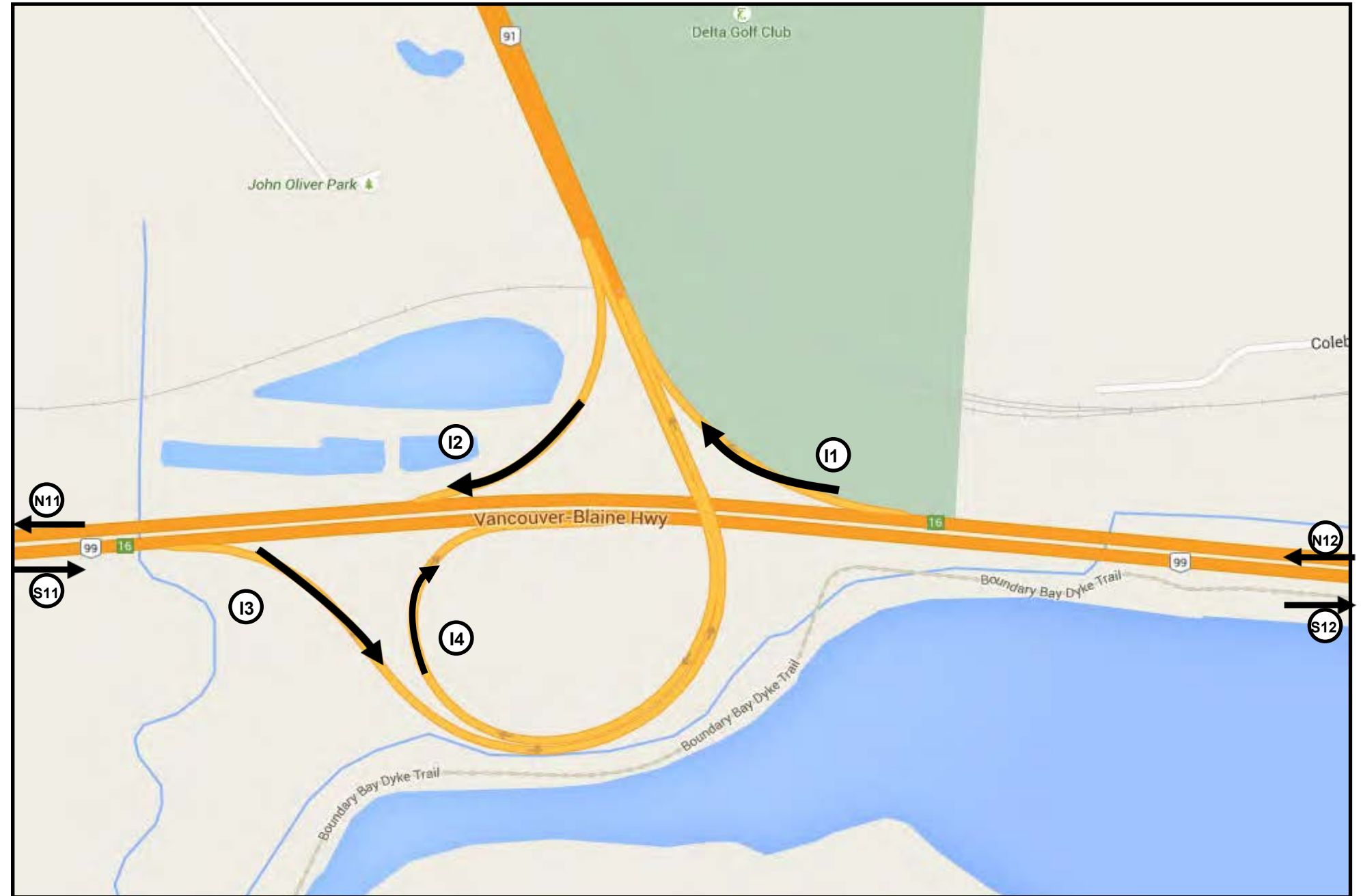
Historical and Forecast Hourly Traffic Volumes - All Vehicles

| I1 Highway 99 NB to Highway 91 EB | | |
|-----------------------------------|-------|-------|
| | 2014 | DHV |
| AM | 997 | 1,450 |
| PM | 1,007 | 1,450 |

| I2 Highway 91 WB to Highway 99 NB | | |
|-----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 849 | 1,400 |
| PM | 88 | 200 |

| I3 Highway 99 SB to Highway 91 EB | | |
|-----------------------------------|------|-------|
| | 2014 | DHV |
| AM | 195 | 400 |
| PM | 778 | 1,200 |

| I4 Highway 91 EB to Highway 99 SB | | |
|-----------------------------------|-------|-------|
| | 2014 | DHV |
| AM | 433 | 600 |
| PM | 1,183 | 1,400 |



| S11 Highway 99 Mainline SB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 609 | 1,210 |
| PM | 2,820 | 4,150 |

| S12 Highway 99 Mainline SB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 847 | 1,410 |
| PM | 3,225 | 4,350 |

| N11 Highway 99 Mainline NB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 2,641 | 4,280 |
| PM | 682 | 945 |

| N12 Highway 99 Mainline NB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 2,789 | 4,330 |
| PM | 1,601 | 2,195 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| J1 Highway 99 SB to King George EB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 53 | 100 |
| PM | 398 | 600 |

| J2 Highway 99 SB to King George WB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 57 | 100 |
| PM | 285 | 750 |

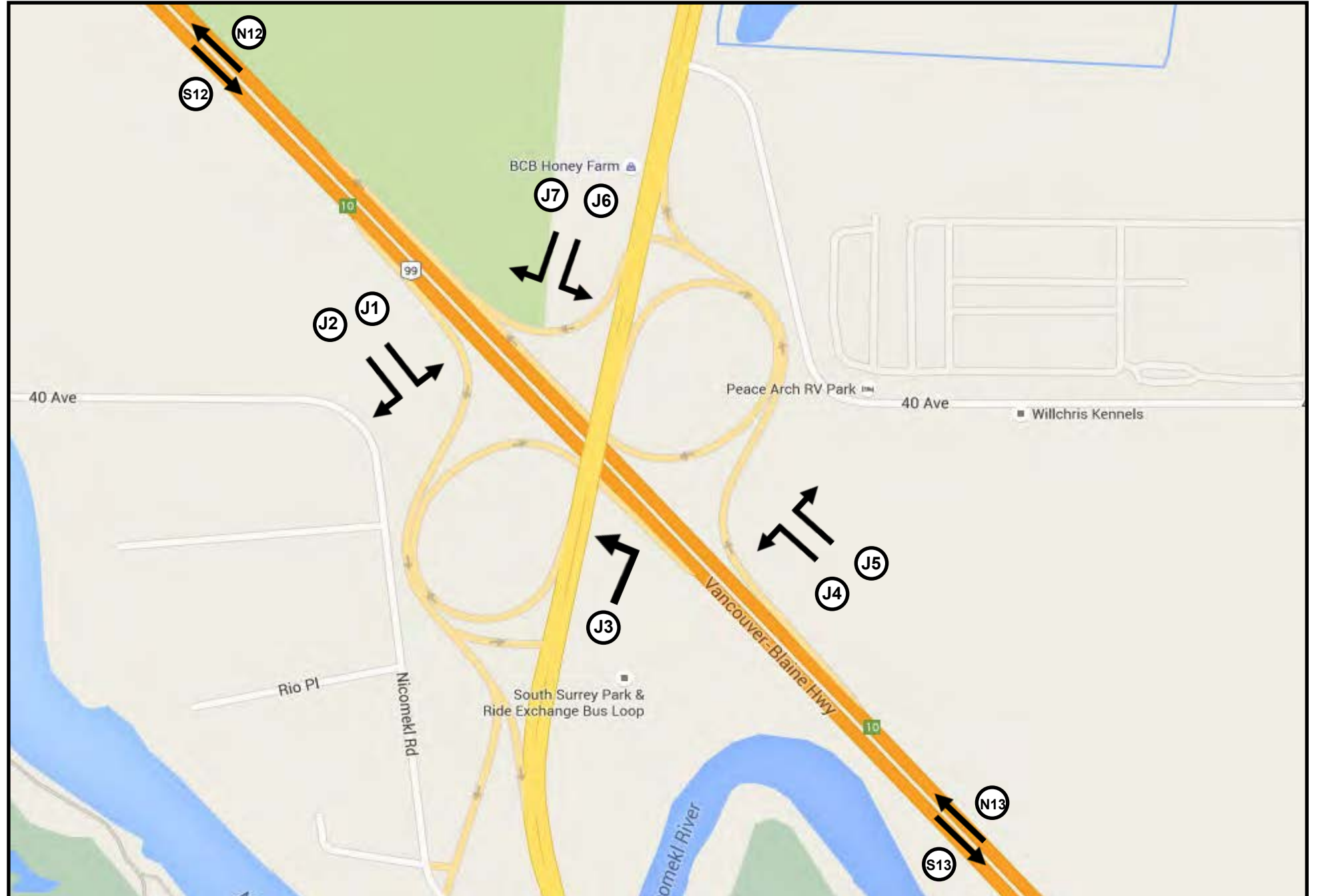
| J3 King George EB to Highway 99 NB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 633 | 875 |
| PM | 299 | 450 |

| J4 Highway 99 NB to King George WB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 33 | 50 |
| PM | 22 | 50 |

| J5 Highway 99 NB to King George EB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 278 | 300 |
| PM | 395 | 600 |

| J6 King George WB to Highway 99 SB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 162 | 300 |
| PM | 457 | 850 |

| J7 King George WB to Highway 99 NB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 486 | 925 |
| PM | 74 | 150 |



| S12 Highway 99 Mainline SB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 847 | 1,410 |
| PM | 3,225 | 4,350 |

| S13 Highway 99 Mainline SB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 899 | 1,510 |
| PM | 2,999 | 3,850 |

| N12 Highway 99 Mainline NB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 2,789 | 4,330 |
| PM | 1,601 | 2,195 |

| N13 Highway 99 Mainline NB | | |
|----------------------------|-------|-------|
| | 2014 | DHV |
| AM | 1,981 | 2,880 |
| PM | 1,645 | 2,245 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| Z1 No.5 Road NB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 17 | 25 |
| PM | 97 | 130 |

| Z2 No.5 Road NB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 53 | 70 |
| PM | 279 | 380 |

| Z3 No.5 Road NB to Steveston EB | | |
|---------------------------------|------|-------|
| | 2014 | DHV |
| AM | 177 | 273 |
| PM | 689 | 1,163 |

| Z4 No.5 Road SB to Steveston EB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 161 | 248 |
| PM | 187 | 318 |

| Z5 No.5 Road SB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 182 | 250 |
| PM | 319 | 435 |

| Z6 No.5 Road SB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 36 | 50 |
| PM | 132 | 180 |

| Z7 Steveston EB to No.5 Road NB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 32 | 45 |
| PM | 90 | 125 |

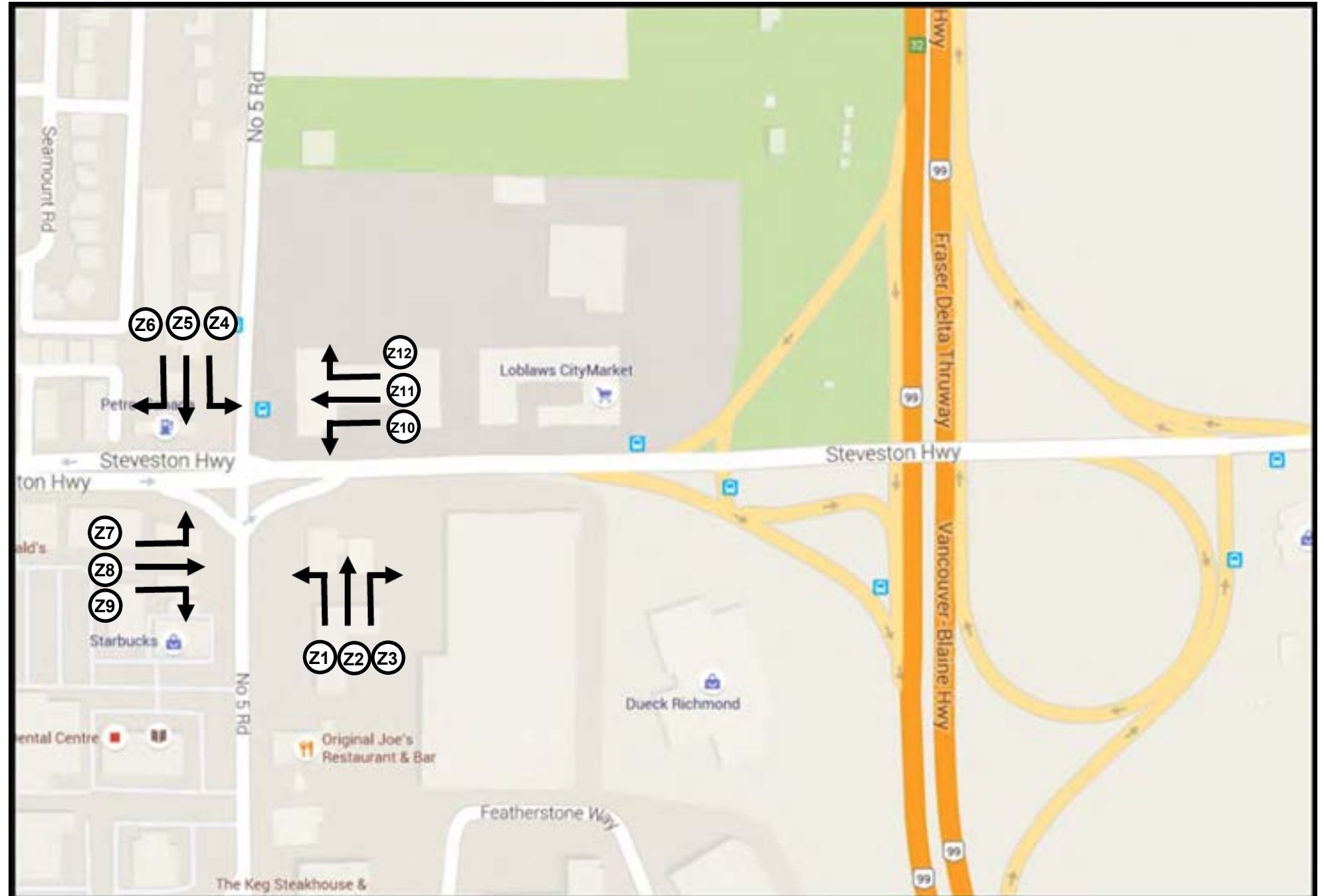
| Z8 Steveston Highway EB Thru | | |
|------------------------------|------|-------|
| | 2014 | DHV |
| AM | 864 | 1,304 |
| PM | 780 | 1,319 |

| Z9 Steveston EB to No.5 Road SB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 61 | 85 |
| PM | 24 | 30 |

| Z10 Steveston WB to No.5 Road SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 637 | 970 |
| PM | 186 | 420 |

| Z11 Steveston Highway WB Thru | | |
|-------------------------------|------|-------|
| | 2014 | DHV |
| AM | 569 | 870 |
| PM | 486 | 1,090 |

| Z12 Steveston Highway to No.5 Road NB | | |
|---------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 72 | 110 |
| PM | 85 | 190 |



George Massey Tunnel Replacement Project

TRUCK VOLUMES

DRAFT - MARCH 2016

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

BRIDGEPORT ROAD / SEA ISLAND WAY

Historical and Forecast Hourly Traffic Volumes - Trucks

| A1 Highway 99 SB to Sea Island WB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 3 | 10 |
| PM | 9 | 20 |

| A2 Sea Island EB to Highway 99 SB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 42 | 135 |
| PM | 50 | 150 |

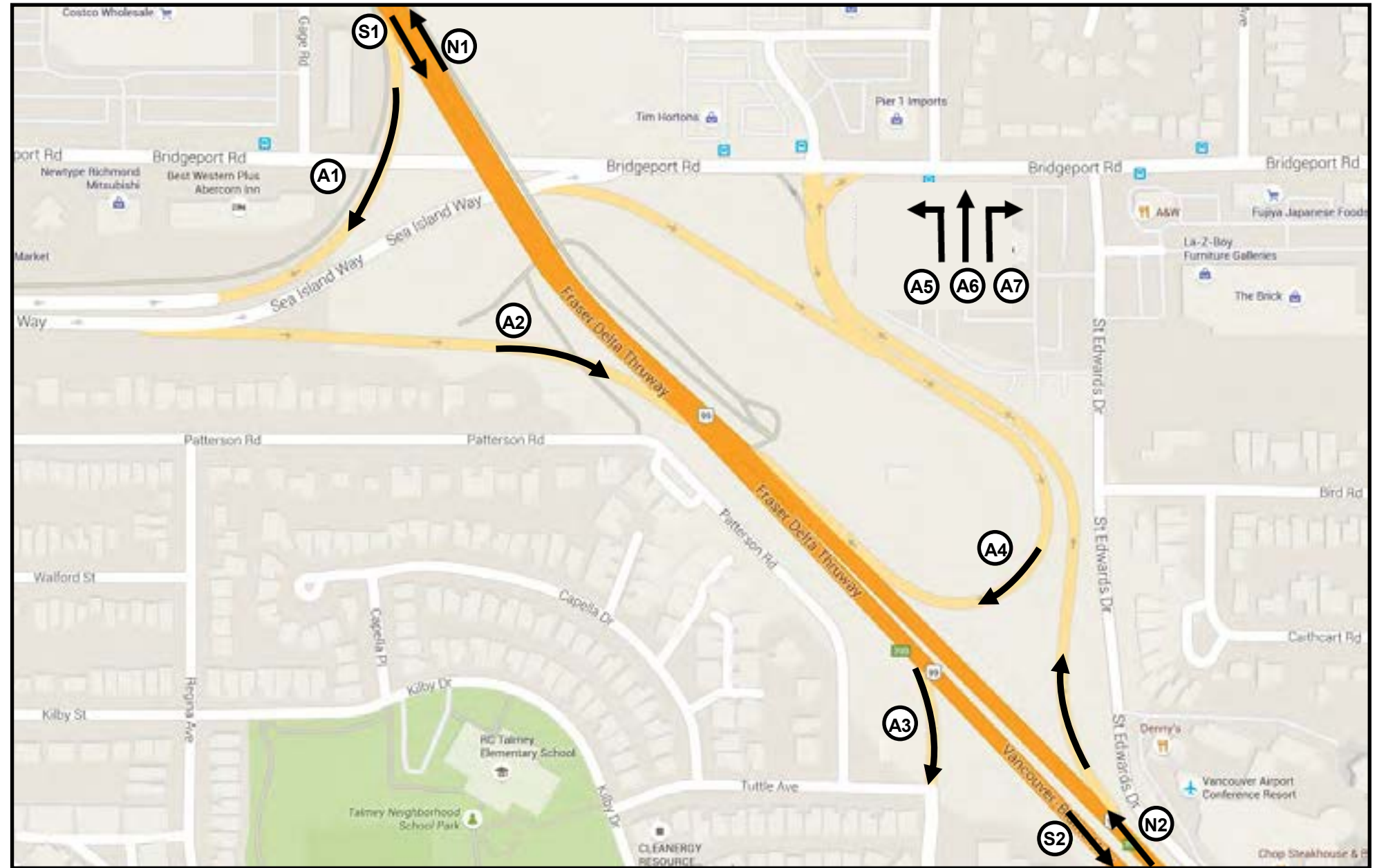
| A3 Highway 99 SB to No.4 Road | | |
|-------------------------------|------|-----|
| | 2014 | DHV |
| AM | 5 | 10 |
| PM | 24 | 50 |

| A4 Sea Island EB to Highway 99 NB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 20 | 40 |
| PM | 52 | 100 |

| A5 Highway 99 NB to Bridgeport WB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 46 | 100 |
| PM | 70 | 140 |

| A6 Highway 99 NB to Mall Entrance | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 4 | 10 |
| PM | 3 | 10 |

| A7 Highway 99 NB to Bridgeport EB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | 5 |
| PM | 2 | 5 |



| S1 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 87 | 415 |
| PM | 105 | 265 |

| S2 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 121 | 530 |
| PM | 122 | 345 |

| N1 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 207 | 655 |
| PM | 81 | 345 |

| N2 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 238 | 730 |
| PM | 104 | 400 |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

SHELL ROAD

Historical and Forecast Hourly Traffic Volumes - Trucks

B1 Highway 99 SB to Shell Road EB

| | 2014 | DHV |
|----|------|-----|
| AM | 0 | 5 |
| PM | 1 | 5 |

B2 Highway 99 SB to Shell Road WB

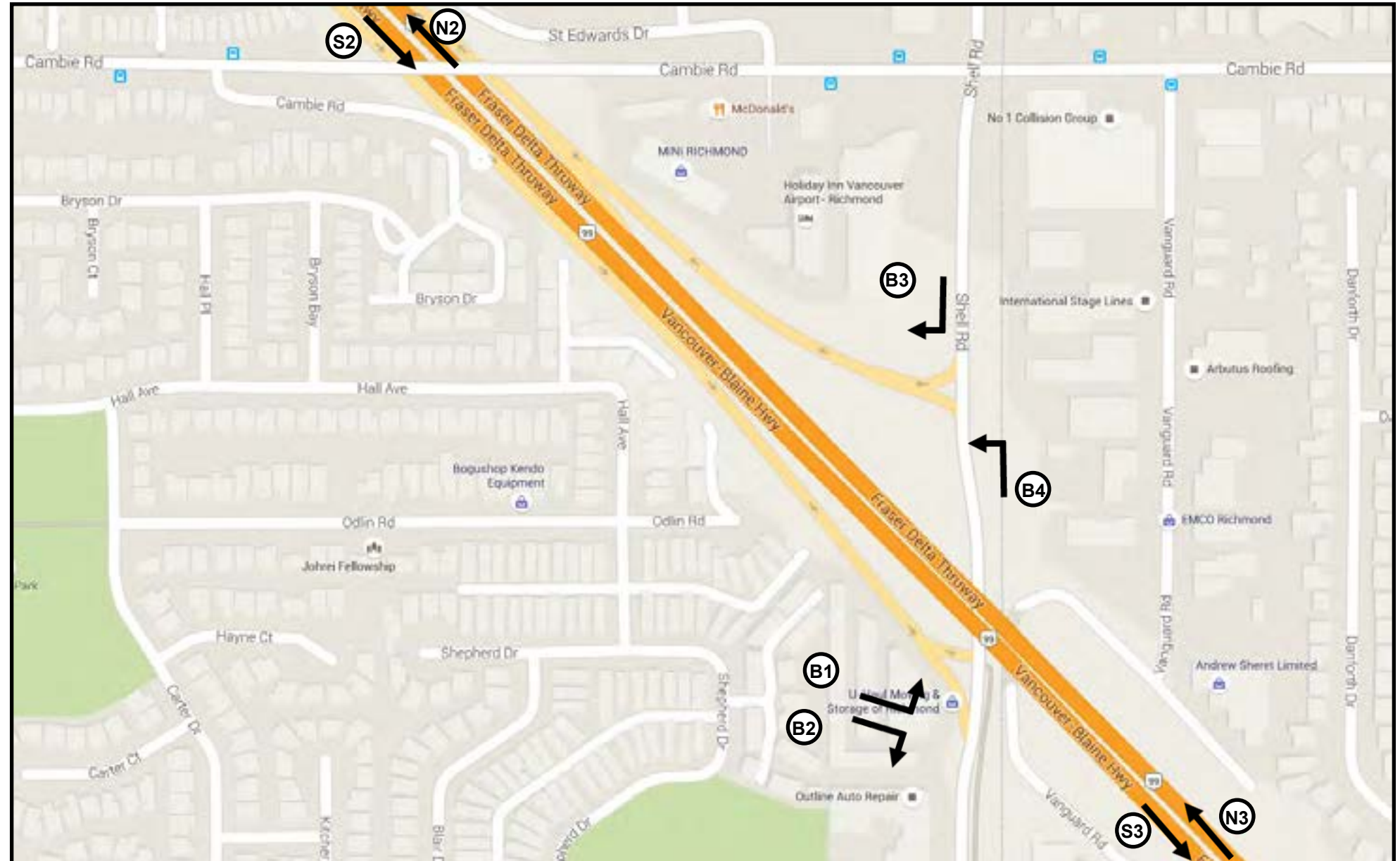
| | 2014 | DHV |
|----|------|-----|
| AM | 2 | 10 |
| PM | 9 | 20 |

B3 Shell Road WB to Highway 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | 1 | 5 |
| PM | 6 | 20 |

B4 Shell Road EB to Highway 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | 14 | 30 |
| PM | 4 | 10 |



S2 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 121 | 530 |
| PM | 122 | 345 |

S3 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 119 | 515 |
| PM | 112 | 320 |

N2 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 238 | 730 |
| PM | 104 | 400 |

N3 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 223 | 695 |
| PM | 94 | 370 |

Historical and Forecast Hourly Traffic Volumes - Trucks

C1 Highway 99 SB to Highway 91 EB

| | 2014 | DHV |
|----|------|-----|
| AM | 41 | 80 |
| PM | 42 | 80 |

C2 Highway 99 NB to Highway 91 EB

| | 2014 | DHV |
|----|------|-----|
| AM | 58 | 120 |
| PM | 20 | 40 |

C3 Highway 91 WB to Highway 99 SB

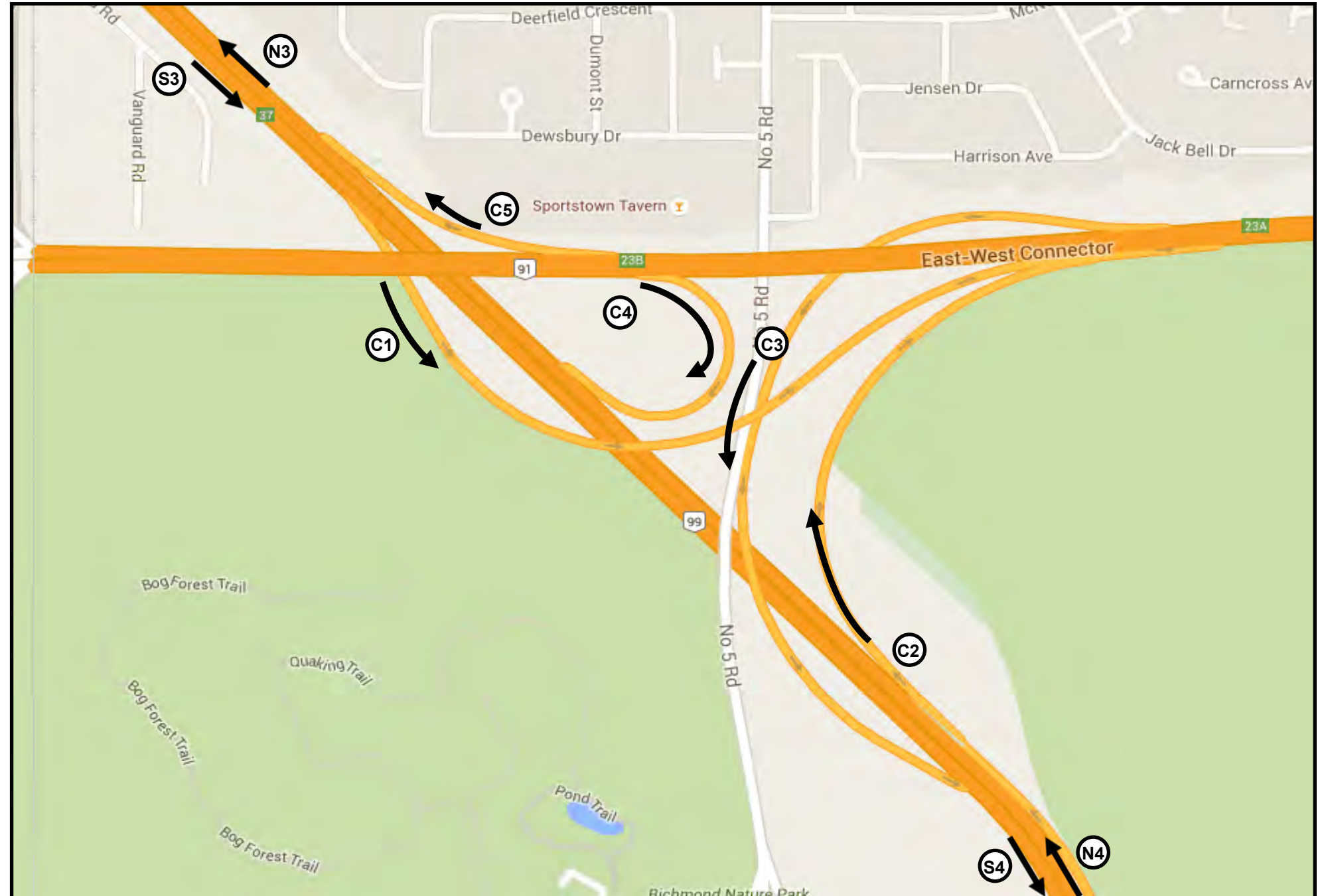
| | 2014 | DHV |
|----|------|-----|
| AM | 32 | 60 |
| PM | 37 | 120 |

C4 Alderbridge Way EB to Highway 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | 1 | 5 |
| PM | 3 | 5 |

C5 Highway 91 WB to Highway 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | 46 | 60 |
| PM | 62 | 80 |



S3 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 119 | 515 |
| PM | 112 | 320 |

S4 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 110 | 495 |
| PM | 107 | 360 |

N3 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 223 | 695 |
| PM | 94 | 370 |

N4 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 234 | 750 |
| PM | 49 | 325 |

Historical and Forecast Hourly Traffic Volumes - Trucks

D1 Westminster Highway EB Thru

| | 2014 | DHV |
|----|------|-----|
| AM | 10 | 30 |
| PM | 23 | 30 |

D2 Westminster EB to Highway 99 SB

| | 2014 | DHV |
|----|------|-----|
| AM | 3 | 50 |
| PM | 8 | 50 |

D3 Highway 99 NB to Westminster WB

| | 2014 | DHV |
|----|------|-----|
| AM | 25 | 50 |
| PM | 0 | 50 |

D4 Highway 99 NB to Westminster EB

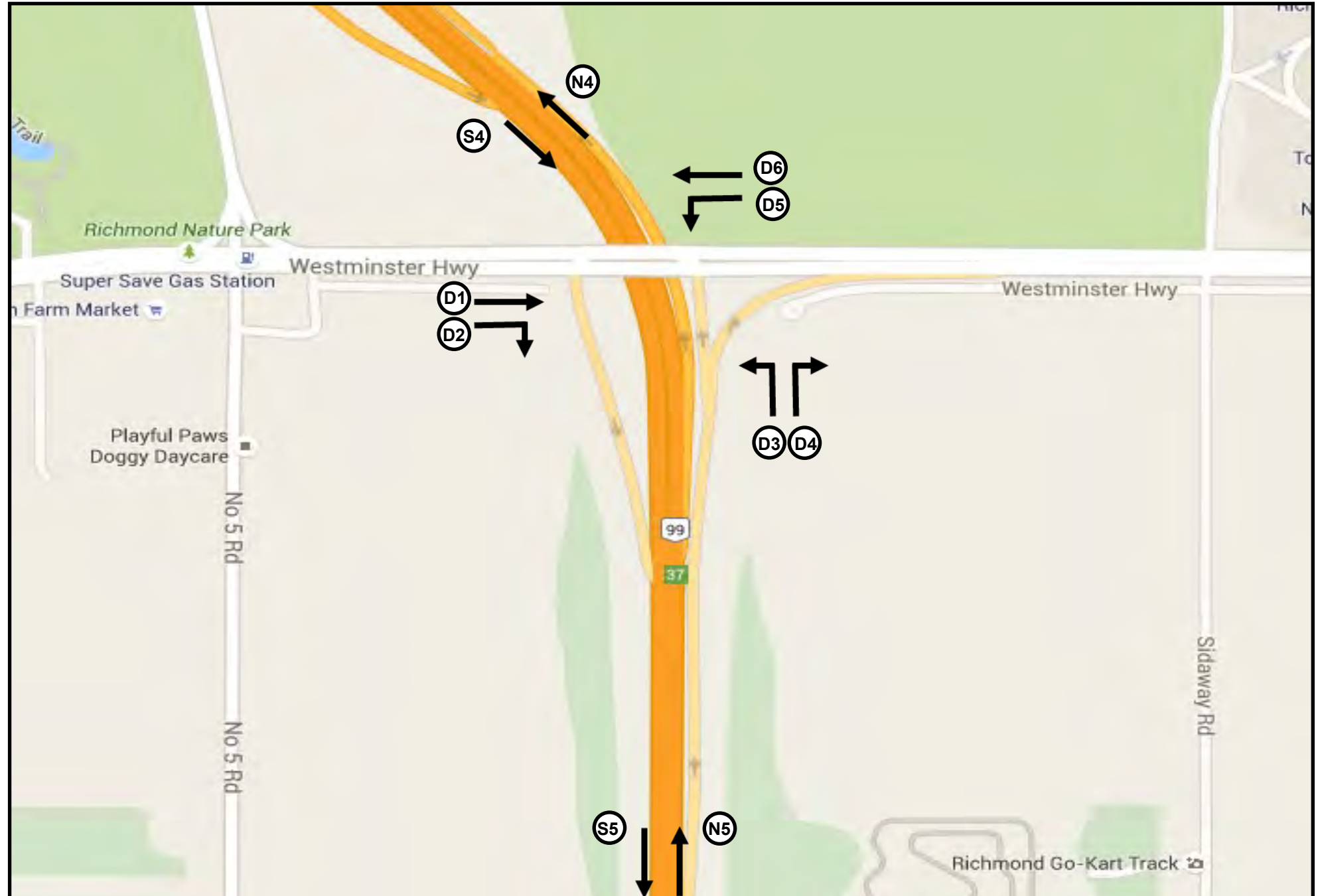
| | 2014 | DHV |
|----|------|-----|
| AM | 14 | 30 |
| PM | 2 | 30 |

D5 Westminster WB to Highway 99 SB

| | 2014 | DHV |
|----|------|-----|
| AM | 2 | 30 |
| PM | 10 | 30 |

D6 Westminster Highway WB Thru

| | 2014 | DHV |
|----|------|-----|
| AM | 18 | 30 |
| PM | 11 | 30 |



S4 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 110 | 495 |
| PM | 107 | 360 |

S5 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 115 | 575 |
| PM | 125 | 440 |

N4 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 234 | 750 |
| PM | 49 | 325 |

N5 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 273 | 830 |
| PM | 51 | 405 |

Historical and Forecast Hourly Traffic Volumes - Trucks

| E1 Highway 99 SB to Steveston EB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 12 | 30 |
| PM | 3 | 30 |

| E2 Highway 99 SB to Steveston WB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 20 | 100 |
| PM | 7 | 40 |

| E3 Steveston EB to Highway 99 NB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 34 | 80 |
| PM | 11 | 80 |

| E4 Steveston Highway EB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 5 | 20 |
| PM | 0 | 20 |

| E5 Steveston EB to Highway 99 SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 24 | 50 |
| PM | 25 | 100 |

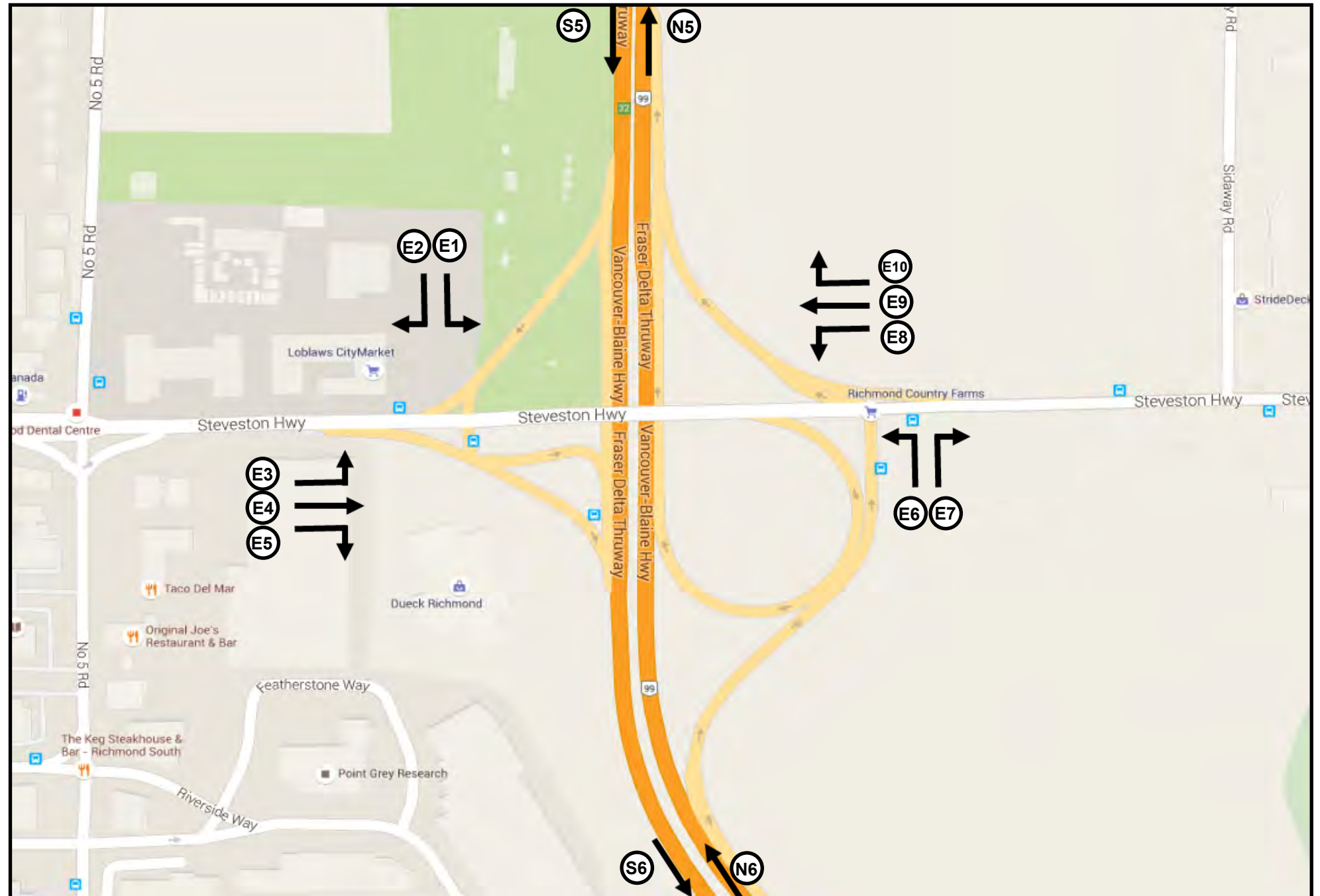
| E6 Highway 99 NB to Steveston WB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 46 | 100 |
| PM | 11 | 50 |

| E7 Highway 99 NB to Steveston EB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 12 | 30 |
| PM | 0 | 30 |

| E8 Steveston WB to Highway 99 SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 15 | 25 |
| PM | 3 | 30 |

| E9 Steveston Highway WB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 2 | 20 |
| PM | 0 | 20 |

| E10 Steveston WB to Highway 99 NB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 3 | 15 |
| PM | 2 | 15 |



| S5 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 115 | 575 |
| PM | 125 | 440 |

| S6 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 122 | 520 |
| PM | 143 | 500 |

| N5 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 273 | 830 |
| PM | 51 | 405 |

| N6 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 294 | 865 |
| PM | 49 | 390 |

Historical and Forecast Hourly Traffic Volumes - Trucks

| F1 River Road Off-Ramp | | |
|------------------------|------|-----|
| | 2014 | DHV |
| AM | 0 | 10 |
| PM | 5 | 20 |

| F2 Highway 99 SB to Highway 17A EB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 18 | 35 |
| PM | 34 | 70 |

| F3 Highway 99 SB to Highway 17A WB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 7 | 30 |
| PM | 4 | 30 |

| F4 Highway 17A EB to Highway 99 NB HOV | | |
|--|------|-----|
| | 2014 | DHV |
| AM | 2 | 0 |
| PM | 2 | 0 |

| F5 Highway 17A EB to Highway 99 NB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 15 | 30 |
| PM | 4 | 30 |

| F6 Highway 17A EB Thru | | |
|------------------------|------|-----|
| | 2014 | DHV |
| AM | 18 | 40 |
| PM | 10 | 20 |

| F7 Highway 17A EB to Highway 99 SB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 0 | 10 |
| PM | 7 | 30 |

| F8 Highway 99 NB to Highway 17A WB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 10 | 30 |
| PM | 3 | 30 |

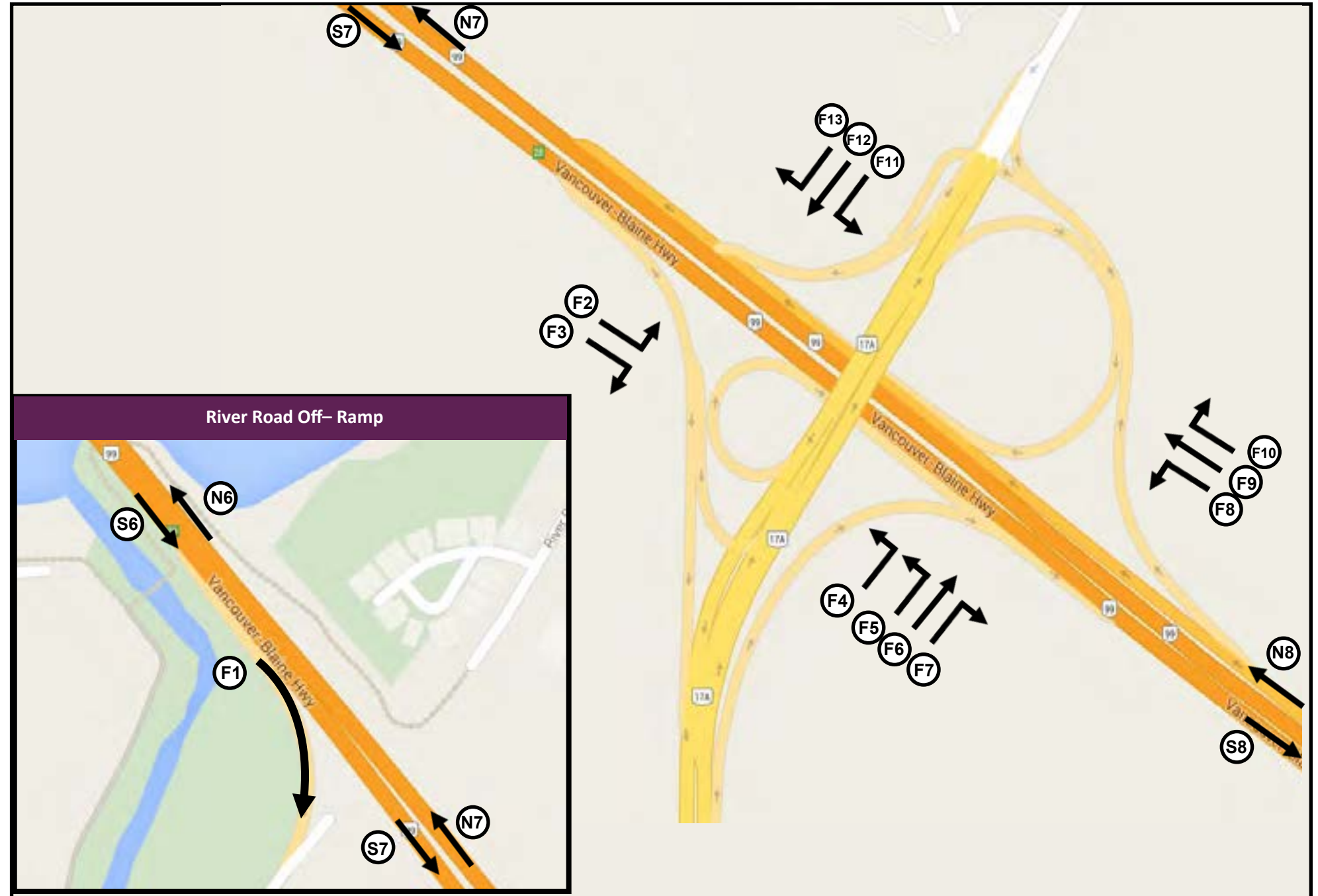
| F9 Highway 99 NB to Highway 99 NB HOV | | |
|---------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | N/A |
| PM | 2 | N/A |

| F10 Highway 99 NB to Highway 17A EB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 17 | 60 |
| PM | 6 | 20 |

| F11 Highway 17A WB to Highway 99 SB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 27 | 30 |
| PM | 19 | 40 |

| F12 Highway 17A WB Thru | | |
|-------------------------|------|-----|
| | 2014 | DHV |
| AM | 0 | 20 |
| PM | 4 | 40 |

| F13 Highway 17A WB to Highway 99 NB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 107 | 200 |
| PM | 18 | 200 |



| S7 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 122 | 510 |
| PM | 138 | 480 |

| S8 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 124 | 485 |
| PM | 126 | 450 |

| N7 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 294 | 865 |
| PM | 49 | 390 |

| N8 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 197 | 725 |
| PM | 34 | 210 |

Historical and Forecast Hourly Traffic Volumes - Trucks

G1 Highway 99 SB to Highway 17 EB

| | 2014 | DHV |
|----|------|-----|
| AM | 27 | 40 |
| PM | 18 | 40 |

G2 Highway 99 SB to Highway 17 WB

| | 2014 | DHV |
|----|------|-----|
| AM | 48 | 100 |
| PM | 42 | 100 |

G3 Highway 17 EB Thru

| | 2014 | DHV |
|----|------|-----|
| AM | 63 | 100 |
| PM | 102 | 150 |

G4 Highway 17 EB to Highway 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | 8 | 20 |
| PM | 18 | 50 |

G5 Highway 17 EB to Highway 99 SB

| | 2014 | DHV |
|----|------|-----|
| AM | 2 | 10 |
| PM | 13 | 30 |

G6 Highway 99 NB to Highway 17 WB

| | 2014 | DHV |
|----|------|-----|
| AM | 12 | 30 |
| PM | 5 | 10 |

G7 Highway 99 NB to Highway 17 EB (Future)

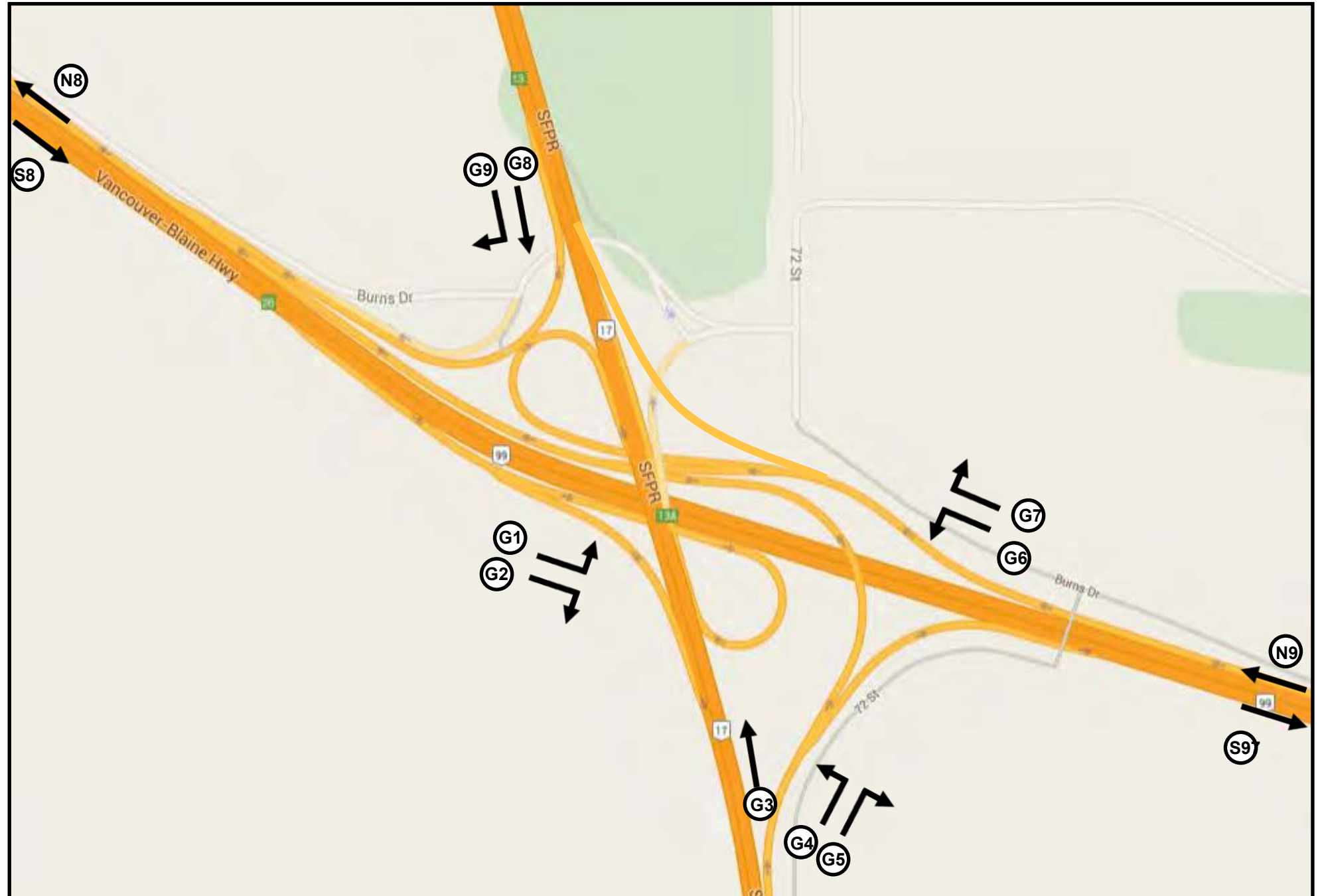
| | 2014 | DHV |
|----|------|-----|
| AM | N/A | 60 |
| PM | N/A | 20 |

G8 Highway 17 WB Thru

| | 2014 | DHV |
|----|------|-----|
| AM | 95 | 125 |
| PM | 101 | 125 |

G9 Hwy 17 WB + Burns Dr. to Hwy 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | 79 | 180 |
| PM | 7 | 20 |



| S8 | Highway 99 Mainline SB | |
|-----------|------------------------|-----|
| | 2014 | DHV |
| AM | 124 | 485 |
| PM | 126 | 450 |

| S9 | Highway 99 Mainline SB | |
|-----------|------------------------|-----|
| | 2014 | DHV |
| AM | 51 | 355 |
| PM | 79 | 340 |

| N8 | Highway 99 Mainline NB | |
|-----------|------------------------|-----|
| | 2014 | DHV |
| AM | 197 | 725 |
| PM | 34 | 210 |

| N9 | Highway 99 Mainline NB | |
|-----------|------------------------|-----|
| | 2014 | DHV |
| AM | 122 | 615 |
| PM | 14 | 170 |

Historical and Forecast Hourly Traffic Volumes - Trucks

| H1 80th Street Off-Ramp | | |
|-------------------------|------|-----|
| | 2015 | DHV |
| AM | 0 | 10 |
| PM | 0 | 10 |

| H2 Highway 99 SB to Ladner Trunk Rd | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 2 | 10 |
| PM | 11 | 30 |

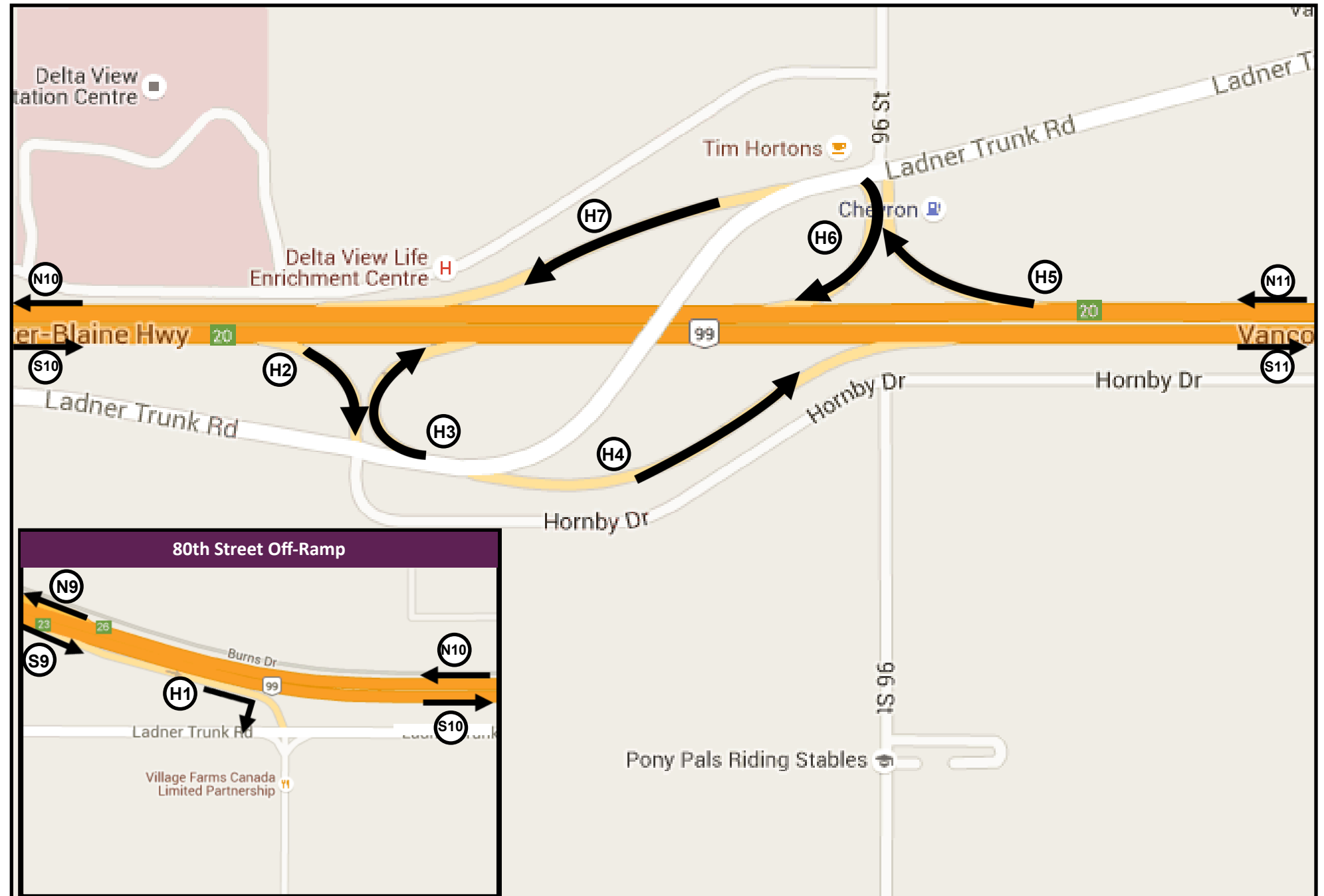
| H3 Ladner Trunk WB to Highway 99 SB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 0 | 10 |
| PM | 1 | 10 |

| H4 Ladner Trunk EB to Highway 99 SB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 8 | 15 |
| PM | 9 | 15 |

| H5 Highway 99 NB to Ladner Trunk Rd. | | |
|--------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 7 | 20 |
| PM | 10 | 20 |

| H6 Ladner Trunk EB to Highway 99 NB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 4 | 10 |
| PM | 0 | 10 |

| H7 Ladner Trunk WB to Highway 99 NB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 33 | 60 |
| PM | 11 | 20 |



| S10 Highway 99 Mainline SB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 51 | 345 |
| PM | 79 | 330 |

| S11 Highway 99 Mainline SB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 57 | 360 |
| PM | 78 | 325 |

| N10 Highway 99 Mainline NB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 122 | 615 |
| PM | 14 | 170 |

| N11 Highway 99 Mainline NB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 92 | 565 |
| PM | 13 | 160 |

Historical and Forecast Hourly Traffic Volumes - Trucks

I1 Highway 99 NB to Highway 91 EB

| | 2014 | DHV |
|----|------|-----|
| AM | 50 | 100 |
| PM | 50 | 100 |

I2 Highway 91 WB to Highway 99 NB

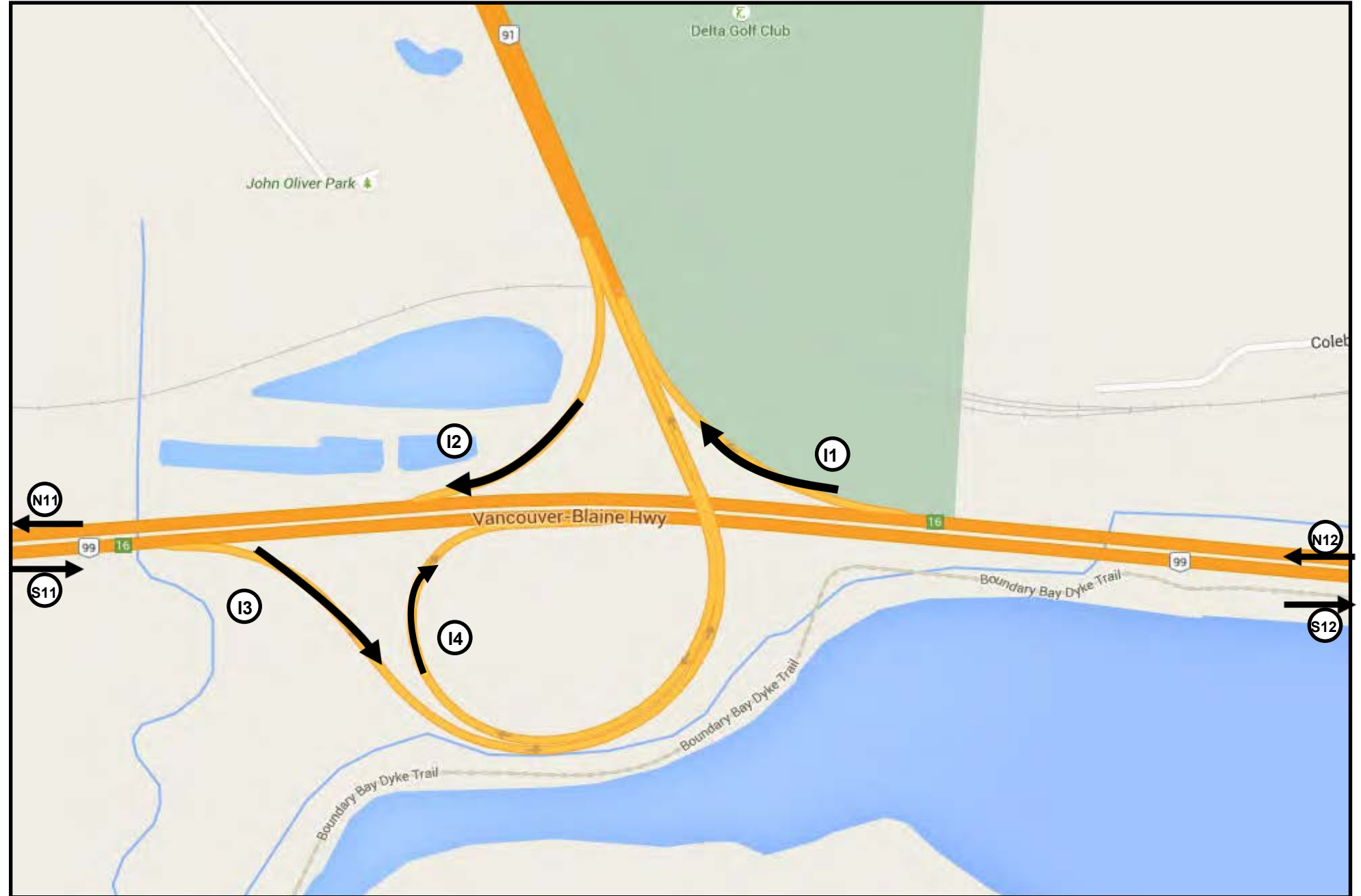
| | 2014 | DHV |
|----|------|-----|
| AM | 42 | 100 |
| PM | 4 | 20 |

I3 Highway 99 SB to Highway 91 EB

| | 2014 | DHV |
|----|------|-----|
| AM | 10 | 20 |
| PM | 39 | 100 |

I4 Highway 91 EB to Highway 99 SB

| | 2014 | DHV |
|----|------|-----|
| AM | 22 | 50 |
| PM | 59 | 120 |



S11 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 57 | 360 |
| PM | 78 | 325 |

S12 Highway 99 Mainline SB

| | 2014 | DHV |
|----|------|-----|
| AM | 69 | 390 |
| PM | 98 | 345 |

N11 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 92 | 565 |
| PM | 13 | 160 |

N12 Highway 99 Mainline NB

| | 2014 | DHV |
|----|------|-----|
| AM | 100 | 565 |
| PM | 59 | 240 |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

KING GEORGE INTERCHANGE

Historical and Forecast Hourly Traffic Volumes - Trucks

| J1 Highway 99 SB to King George EB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 3 | 10 |
| PM | 20 | 50 |

| J2 Highway 99 SB to King George WB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 3 | 10 |
| PM | 14 | 30 |

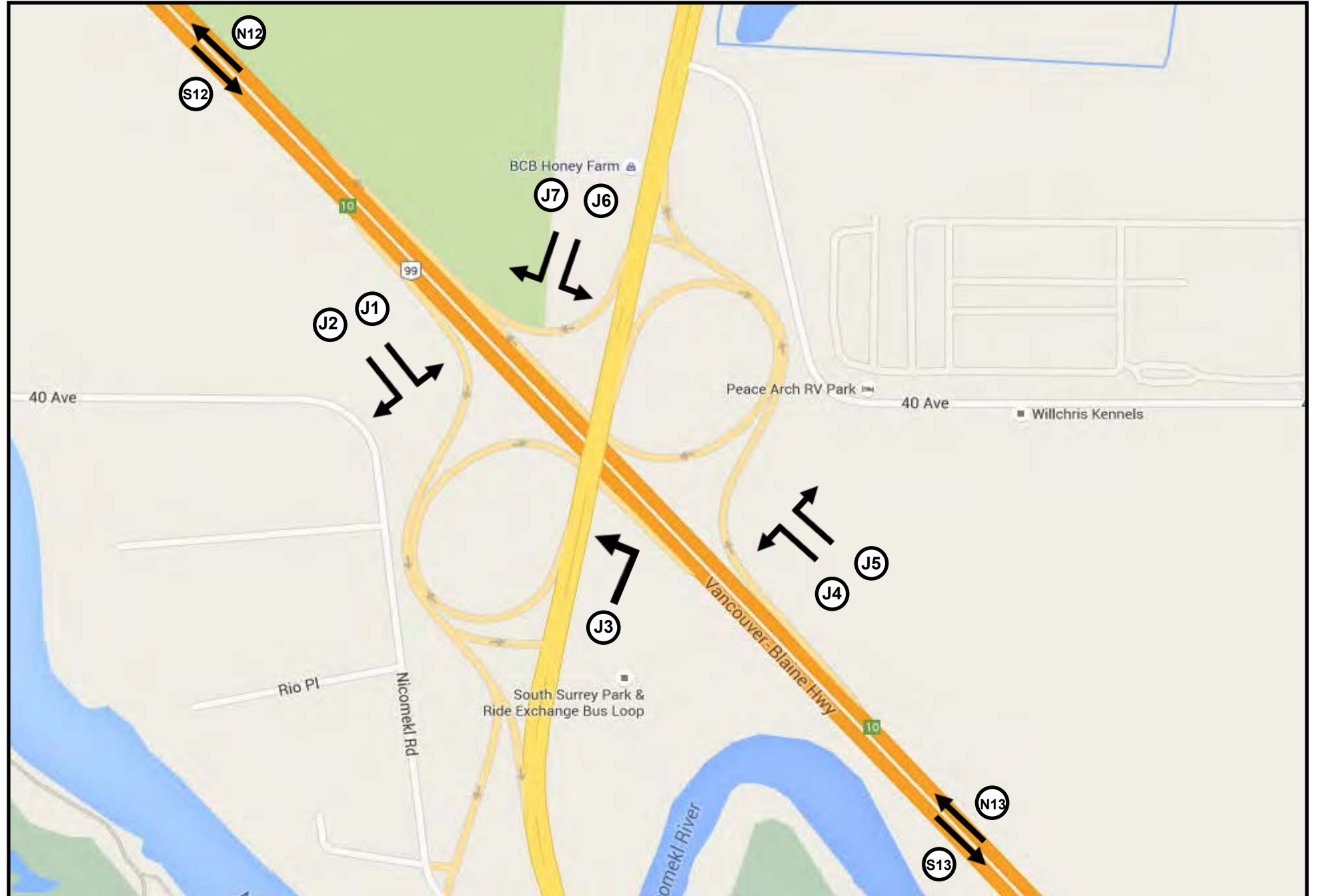
| J3 King George EB to Highway 99 NB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 32 | 60 |
| PM | 15 | 30 |

| J4 Highway 99 NB to King George WB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 2 | 10 |
| PM | 1 | 10 |

| J5 Highway 99 NB to King George EB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 14 | 20 |
| PM | 20 | 40 |

| J6 King George WB to Highway 99 SB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 8 | 20 |
| PM | 23 | 50 |

| J7 King George WB to Highway 99 NB | | |
|------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 24 | 50 |
| PM | 4 | 10 |



| S12 Highway 99 Mainline SB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 69 | 390 |
| PM | 98 | 345 |

| S13 Highway 99 Mainline SB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 71 | 390 |
| PM | 87 | 315 |

| N12 Highway 99 Mainline NB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 100 | 565 |
| PM | 59 | 240 |

| N13 Highway 99 Mainline NB | | |
|----------------------------|------|-----|
| | 2014 | DHV |
| AM | 60 | 485 |
| PM | 61 | 250 |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

No.5 Road at Steveston Highway

Historical and Forecast Hourly Traffic Volumes - Trucks

| Z1 No.5 Road NB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | 5 |
| PM | 1 | 5 |

| Z2 No.5 Road NB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 5 | 10 |
| PM | 5 | 10 |

| Z3 No.5 Road NB to Steveston EB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 34 | 78 |
| PM | 20 | 100 |

| Z4 No.5 Road SB to Steveston EB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 6 | 10 |
| PM | 3 | 20 |

| Z5 No.5 Road SB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 10 | 20 |
| PM | 13 | 20 |

| Z6 No.5 Road SB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | 5 |
| PM | 0 | 5 |

| Z7 Steveston EB to No.5 Road NB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 0 | 5 |
| PM | 2 | 5 |

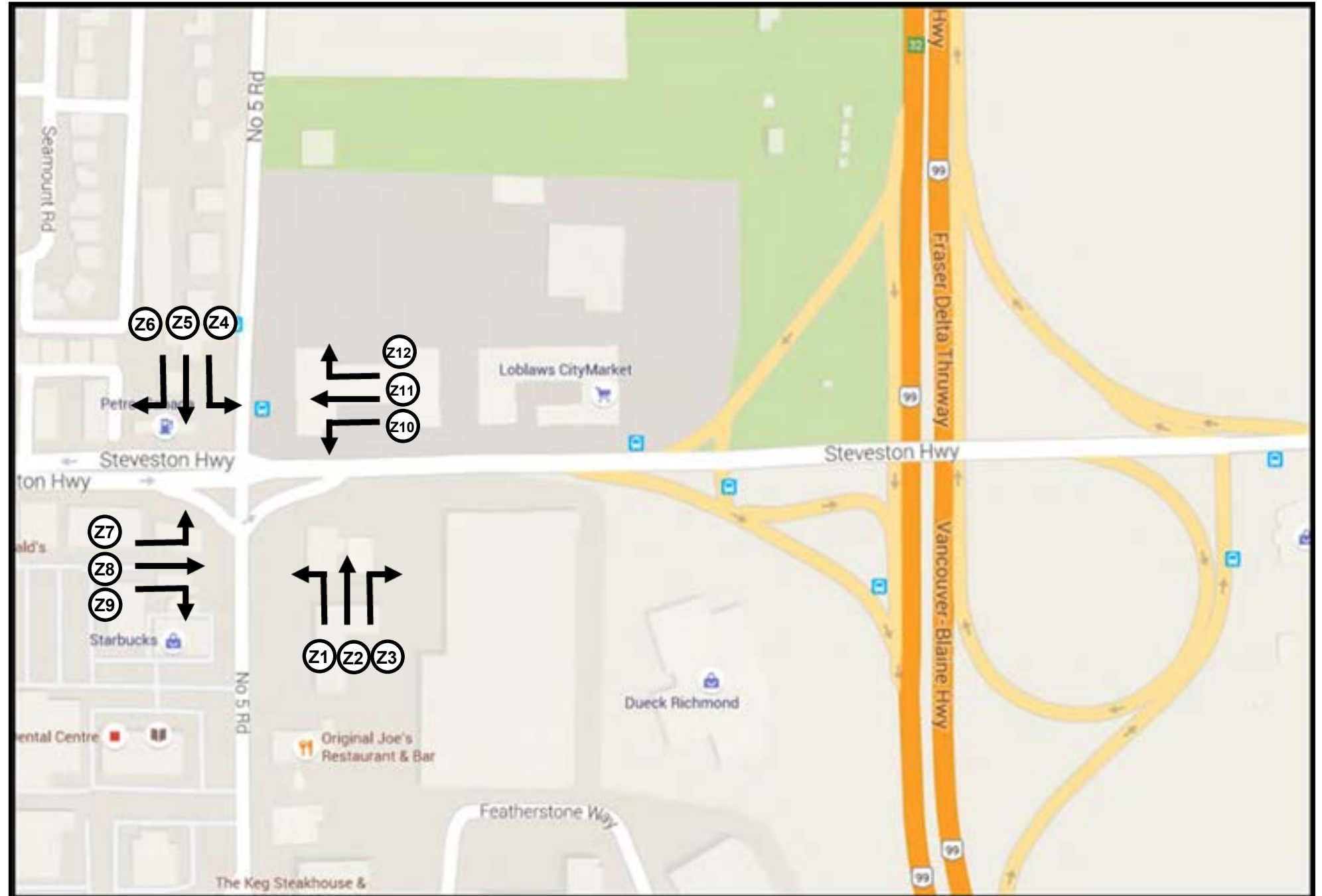
| Z8 Steveston Highway EB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 23 | 62 |
| PM | 13 | 80 |

| Z9 Steveston EB to No.5 Road SB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | 5 |
| PM | 0 | 5 |

| Z10 Steveston WB to No.5 Road SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 26 | 79 |
| PM | 9 | 31 |

| Z11 Steveston Highway WB Thru | | |
|-------------------------------|------|-----|
| | 2014 | DHV |
| AM | 39 | 125 |
| PM | 7 | 63 |

| Z12 Steveston Highway to No.5 Road NB | | |
|---------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 3 | 16 |
| PM | 2 | 16 |



George Massey Tunnel Replacement Project

RICE MILL ROAD CONNECTION

DRAFT - JUNE 2016

Historical and Forecast Hourly Traffic Volumes - All Vehicles

E1 Highway 99 SB to Steveston EB

| | 2014 | DHV |
|----|------|-----|
| AM | 24 | 200 |
| PM | 34 | 200 |

E2 Highway 99 SB to Steveston WB

| | 2014 | DHV |
|----|------|-----|
| AM | 446 | 501 |
| PM | 121 | 293 |

E3 Steveston EB to Highway 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | 508 | 623 |
| PM | 554 | 673 |

E4 Steveston Highway EB Thru

| | 2014 | DHV |
|----|------|-----|
| AM | 109 | 200 |
| PM | 250 | 350 |

E5 Steveston EB to Highway 99 SB

| | 2014 | DHV |
|----|------|-------|
| AM | 585 | 950 |
| PM | 852 | 1,600 |

E6 Highway 99 NB to Steveston WB

| | 2014 | DHV |
|----|------|-------|
| AM | 747 | 1,000 |
| PM | 359 | 950 |

E7 Highway 99 NB to Steveston EB

| | 2014 | DHV |
|----|------|-----|
| AM | 100 | 300 |
| PM | 89 | 200 |

E8 Steveston WB to Highway 99 SB

| | 2014 | DHV |
|----|------|-----|
| AM | 65 | 100 |
| PM | 354 | 500 |

E9 Steveston Highway WB Thru

| | 2014 | DHV |
|----|------|-----|
| AM | 85 | 200 |
| PM | 277 | 400 |

E10 Steveston WB to Highway 99 NB

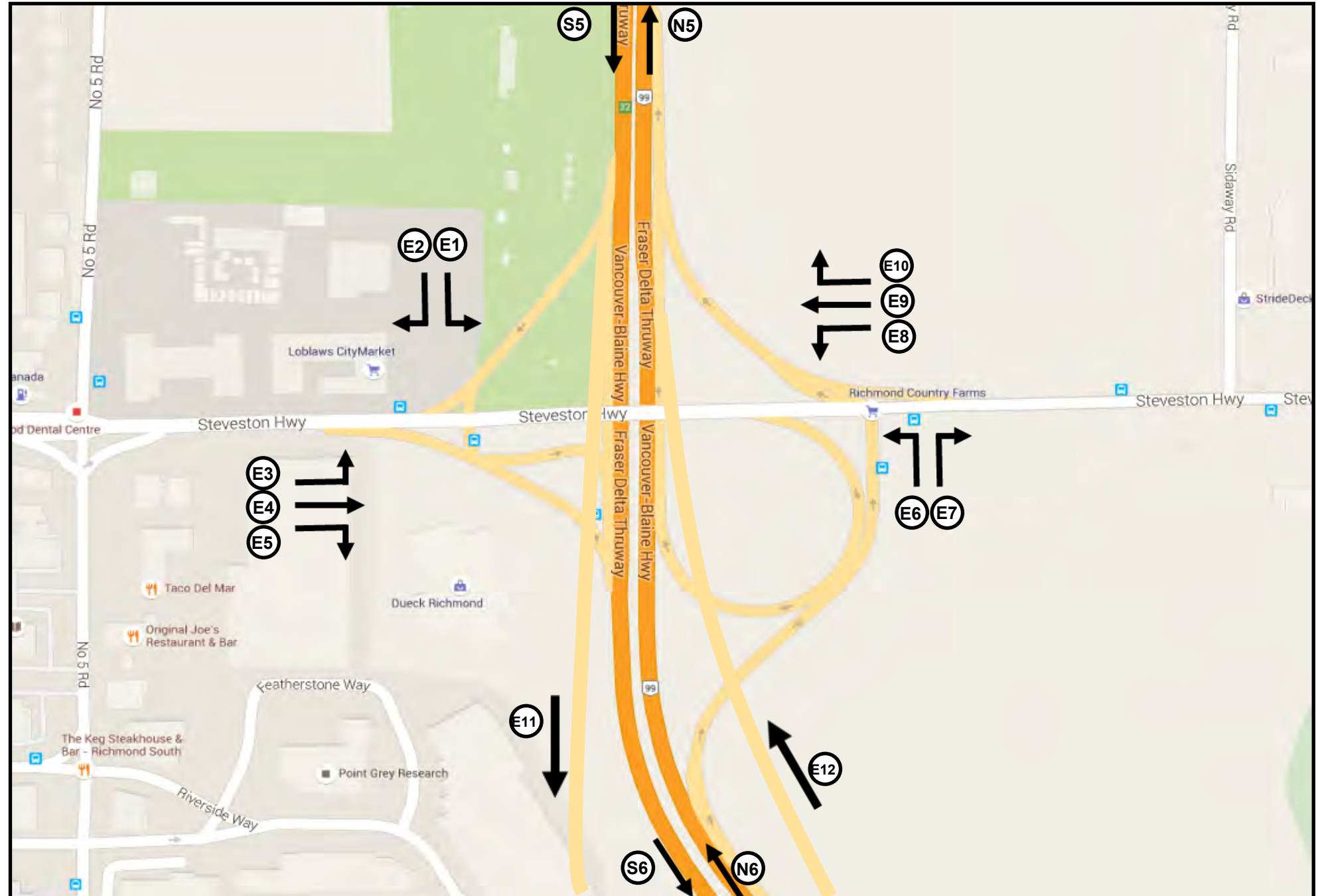
| | 2014 | DHV |
|----|------|-----|
| AM | 36 | 100 |
| PM | 62 | 100 |

E11 Highway 99 SB to Rice Mill Road

| | 2014 | DHV |
|----|------|-----|
| AM | N/A | 249 |
| PM | N/A | 57 |

E12 Rice Mill Road to Highway 99 NB

| | 2014 | DHV |
|----|------|-----|
| AM | N/A | 52 |
| PM | N/A | 177 |



S5 Highway 99 Mainline SB

| | 2014 | DHV |
|----|-------|-------|
| AM | 1,231 | 2,310 |
| PM | 3,746 | 6,450 |

S6 Highway 99 Mainline SB

| | 2014 | DHV |
|----|-------|-------|
| AM | 1,411 | 2,410 |
| PM | 4,797 | 8,000 |

N5 Highway 99 Mainline NB

| | 2014 | DHV |
|----|-------|-------|
| AM | 4,774 | 7,530 |
| PM | 1,590 | 2,045 |

N6 Highway 99 Mainline NB

| | 2014 | DHV |
|----|-------|-------|
| AM | 5,077 | 8,055 |
| PM | 1,422 | 2,245 |

Historical and Forecast Hourly Traffic Volumes - All Vehicles

| Z1 No.5 Road NB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 17 | 25 |
| PM | 97 | 130 |

| Z2 No.5 Road NB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 53 | 70 |
| PM | 279 | 380 |

| Z3 No.5 Road NB to Steveston EB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 177 | 221 |
| PM | 689 | 986 |

| Z4 No.5 Road SB to Steveston EB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 161 | 248 |
| PM | 187 | 318 |

| Z5 No.5 Road SB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 182 | 250 |
| PM | 319 | 435 |

| Z6 No.5 Road SB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 36 | 50 |
| PM | 132 | 180 |

| Z7 Steveston EB to No.5 Road NB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 32 | 45 |
| PM | 90 | 125 |

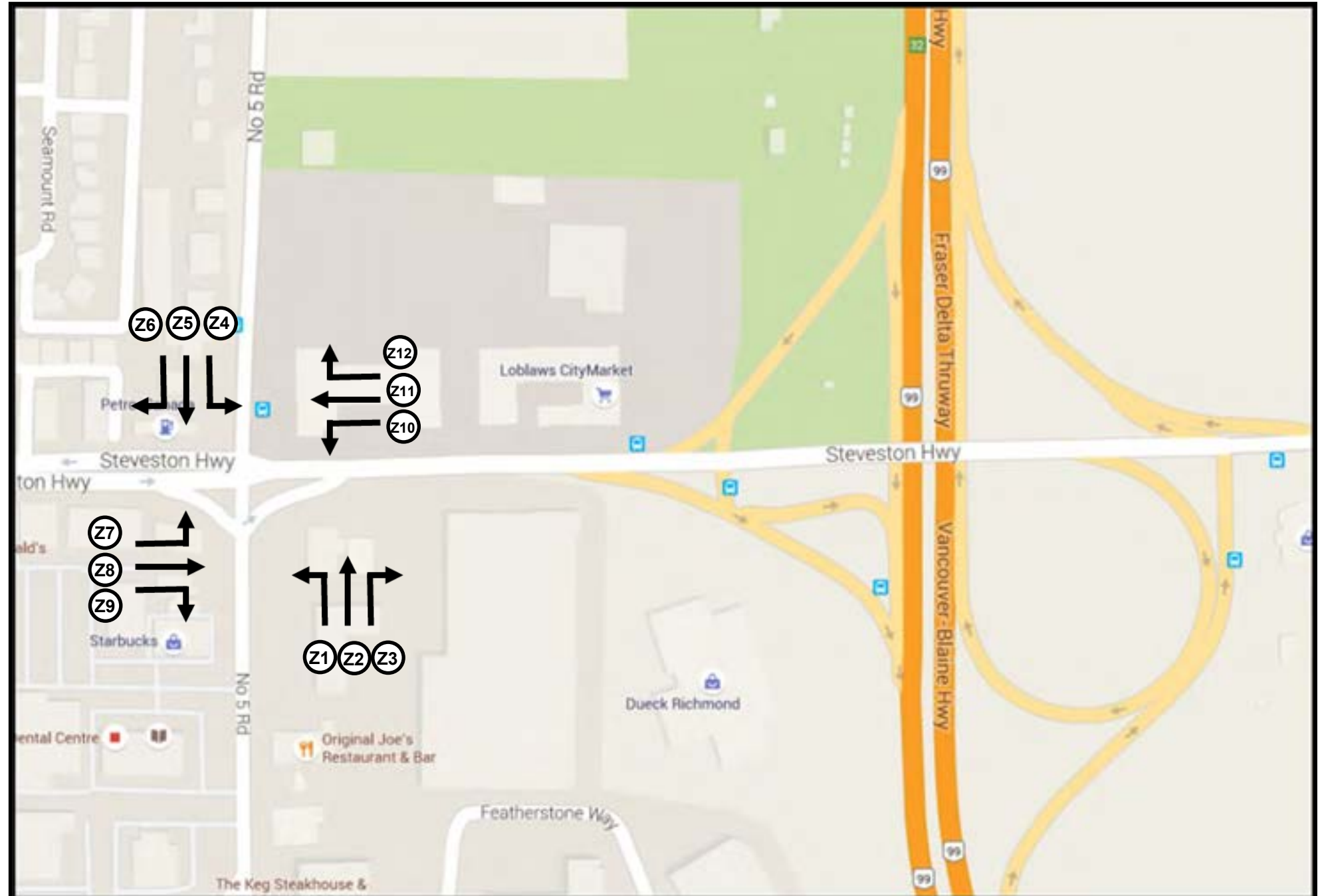
| Z8 Steveston Highway EB Thru | | |
|------------------------------|------|-------|
| | 2014 | DHV |
| AM | 864 | 1,304 |
| PM | 780 | 1,319 |

| Z9 Steveston EB to No.5 Road SB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 61 | 85 |
| PM | 24 | 30 |

| Z10 Steveston WB to No.5 Road SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 637 | 721 |
| PM | 186 | 363 |

| Z11 Steveston Highway WB Thru | | |
|-------------------------------|------|-------|
| | 2014 | DHV |
| AM | 569 | 870 |
| PM | 486 | 1,090 |

| Z12 Steveston Highway to No.5 Road NB | | |
|---------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 72 | 110 |
| PM | 85 | 190 |



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

STEVESTON HIGHWAY w/ RMR Connection

Historical and Forecast Hourly Traffic Volumes - Trucks

| E1 Highway 99 SB to Steveston EB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 12 | 30 |
| PM | 3 | 30 |

| E2 Highway 99 SB to Steveston WB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 20 | 76 |
| PM | 7 | 33 |

| E3 Steveston EB to Highway 99 NB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 34 | 59 |
| PM | 11 | 60 |

| E4 Steveston Highway EB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 5 | 20 |
| PM | 0 | 20 |

| E5 Steveston EB to Highway 99 SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 24 | 50 |
| PM | 25 | 100 |

| E6 Highway 99 NB to Steveston WB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 46 | 100 |
| PM | 11 | 50 |

| E7 Highway 99 NB to Steveston EB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 12 | 30 |
| PM | 0 | 30 |

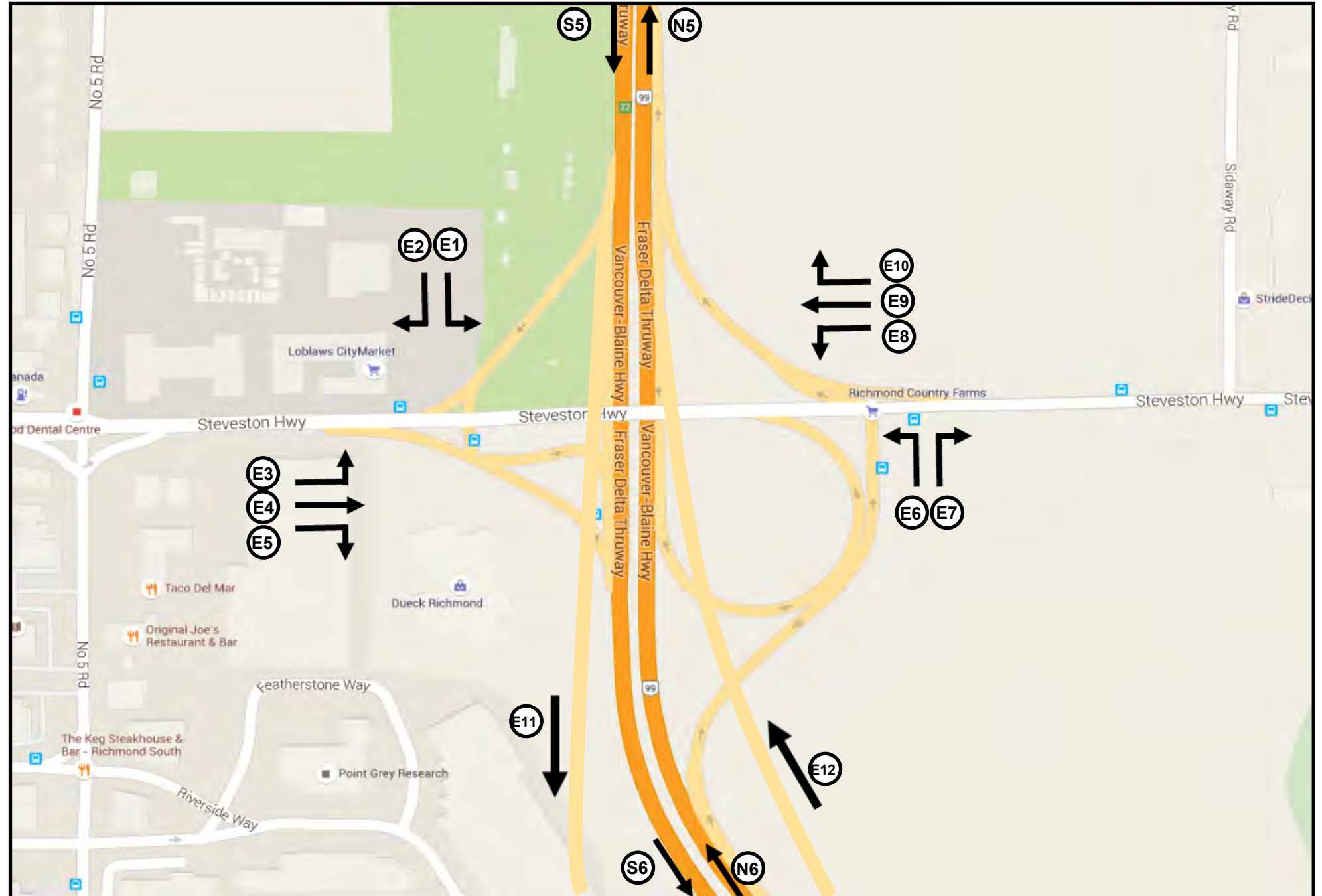
| E8 Steveston WB to Highway 99 SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 15 | 25 |
| PM | 3 | 30 |

| E9 Steveston Highway WB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 2 | 20 |
| PM | 0 | 20 |

| E10 Steveston WB to Highway 99 NB | | |
|-----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 3 | 15 |
| PM | 2 | 15 |

| E11 Highway 99 SB to Rice Mill Road | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | N/A | 24 |
| PM | N/A | 7 |

| E12 Rice Mill Road to Highway 99 NB | | |
|-------------------------------------|------|-----|
| | 2014 | DHV |
| AM | N/A | 21 |
| PM | N/A | 20 |



| S5 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 115 | 575 |
| PM | 125 | 440 |

| S6 Highway 99 Mainline SB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 122 | 520 |
| PM | 143 | 500 |

| N5 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 273 | 830 |
| PM | 51 | 405 |

| N6 Highway 99 Mainline NB | | |
|---------------------------|------|-----|
| | 2014 | DHV |
| AM | 294 | 865 |
| PM | 49 | 390 |

Historical and Forecast Hourly Traffic Volumes - Trucks

| Z1 No.5 Road NB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | 5 |
| PM | 1 | 5 |

| Z2 No.5 Road NB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 5 | 10 |
| PM | 5 | 10 |

| Z3 No.5 Road NB to Steveston EB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 31 | 57 |
| PM | 19 | 80 |

| Z4 No.5 Road SB to Steveston EB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 6 | 10 |
| PM | 3 | 20 |

| Z5 No.5 Road SB Thru | | |
|----------------------|------|-----|
| | 2014 | DHV |
| AM | 10 | 20 |
| PM | 13 | 20 |

| Z6 No.5 Road SB to Steveston WB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | 5 |
| PM | 0 | 5 |

| Z7 Steveston EB to No.5 Road NB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 0 | 5 |
| PM | 2 | 5 |

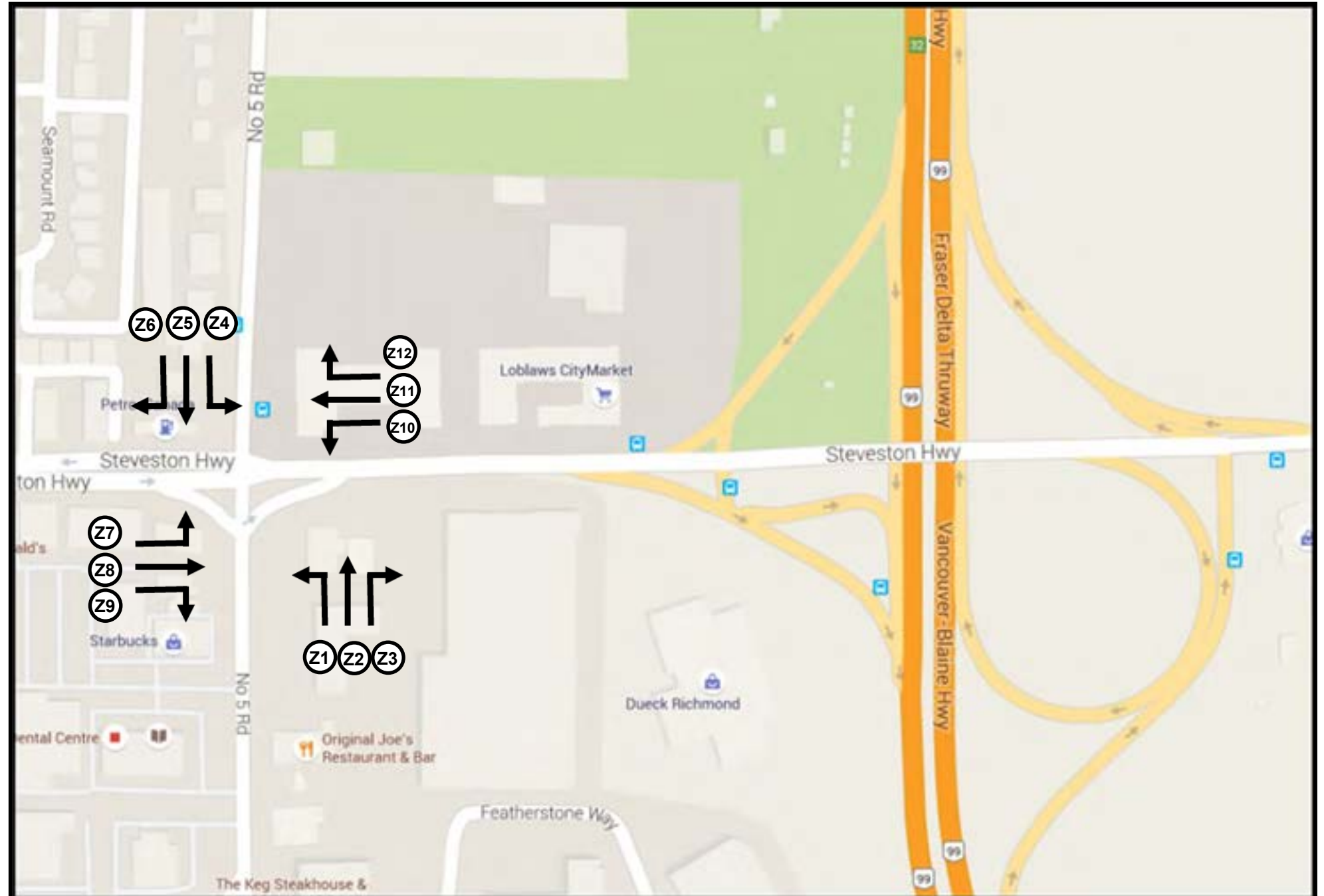
| Z8 Steveston Highway EB Thru | | |
|------------------------------|------|-----|
| | 2014 | DHV |
| AM | 23 | 62 |
| PM | 13 | 80 |

| Z9 Steveston EB to No.5 Road SB | | |
|---------------------------------|------|-----|
| | 2014 | DHV |
| AM | 1 | 5 |
| PM | 0 | 5 |

| Z10 Steveston WB to No.5 Road SB | | |
|----------------------------------|------|-----|
| | 2014 | DHV |
| AM | 26 | 55 |
| PM | 9 | 24 |

| Z11 Steveston Highway WB Thru | | |
|-------------------------------|------|-----|
| | 2014 | DHV |
| AM | 39 | 125 |
| PM | 7 | 63 |

| Z12 Steveston Highway to No.5 Road NB | | |
|---------------------------------------|------|-----|
| | 2014 | DHV |
| AM | 3 | 16 |
| PM | 2 | 16 |



5.2 Marine Use Assessment Highlights:

- The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, sorting and booming, as well as commercial, recreational, and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place in the vicinity of the Project.
- The proposed clear span crossing of the Fraser River will avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span, improving navigation in and out of the slough.
- Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.
- Working with Aboriginal Groups and key stakeholders to develop a Marine Access Management Plan will mitigate temporary impacts to marine use associated with Project construction.
- Key mitigation considerations to ensure marine use activities can continue in a safe manner during Project construction include:
 - Communications protocols to establish and advise of in-stream construction activities.
 - Lighting and marking for safe navigation.
 - Establishing navigation protection zones during construction to avoid or minimize impacts on marine use.

5.2 Marine Use

This section presents the assessment of potential effects of the Project on marine use and includes a description of existing conditions, potential Project-related effects including proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects.

5.2.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on marine use in terms of Project setting, and defines the spatial, temporal, administrative, and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

5.2.1.1 Assessment Context

The Fraser River South Arm supports a variety of marine uses, including international and domestic shipping; commercial, recreational and Aboriginal (CRA) fishing; and recreational boating and moorage. Two recreational boat marinas and a rowing club are located along the south and east shorelines of Deas Slough with year-round water access.

Maintaining waterway navigation needs and access is important to the provincial and federal economies, Aboriginal Groups, many businesses, and the general public. In addition, the public's right to navigate the Fraser River South Arm is protected by the *Navigation Protection Act (NPA)*, R.S.C. 1987, c. N-22.

The Project will involve construction activities in the Fraser River South Arm and Deas Slough that may temporarily affect navigation, CRA fisheries, and other recreational boating. The Fraser River South Arm in the vicinity of the Project supports a variety of marine uses, and activities associated with Project construction may result in temporary changes to access and navigability in the vicinity of the Project.

Consultation with the public, Aboriginal Groups, and marine users informed the selection of Marine Use as a Valued Component (VC) for the assessment of potential effects of the Project. Changes in marine use and marine access were raised as areas of interest to local industry located along the Fraser River including port-related businesses that rely on marine access, Aboriginal Groups, and the general public during consultation. Additional information supporting the selection of marine use as VC is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

5.2.1.2 Methodology

The assessment of marine use follows the general methodology described in **Section 3.0 Assessment Methodology** and is applied to all VCs. Building on this approach, the assessment of marine use focuses on the following sub-components:

- Commercial navigation
- Navigation for CRA fisheries
- Recreational navigation

Changes in access to, and within, the South Arm of the Fraser and changes in marine traffic (i.e., frequency and volume) that could affect navigability were selected as indicators to assess trends in marine use and to evaluate potential Project-related effects on commercial navigation, CRA fisheries, and recreational navigation.

Access to waterways is evaluated in terms of potential change in vessel access to or within the Fraser River South Arm as a result of construction or operation of the Project. Marine traffic frequency and volume is evaluated in terms of potential for increase in the number of vessels or equipment within the Project area that are directly associated with the Project. Evaluation of this indicator is therefore limited to the Project construction phase.

5.2.1.3 Assessment Boundaries

Spatial, temporal, administrative, and technical boundaries identified for the assessment of Project-related effects on marine use, and the rationale for selecting them are discussed below.

Spatial Boundaries

The local assessment area (LAA) and regional assessment area (RAA) for marine use are defined in **Table 5.2-1** and shown in **Figure 5.2-1**. The boundaries of the assessment area take into account the scale and spatial extent of potential environmental effects that are appropriate for the three marine use sub-components.

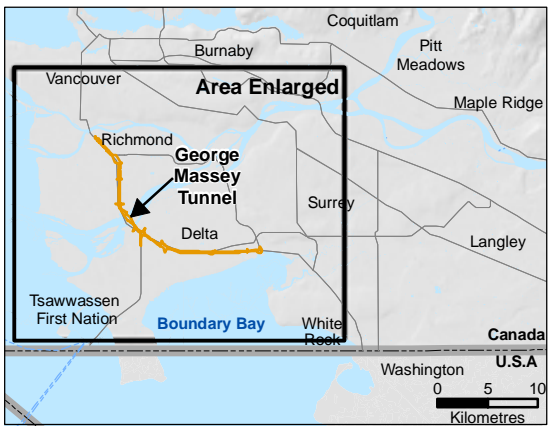
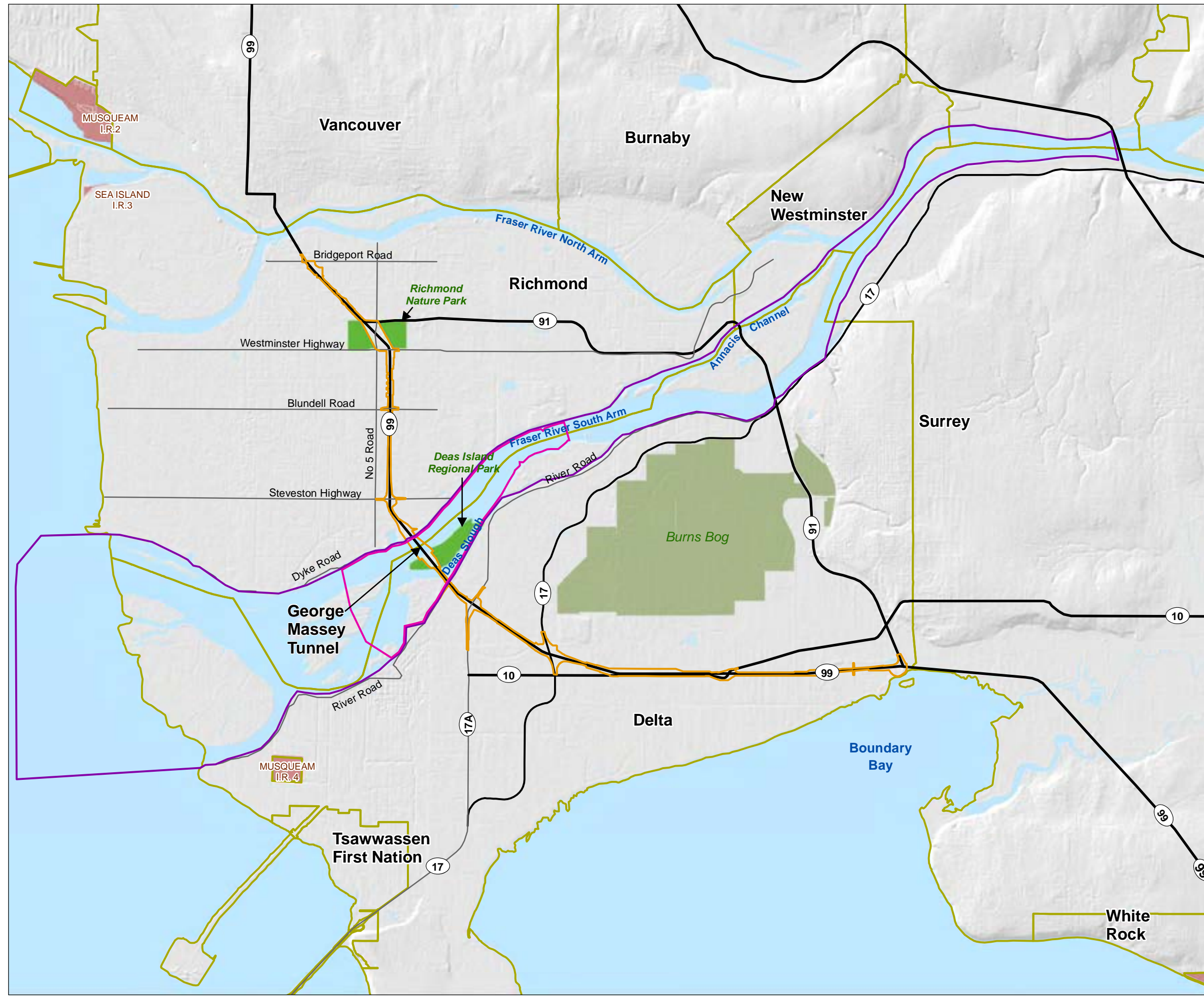
Table 5.2-1 Spatial Boundary for Marine Use Assessment

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local assessment area (LAA) | 2.5 km downstream and 5 km upstream of the Tunnel, in the Fraser River South Arm main channel, and 500 m on either side of the existing Deas Slough Bridge. |
| Regional assessment area (RAA) | Vancouver Fraser Port Authority (VFPA) Land Use Planning Area 5 (Fraser River Central, from approximately three kilometers southwest of the Alex Fraser Bridge) and Planning Area 7 (including only Fraser River South Arm, from approximately three kilometres southwest of the Alex Fraser Bridge to the river mouth). |

The LAA for marine use was established to encompass the area within which the Project is most likely to interact and potentially affect marine use. In determining the LAA boundary, consideration was given to the nature and characteristics of marine use, potential exposure to various influences (e.g., changes in river hydraulics and morphology following Tunnel removal), and the maximum extent of potential Project-related effects on marine use.

The RAA includes most of VFPA's Land Use Planning Area 5 and 7 (further discussed as a part of the administrative boundary below) and was established to provide a regional context in terms of marine use in nearby marine planning areas.

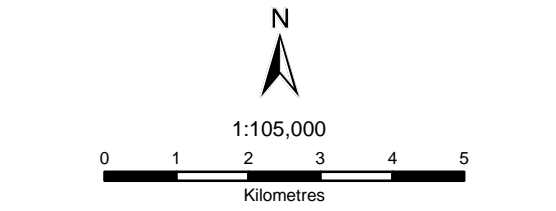
Path: C:\1217-299\285\077\03\mxd\Marine_Use\EA\Fig5-2-1_285_077_03_EA_MarineUse_LAA-RAA_160517_FINAL.mxd



- Legend**
- Marine Use Local Assessment Area
 - Marine Use Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| MARINE USE LOCAL AND REGIONAL ASSESSMENT AREAS | |
| Figure 5.2-1 | 17/05/2016 |
| | |

Temporal Boundaries

The temporal boundaries established for the assessment of adverse Project effects on marine use encompass the existing conditions, the Project construction phase (including decommissioning of the Tunnel and Deas Slough Bridge), and the Project operations phase (i.e., the new bridge and improvements in operation). Temporal characteristics of the Project's construction phase are defined in **Section 1.1 Description of Proposed Project**.

Administrative Boundaries

The assessment areas for the Project were selected based on the spatial extent of potential Project-related effects on marine use. The LAA and the RAA include the following administrative boundaries:

- The LAA overlaps two Fisheries and Oceans Canada (DFO) sub-areas in the Pacific Fisheries Management Area (PFMA) 29 (i.e., sub-areas 13 and 14). The RAA overlaps four sub-areas in PFMA 29 (i.e., sub-areas 9, 13, 14, and 17).
 - Sub-area 29-13 consists of the Fraser River South Arm from Steveston Island upstream to the Pattullo Bridge.
 - Sub-area 29-14 is south of sub-area 29-13 and consists of the waters south of the Woodward Island training structure from Reifel Island upstream to Deas Slough.
 - Sub-area 29-9 is downstream from sub-areas 29-13 and 29-14 and extends from the mouth of the Fraser River South Arm upstream to Reifel Island.
 - Sub-area 29-17 is upstream of sub-area 29-13 and consists of the Fraser River South Arm from the Pattullo Bridge to the Alex Fraser Bridge.
- The LAA is located within the VFPA Land Use Planning Area 7.
- The RAA is located within VFPA Land Use Planning Areas 5 and 7.
 - Planning Area 7 extends from the North Arm Jetty and Sturgeon Bank to the north end of Boundary Road in New Westminster, and from the Sand Heads to just east of Tilbury Island.
 - Planning Area 5 is upstream from Planning Area 7 and extends from approximately three kilometres southwest of the Alex Fraser Bridge on the south reach to west of the Port Mann Bridge.

Technical Boundaries

There were some limitations in availability of historic data on fisheries use and vessel activity as discussed in **5.2.2.1 Baseline Data Collection**; however, the Ministry's ongoing engagement with commercial, aboriginal, and recreational marine users has provided information to address such data gaps prior to undertaking the assessment of Project-related effects.

No other constraints such as accessibility or gaps in data that could limit the ability to predict the effects of the Project on marine use have been identified; therefore no technical boundaries were defined.

5.2.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of marine use within the assessment areas. An overview of the regulatory context for management of marine use as relevant to the Project is also provided.

5.2.2.1 Baseline Data Collection

In 2014, the Ministry initiated a desktop review of marine use to support Project planning and assessment. Building on available information, the review was designed to address known data gaps, as summarized in **Table 5.2-2**, and described in further detail below.

Table 5.2-2 Marine Use Studies

| Study Name | Purpose of Study |
|--------------------------|--|
| Desktop Review | Understand the existing information available about marine use near the Project through a review of background information including reports and data. |
| Preliminary Consultation | Meet with key marine and water-based land users and agencies to discuss potential effects of the Project and understand interests. |

Desktop Review

Existing background information relevant to the Project, including the following, was assembled and reviewed:

- Relevant discussion on marine use issues, effects and mitigation from previous environmental assessment reports.
- Navigation and river use information, including:
 - Physical characteristics and navigability of the lower Fraser River and smaller channels
 - Marine and water-dependent land uses (e.g., deep sea berths, marinas, and vessel moorage)
 - Frequency of vessel use and vessel types navigating the lower Fraser River

- Publicly available fisheries information, including
 - Fraser River fisheries information (DFO 2013a), notices (DFO 2015), and First Nations catch reports (DFO 2014a)
 - Other sources of information (e.g., DFO harvesting statistics and fisheries management plans, VFPA Land Use Plan 2014) with respect to marine use within the LAA and RAA
 - Port of Vancouver’s Fraser River Tanker Traffic Study (DNV 2012)
- Relevant information regarding current and traditional fishing activities gathered from Traditional Use Studies and information provided by Aboriginal Groups during pre-Application consultation

Preliminary Consultation

Aboriginal Groups

Consultation with Schedule B Aboriginal Groups with respect to marine use began during the Initial Consultation Phase, is ongoing, and described in **Section 10.1.2 Consultation Activities**.

Schedule B Aboriginal Groups have raised concerns related to marine access during construction, including Tunnel decommissioning, and the Ministry is continuing to work with these groups to better understand how they would like to participate in the development and implementation of mitigation measures. For further analysis on potential Project-related effects on Aboriginal access, including fishing access, refer to **Section 10.1.3 Aboriginal Interests Assessment**.

Commercial/recreational marine users

Between May 2014 and June 2015, the Ministry met with key representatives of commercial and recreational marine users, and other stakeholders with specific interest in the Project and its potential influence on marine activity. Individuals and organizations likely to have a potential interest were identified based on the Ministry’s experience in consulting with marine user groups during planning and implementation of projects such as the Port Mann Highway 1 Improvement Project and the Pitt River Bridge & Mary Hill Interchange Project, and issues/interests identified during general consultation on these projects.

A total of four meetings, two each with specific focus on commercial use and recreational use, were held to review Project components and discuss potential effects of the Project.

Initial meetings, on May 26, 2014 and May 21, 2015, were held with marine users and other stakeholders with a specific interest in the use of the river and sloughs for commercial purposes. A total of 68 participants, representing 29 marine businesses: one terminal, a rescue group, a community group, BC Coast Pilots, Fish Safe BC, the Council of Marine Carriers (CMC, which represents over 25 local marine businesses), VFPA, and Transport Canada, were invited to, and attended, each meeting. Eighteen individuals attended the May 26, 2014 meeting, representing eight marine businesses, BC Coast Pilots, the terminal, Fish Safe BC, CMC, VFPA, and Transport Canada. Twenty-four participants attended the May 21, 2015 meeting, representing 13 marine businesses, BC Coast Pilots, the terminal, Fish Safe BC, CMC, VFPA, and Transport Canada.

A Project overview, including consultation to date, technical work underway, existing marine traffic patterns, Tunnel removal options, vertical and horizontal clearances, river hydraulics and next steps, was provided at each meeting. A question and answer session took place after each Project update, which included further discussion on Tunnel removal, bridge clearances, interchange replacements, time frames, river hydraulics and morphology, and current marine traffic information. The need for an established forum (Marine Users Group) for communications between marine users during construction was a key outcome of these preliminary meetings.

Meetings with recreational marine users and stakeholders were held on June 25, 2014 and May 21, 2015. A total of twenty individuals representing seven recreational businesses, six recreational groups, one rescue group, one community group and Transport Canada, were invited to both meetings. The June 25, 2014 meeting was attended by five individuals who represented one recreational business, one recreational group, the rescue group, and Transport Canada. Two individuals, both representing one recreational group, attended the May 21, 2015 meeting.

An overall Project update was provided at each meeting, followed by a question and answer session where the following aspects were discussed: height of the bridge over Deas Slough; importance of effective communication during construction, specifically in the context of regattas in Deas Slough; potential noise impacts and mitigation; influence on the Millennium Trail; and Captain's Cove Marina's new housing development and marine enlargement (250 to 350 dock slips). Participants expressed a key interest in waterway closures, equipment in the water, and safety.

Data Limitations

Fisheries Data

Fisheries and Oceans Canada's reporting structure of fishing vessel activity data presents certain limitations for analysis within the LAA and RAA. Fish harvesting data is publicly reported at the PFMA and PFMA sub-area levels. However, the PFMA sub-areas are relatively large; PFMA 29, which overlaps with the LAA, includes areas of commercial fishing activity (e.g., Roberts and Sturgeon banks, southeastern Strait of Georgia) other than the LAA, so data reported at this level have limits for interpreting existing conditions in the LAA. The PFMA sub-areas, however, are sufficiently small, such that LAA fishing activity can be reasonably determined from reviewing data reported at this level.

The marine use LAA traverses PFMA sub-areas 29-13 and 29-14. Although the boundaries of these PFMA sub-areas do not coincide with the LAA boundaries, they portray with reasonable accuracy fishing activity within the marine use LAA. Fisheries and Oceans Canada does not make the data collected on harvest activity publicly available when there are fewer than three vessels active on an annual basis in a PFMA sub-area.

Data on guided sport fishing activity is limited. Recreational fishing data from DFO are only available for areas larger than the PFMA sub-areas, and primarily reflect self-directed recreational fishing.

With respect to Aboriginal fisheries, publicly available information sources generally only listed the broad areas where fishing occurs (e.g., "below Port Mann Bridge"). For more specific information regarding Aboriginal fishing, particularly for domestic or food, social and ceremonial (FSC) purposes, see **Section 10.1.3 Aboriginal Interests Assessment**.

Vessel Movement Data

Vessel movement data may not fully account for all vessel traffic through the LAA. It is not mandatory for commercial vessels less than 20 m or pleasure yachts under 30 m to either participate in the Canadian Coast Guard vessel traffic services or install a satellite automatic identification system; therefore, small vessels may not be fully captured in the available vessel movement data.

5.2.2.2 Regulatory Context

Federal

Transport Canada

The *NPA*, administered by Transport Canada, protects the public's right to navigate waters of Canada, and regulates construction work on navigable waters. The Act requires an authorization to permit the construction or placement of work (i.e., structure, device, or thing, temporary or permanent, made by humans) in, on, over, under, through, or across scheduled navigable waterways. The Fraser River is a scheduled navigable waterway. Under the Act, a Notice to the Minister of Transport is required if the Project is "likely to substantially interfere" (Section 4, 6, 8, and 9 of the Act) with marine use. An approval must be obtained before construction of marine infrastructure associated with the Project. Approval will be subject to review of the final design, and may include stipulations for navigational safety.

VFPA maintains navigational jurisdiction in the Fraser River South Arm and is responsible for the maintenance of deep sea and domestic channels for navigation. Further, the VFPA has developed harbour operations, practices, and procedures pursuant to Section 56 of the *Canada Marine Act*, which apply to vessels in Port jurisdiction, including small craft vessels, as well as other users of the Port.

As the Project is not located on VFPA-administered federal land, it will not undergo a separate review under the VFPA's Project and Environmental Review (PER) process. VFPA will consider potential effects of the Project through participation in the Technical Working Group.

Fisheries and Oceans Canada

Regulation and management of CRA fisheries occurs through the *Fisheries Act*, which protects the ongoing productivity and sustainability of CRA fisheries. The lower Fraser River supports CRA fisheries, of which Pacific salmon and eulachon are managed by Fisheries and Oceans Canada (DFO). Licensing and regulation of fisheries authorized under the *Fisheries Act* are regulated by:

- *Fishery (General) Regulations*
- *Pacific Fishery Regulations, 1993*
- *Aboriginal Communal Fishing Licenses Regulations*
- *British Columbia Sport Fishing Regulations, 1996*
- *Pacific Fishery Management Area Regulations, 2007*

Pacific Pilotage Authority and the B.C. Coast Pilots

The Pacific Pilotage Authority's and the B.C. Coast Pilots' mandate is to provide safe, reliable and efficient marine pilotage and related services in the Coastal waters of B.C., including the Fraser River. Under the *Pilotage Act* every commercial vessel over 350 gross registered tonnes is required to utilize the services of a qualified and licensed marine pilot when entering B.C. waters. The Fraser River Pilots, responsible for piloting vessel traffic in the Fraser River, provide expert local knowledge and handling ability on the river.

Canada Shipping Act

Transport Canada administers the *Canada Shipping Act S.C. 2001 c. 26*, which is intended to promote safe marine transportation and recreational boating, protects the marine environment from damage due to navigation and shipping activities, ensures that Canada meets international obligations under bilateral and multilateral agreements with respect to navigation and shipping, and establishes an inspection and enforcement program. With respect to the Project, this Act applies to Canadian and foreign vessels navigating the Fraser River, with the exception of Canadian Forces vessels.

5.2.2.3 Existing Conditions

The existing conditions of the study area are described for each sub-component in the following sections.

Commercial Navigation

Hydrodynamic Conditions of the Fraser River

Navigation in the Fraser River South Arm is affected by river flow conditions. Water levels and tides, among others, are factors considered by Fraser River pilots when determining a vessel's passage plan through the Fraser River. Water levels and tides are affected by freshwater discharge; mainly snowmelt. Discharge typically rises in April, peaks between May and July during freshet, and recedes during autumn and winter.

Tides at the Fraser River mouth are mixed semi-diurnal with two highs and two lows per day, with a large diurnal inequality during spring tides. During the low flow months (i.e., September through April), the tides create alternating flood and ebb flows at the lower reach of the Fraser River. During freshet, flows are predominantly seaward, but can be checked or reversed by the flood tide.

Additional information on the hydrodynamic conditions in the Fraser River is described in **Section 4.1 River Hydraulics and River Morphology**.

Fraser River South Arm Navigation

The Fraser River South Arm is navigable by marine vessels from its mouth to Yale, approximately 175 km upstream; however, river depth limits the draft of marine vessels capable of navigating upstream of New Westminster and channel geometry limit the length of vessel that can practically be used on the Fraser River. The lower reaches of the Fraser River South Arm are dredged annually to maintain, with tidal aid, a water draft of 11.5 m for at least two hours per day, every day of the year, from the river mouth to Fraser Surrey Docks, approximately 30 km upstream.

Navigation channels are classified into three official channel types and one unofficial channel type known as a channel reserve. The officially designated channels have design parameters based on the types of vessels transiting the channels as well as the goods being transported through each navigation channel, specifically:

- Deep sea channel: a 200-m wide navigation channel maintained to service ocean going vessels
- Domestic channel: a navigation channel maintained to service barge and towboat industry, or the local coastal community
- Local channel: the portion of the waterway that is neither a deep sea channel nor a domestic channel, but is used by a variety of smaller operators

The deep sea channel is 322 m wide, comprising a 200-m navigation channel, and two 61-m safety zones on either side of the navigation channel. The VFPA maintains an 11.5-m water draft in the channel for two hours per day.

Deas Slough Navigation

Deas Slough is a local navigation channel approximately 50 m wide, with an average depth of 5 m. At the Deas Slough Bridge, vertical clearance of Deas Slough is approximately 2.5 metres at high water datum. Infrequent and localized dredging takes place to maintain access to small craft harbours and moorage (PMV 2015c).

Land Use Supporting Commercial Navigation Requirements

Approximately four per cent of upland waterfront sites along the shoreline of the Fraser River South Arm are administered by VFPA, while the bordering municipalities of Richmond, Delta, Surrey, and New Westminster regulate the remaining sites. Within these municipalities,

industrial lands along the Fraser River shoreline have access to the river and the deep sea channel. The VFPA has identified long-term trends in maritime commercial navigation including containerization and bulk shipping, and continues to focus on maintaining and growing commercial marine use. Existing land use along the Fraser River is supported by deep sea terminals, coastal shipping, port services and industry, water lots, and moorage.

There are three deep sea terminals operating along the Fraser River South Arm:

- Fraser Surrey Docks, located approximately 14 km upstream of the Project, is primarily a break bulk terminal that can also handle containers with six freight sheds, and six deep sea terminals. Principle exported commodities include pulp, paper, and lumber, while steel and general cargo are principle imports.
- Annacis Auto Terminals, located on Annacis Island approximately 14 km upstream of the Project, services auto transport. It includes two deep sea berths, and intermodal rail and truck loading facilities.
- Fraser Wharves, located on Lulu Island approximately 1.5 km upstream of the Project, also services auto transport. It includes one deep sea berth, and an intermodal rail truck loading facility.

Future land use planning in the RAA has been identified in the VFPA's 2014 Land Use Plan (PMV 2014c). VFPA holds a number of upland properties, and leases water lots to support trade activities within Planning Area 7 (which includes the LAA). Future use of these lands is likely to be similar to those now present, although more intensive use of the sites can be anticipated to support trade growth. Planning Area 5, located upstream of the Project, represents the main location of port activity in the Fraser River and includes Fraser Surrey Docks and Annacis Auto Terminals. This area will continue to be the main hub of shipping and goods movement in the Fraser River with anticipated intensification of use and growth in sectors including bulk, break-bulk, liquid bulk, and other commodities.

Marine Traffic and Activity

Over 170,000 reported vessel movements occur annually in the Strait of Georgia between the Strait of Juan de Fuca to the south and Ballenas Island to the north. The majority of vessel movements in B.C.'s coastal waters are passenger traffic and tug-and-barge traffic, representing approximately 56% and 29% of overall vessel traffic, respectively (B.C. MOE 2006). Deep-sea cargo vessel movements (i.e., tanker vessels, bulk cargo carriers, container ships) account for approximately eight per cent, and the remaining are fishing and other vessel traffic (B.C. MOE 2006).

Commercial marine activities are extensive in the lower Fraser River. In 2014, cargo tonnage handled exceeded 140 million metric tonnes, and included general cargo, aggregate, logs, wood chips, hog fuel, paper, steel, cement, and automobiles (PMV 2014a).

Thousands of vessels transit the Fraser River South Arm annually. Vessel traffic in the Fraser River South Arm was examined by Det Norske Veritas (DNV) as part of the VFPA’s Fraser River Tanker Traffic Study (DNV 2012). The study divided traffic in the Fraser River South Arm into nine segments between the mouth of the Fraser to Patullo Bridge. The Project lies within the segment which extends from approximately the western end of Kirkland Island, near the outlet of Finn Slough, to the northern end of Deas Island. Vessel traffic counts for this study were collected from Automatic Information System data.

Table 5.2-3 shows that there were an estimated 12,716 vessel movements (up and down river) on the Fraser River South Arm through the LAA between July 2010 and June 2011 (DNV 2012). Tug-and-barge and cargo ferries were the most frequent vessel movements, accounting for 48% and 36% of total traffic volume, respectively.

As shown in **Table 5.2-3**, within the LAA deep water vessel traffic accounted for 1,076 annual vessel movements up and down river. These vessel movements consisted of the following cargo types and associated number of vessel movements (DNV 2012):

- Auto carrier vessels carrying cars - 564 vessel movements
- Container vessels carrying mixed cargo - 240 vessel movements
- Break bulk vessels carrying steel and lumber - 200 vessel movements
- Dry bulk vessels carrying grain - 74 vessel movements

Table 5.2-3 Vessel Movements through the LAA (July 2010 to June 2011)

| Vessel Type | Number of Vessels Movements Up and Down River | Percentage of Movements (Number of Movements ÷ Total Traffic) |
|-------------------|---|---|
| Deep Water Vessel | 1,076 | 8% |
| Cargo Ferry | 4,576 | 36% |
| Dredger | 678 | 5% |
| Fishing | 50 | <1% |
| Passenger | 48 | <1% |
| Pilot Vessel | 2 | <1% |
| Pleasure | 102 | 1% |
| Sailing Vessel | 4 | <1% |

| Vessel Type | Number of Vessels Movements Up and Down River | Percentage of Movements (Number of Movements ÷ Total Traffic) |
|------------------------|---|---|
| Search and Rescue | 130 | 1% |
| Tug-and-Barge | 6,046 | 48% |
| Unspecified | 4 | <1% |
| Total Vessel Movements | 12,716 | 100% |

Note: Summary of upriver and downriver data modified from DNV 2012.

Future vessel traffic in the LAA has been identified in DNV’s Tanker Traffic Study (DNV 2012). With the exception of tug-and-barge traffic, the majority of the vessel traffic in the Fraser River South Arm is not anticipated to increase over the next ten years (DNV 2012). Tug-and-barge traffic is expected to increase at a nominal rate of 3% per year (DNV 2012).

Since the DNV 2012 report was completed, the estimate for anticipated vessel traffic in the LAA has been updated and now reflects an approximately 10% increase in deep water vessels and a less than 1% increase in barge traffic over the 2012 values.

Commercial, Recreational, and Aboriginal (CRA) Fisheries

Overview of Fisheries

Fraser River fisheries contribute significantly to the economic activity along the river (Richmond Chamber of Commerce and D.E. Park and Associates Ltd. 2014). The Steveston Harbour, approximately nine kilometres downstream of the Project, is the largest commercial fishing harbour in Canada, home to more than 350 commercial fishing vessels. Between 13 and 30 million kg of fish and seafood are unloaded at Steveston annually (Kiesman 2013).

Lower Fraser River fisheries openings are summarized in **Table 5.2-4**, and are discussed in the following sections. Data on commercial (including Aboriginal) fisheries openings is summarized for the period between 2004 and 2014 (DFO 2014a, 2015). Data for Aboriginal FSC fisheries openings (downstream of the Port Mann Bridge to the river mouth) is summarized for the period of 2004 to 2009, and the year 2013, and includes communal licences, communal licences with limited participation, and communal licences with allowance for sale (DFO 2014a). Coho salmon is not included in **Table 5.2-4**, reflecting non-retention and non-possession currently in effect for Fraser River fisheries (DFO 2012). Data on fisheries openings is expressed in number of hours per week and does not represent fishing effort or catch levels.

Table 5.2-4 Species Run Timings and Aboriginal and Commercial Fisheries Openings (in Number of Hours) in the Lower Fraser River (Sources: DFO 2014a, 2015)

| | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|--|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| Chinook salmon | | | | | | | | | | | | |
| Aboriginal (FSC ¹ / EO ²) | | | | | | | | | | | | |
| Commercial | | | | | | | | | | | | |
| Chum salmon | | | | | | | | | | | | |
| Aboriginal (FSC / EO) | | | | | | | | | | | | |
| Commercial | | | | | | | | | | | | |
| Pink salmon | | | | | | | | | | | | |
| Aboriginal (FSC / EO) | | | | | | | | | | | | |
| Commercial | | | | | | | | | | | | |
| Sockeye salmon | | | | | | | | | | | | |
| Aboriginal (FSC / EO) | | | | | | | | | | | | |
| Commercial | | | | | | | | | | | | |
| All Pacific salmon | | | | | | | | | | | | |
| Aboriginal (FSC / EO) | | | | | | | | | | | | |
| Commercial | | | | | | | | | | | | |
| Eulachon | | | | | | | | | | | | |
| Aboriginal (FSC / EO) | | | | | | | | | | | | |
| Commercial | | | | | | | | | | | | |

Notes: ■ Dark grey cells denote run timings for Pacific salmon and eulachon. Data shown for pink salmon represents odd years.
 Fishery openings are expressed in number of hours with a shading gradient transitioning from dark blue (representing greater number of hours) to light blue (representing fewer hours) per week.
 ▤ Crosshatched cells represent non-targeted fisheries (i.e., retention of a species is allowed during fisheries targeting another species).
¹ FSC: Food, social, and ceremonial Aboriginal fisheries; ² EO: Economic opportunity Aboriginal fisheries

Commercial Fisheries

Commercial salmon fisheries within the LAA (i.e., within PFMA sub-areas 29-13 and 29-14) are conducted primarily with gill nets (i.e., under DFO Salmon Area E Gillnet licences). Salmon gill net fisheries openings are relatively short, depending on run strength determined in-season (Table 5.2-4). Specific commercial management areas (Salmon Area E Gillnet, Salmon Area H Troll, and Salmon Area B Seine) apply to commercial salmon fishing activities in the lower Fraser River and are specified within fishing permits. These licences apply to all of Area 29 (as well as to PFMA areas beyond Area 29); however, within the Fraser River, these fisheries typically occur from the Port Mann Bridge downstream to the river mouth, and therefore overlap the Project area. Openings typically last from 3 to 24 hours, and may begin in mid-July through to mid-September and again in mid-October through to mid-November (Table 5.2-4). The number of gill net openings varies annually, typically between two and four openings per year,

with as many as 10 openings during years with peak salmon runs (DFO 2015). Commercial gill net fisheries target sockeye and chum salmon, but permit the retention of pink and chinook (DFO 2015).

Aboriginal Groups participate in commercial salmon fisheries in the lower Fraser River, both in the general commercial fishery and under communal commercial licences, deriving economic benefits from fishery revenues and employment-generated income. Aboriginal commercial harvest opportunities under communal commercial licences are managed using rules that are similar to those applied to general commercial fisheries (DFO 2014b). Schedule B Aboriginal Groups hold Salmon Area E Gillnet licences, and some are in the process of acquiring additional licences.. Commercial licences and businesses owned by Schedule B Aboriginal Groups are identified in **Section 10.0 Aboriginal Consultation** and includes information provided by Aboriginal Groups as well as that collected through publicly available sources.

The Musqueam Indian Band is involved in commercial fisheries through Salish Seas Limited Partnership, a business owned jointly with the Tsleil-Waututh Nation and Sliammon First Nation. Species harvested commercially through this enterprise include crab, prawn, halibut, and herring. Individual Musqueam members also hold commercial licences (PMV 2015). In 2013, 2014, and 2015, Musqueam were licenced to harvest crab (targeting Dungeness, graceful and red rock) within the Musqueam Crab Area and prawn in PFMA sub-areas 29-2, 29-3, and 29-4 throughout the year (DFO 2016). Musqueam have noted that they have over 60 registered fishing vessels that are used to exercise their fishing rights.

The Project area lies within Tsawwassen Territory, and is situated in or near several harvesting areas defined in the Tsawwassen First Nation Final Agreement relating to fishing. The Tsawwassen First Nation Harvest Agreement provides for an annual commercial allocation of Fraser River sockeye, chum, and pink salmon (odd years only). These commercial allocations vary with the size of the Canadian Commercial Total Allowable Catch (TAC) for sockeye and pink salmon and the Terminal Commercial Catch for chum salmon (TFN 2015). In 2013, there were seven openings for these purposes for pink salmon in September, and two openings for chum salmon in late October. In 2014, there were nine commercial openings for sockeye salmon in August and September, and two openings for chum salmon in late October. There were also two commercial openings for chum salmon in late October 2015 (DFO 2016). The Tsawwassen First Nation Harvest Agreement is also supported by the Tsawwassen Commercial Fish Fund and Tsawwassen Commercial Crab Fund, the monies from which are used to secure general commercial licences for salmon or crab for conversion to Tsawwassen First Nation Harvest Agreement licences (PMV 2015a).

The Hul'qumi'num Fisheries Limited Partnership (HFLP) is a commercial fishing business in which Cowichan Tribes, Halalt First Nation, Penelakut Tribe, Stz'uminus First Nation, Lake Cowichan First Nation and Lyackson First Nation are affiliated. Species harvested through this enterprise are crab (one Area H licence), prawn (two local / coast wide licences), halibut (one licence and annual TAC quota), herring (13 gillnet and 1 seine), rockfish (two Area Inside licences, targeting yelloweye, quillback, copper, china, and tiger), sablefish (annual TAC quota), and salmon (five Area E gillnet licences) (HFLP 2014). Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island (PMV 2015, LFN 2016).

As recently as 2014, Katzie and other Lower Fraser First Nations, participated in an economic opportunity fishery for sockeye, of which Katzie are said to have had a share of 10,000 sockeye that could be sold (Melnychuk 2014).

Until the early 1990s, no directed net fisheries on coho or chinook were conducted in the Fraser River; however, these species, as well as steelhead, were harvested incidentally in the sockeye, pink, and chum salmon fisheries (B.C. MELP and DFO 1998).

A commercial eulachon fishery in the Fraser River was suspended in 1997 due to conservation concerns for the status of the stock and the inability to control fishing effort (DFO 2013b). Only a very small Aboriginal ceremonial fishery continues to the present (Schweigert et al. 2012).

Since 1994 a commercial sturgeon fishery in the lower Fraser River no longer exists, but until 1994, white sturgeon were retained as bycatch (caught unintentionally) in the salmon gill net fishery and sold commercially. Since 1994, commercial gill net fisheries are no longer permitted to take sturgeon, and Aboriginal Groups are discouraged from taking sturgeon (Fraser River White Sturgeon Working Group 2009).

Recreational Fisheries

Recreational fishing occurs within the lower Fraser River to provide food for personal use, as a leisure activity, or both. Recreational fishing is undertaken with a sport fishing licence. Fishing techniques within the lower Fraser River include trolling, mooching, and casting from boats, piers, or the shore, using bait, lures, or artificial flies. Casting from shore appears to be most prevalent. Recreational fisheries primarily target salmon (typically retention fisheries), and sturgeon (catch and release). Access to fishing along the lower Fraser River shoreline is possible from recreational parks (e.g., Deas Island Regional Park in the vicinity of the Project), piers, floating docks, boat launches (e.g., Ladner boat launch at the mouth of Deas Slough), and private and public marinas (e.g., Captain's Cove and the River House marinas in Deas Slough).

In the immediate vicinity of the Project, fishing from the river's riprap shoreline for pink salmon (during odd years) using hook and line is a popular recreational activity. The lower Fraser River, especially the river mouth, is a guided sport fishing destination, particularly during sockeye salmon runs. No recreational salmon catch data is available for the Fraser River South Arm in the vicinity of the Project.

Aboriginal Fisheries

Aboriginal Groups participate in domestic and FSC fisheries in the lower Fraser River in the vicinity of the Project. In general, DFO manages Aboriginal fisheries to provide access for food, social, and ceremonial (FSC) purposes. Aboriginal Groups that participate in domestic and FSC fisheries in the lower Fraser River in the vicinity of the Project are described in detail in **Section 10.1.3. Aboriginal Interests Assessment**. Information on relevant past, present, or desired future marine activities, including fishing access and methods have been gathered through consultation activities and publicly available sources and therefore may not necessarily reflect all current or desired future commercial, domestic, or FSC fisheries uses of all Schedule B Aboriginal Groups. More detail on traditional, historical, and current fishing and Aboriginal Interests within the Fraser River South Arm is provided in **Section 10.1.3 Aboriginal Interests Assessment**

FSC fisheries take priority over other uses, including other fisheries, after conservation targets have been met. The primary method of fishing for FSC purposes in the Fraser River is by use of drift gill nets.

Salmon fisheries for domestic or FSC purposes target all five species of Pacific salmon and occur throughout the lower Fraser River, primarily using drift gill nets. Aboriginal drift gill net fisheries are normally conducted on weekends from Friday through Sunday. Openings range from two hours to multiple days, between early March and late December, with peak efforts coinciding with the run timing of targeted species. In general, periods with the most openings occur during June, August, and October through November (**Table 5.2-4**; DFO 2013a).

Aboriginal harvesting of eulachon for domestic or FSC purposes in the lower Fraser River is authorized by communal licenses, issued for small amounts of eulachon on a case by case basis. Due to the limited nature of this fishery, fishing times are restricted to one day per year for each communal licence, and participants are required to report catches to DFO (DFO 2013c).

Cowichan Nation Alliance

Cowichan Nation Alliance historically harvested sockeye and pink salmon, sturgeon, shellfish, and marine mammals within the South Arm of the Fraser River. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while they were resident on the Fraser River. *Tl'uq̓tinus* was used seasonally for harvesting purposes. Areas within the wider Fraser River estuary were also utilized by *Hul'q'umi'num'*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations. Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO). Access to sockeye for member First Nations is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008. In those years, the specific locations in the South Arm in which member First Nations of the Hul'qumi'num Treaty Group fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River.

Katzie First Nation

Currently, Katzie are among the numerous First Nations involved in the Lower Fraser River salmon fishery under food, social and ceremonial (FSC) licences issued by Fisheries and Oceans Canada (DFO). Of the 570 registered members of Katzie, roughly one third of those members is reportedly licenced to fish during openings on the Fraser River, and an estimated 120 Katzie vessels use the Fraser River to harvest fish annually. Their fishing area is in the vicinity of their communities. Since 2004, Katzie appear to have been licensed to fish in this area for Chinook, sockeye, and chum salmon, steelhead, and eulachon, as well as for chum salmon specifically in the Pitt River, although the targeted species, timing, and frequency have varied year over year. In 2015, Kwantlen had opportunities to harvest salmon from the Fraser River under FSC communal licences, limited participation (i.e., ceremonial) licences, and economic opportunity licences. Communal licences appear to have been issued only for Chinook salmon, over three days in September, while limited participation licences were

issued for Chinook and chum salmon for a portion of one day each, in April and November, respectively, and eulachon on four occasions in April. Kwantlen consider the vitality of the Fraser River and its resources to be an important element of their culture. Salmon was and remains a primary resource and is the basis of Kwantlen’s economy.

Kwantlen First Nation

Kwantlen First Nation consider the vitality of the Fraser River and its resources to be an important element of Kwantlen culture. Salmon was and remains a primary resource and is the basis of Kwantlen’s economy. Kwantlen are among the numerous First Nations involved in the Lower Fraser River salmon fishery under food, social and ceremonial (FSC) licences issued by Fisheries and Oceans Canada (DFO). Kwantlen are typically licenced to fish for FSC purposes in the stretch of the Fraser River between the Port Mann Bridge and Mission, using both drift and set nets (DFO 2016); and appear to fish in this area for Chinook, sockeye, and chum salmon and eulachon.

Lake Cowichan First Nation

Lake Cowichan followed a seasonal round of resource use and regional settlement. Within this round, the Fraser River estuary has been described as the “most important economically”. Species harvested historically on the South Arm of the Fraser River included salmon, sturgeon, eulachon, shellfish, and marine mammals (particularly seals). Access to sockeye for Hul’qumi’num Treaty Group member nations for food, social, and ceremonial (FSC) purposes is said to be provided annually by Fisheries and Oceans Canada (DFO) in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008.

Lyackson First Nation

The Fraser River, from its mouth up to Seabird Island (east of Chilliwack), has been described as a key fish and shellfish harvesting area for Lyackson, with Canoe Passage (*Hwlhitsu’um*) identified as particularly important for salmon fishing. Areas within the wider Fraser River estuary were also utilized by *Hul’q’umi’num’*-speaking peoples for fishing salmon, sturgeon, groundfish, halibut, and other marine resources on the foreshore. Lyackson First Nation has said that the mouth and South Arm of the Fraser River is currently the source of over 50% of their current subsistence salmon catch; however, they say fishing in the Fraser River area has become largely unavailable to them due in part to low present-day fish populations and the cost of boats and technology.

Musqueam Indian Band

Musqueam has an established right to fish for food, social, and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River pursuant to *R. v. Sparrow* [1990], 1 S.C.R. 1075 (SCC 1990). The Project area lies immediately upstream of this area, and within the area where this right is considered by the Ministry to be asserted. Musqueam also assert an Aboriginal right to fish for food, social and ceremonial purposes in a broader area that includes, but is not limited to, all waters of the Fraser River – including its North Arm, Middle Arm, and South Arm – downstream of the Port Mann Bridge to the Strait of Georgia. All five species of Pacific salmon, steelhead, rockfish (rock cod, red snapper), herring and herring spawn, smelt, halibut, eulachon, trout, and sturgeon were fished historically by the Musqueam in their traditional territory, and all were important economically. The most commonly harvested marine mammals included harbour seal, sea lion, and porpoise; harvesting areas included the Fraser River estuary. At productive beaches within Musqueam traditional territory, abalone, barnacles, clams, chitons, cockles, mussels, crabs, crayfish, octopus, oysters, prawn, scallops, sea urchins, sea cucumber, shrimp, and seaweed were harvested and set aside for winter supplies; however, clams were the most abundant and heavily harvested, including at Boundary Bay. Fishing remains central to Musqueam, and they have specified that the waters outside Steveston, Canoe Passage, and the lower of the Fraser River, and Roberts Bank are their most intensive salmon harvesting areas. Salmon is a key species to the Musqueam, important for FSC and economic purposes.

Hwlitsum

Hwlitsum followed a seasonal round of resource use and regional settlement that involved spending winter on the Gulf Islands and southern part of Vancouver Island (December to February) and summer on the Lower Mainland (March to November) (HFN 2016a). While part of their salmon fishing season was also spent at *Tl'uq̓tinus* (BC and PMV 2012), all species of salmon, cutthroat, Dolly Varden, dogfish, flounder, steelhead, smelt oysters, crab, sturgeon, eulachon, and trout are or have been obtained by Hwlitsum at Canoe Pass or at nearby locations, such as Kirkland Island (salmon), Cohilakthan Slough (steelhead and salmon), Steveston (eulachon, up to the Highway 99 crossing), Ladner Reach (crab), and Roberts Bank (crab and sockeye) (HFN 2016a; PMV 2015). Salmon, steelhead, trout, and sturgeon were also taken further up the Fraser River and its tributaries. Areas within the wider Fraser River estuary were also reportedly utilized by Hwlitsum for fishing salmon, sturgeon, groundfish, and other marine resources (e.g., Tsawwassen, Point Roberts, Boundary Bay) (HFN 2016a). Hwlitsum have said that access to and use of Fraser River resources has and remains aided by physical presence, including “a set of houses, two wharves and two net sheds” on or near Canoe Pass,

as well as through kinship ties with other First Nations (HFN 2016a); however, other sources suggest that Hwlitsum do not currently have a communal licence to fish in the Fraser River for food, social and ceremonial (FSC) purposes, and that their access to their FSC allocation must be gained through negotiations with First Nations with a communal licence (Cohen Commission 2011). Hwlitsum harvest crab and bivalve species such as clams (i.e., butter, manila, and littleneck), cockles, mussels, oysters, and abalone in the Gulf Islands. Shrimp are generally harvested throughout the Strait of Georgia (between the Gulf Islands and the Lower Mainland), as well as immediately west of the existing Roberts Bank terminals, with targeted shrimp harvesting at Sturgeon Bank. Other marine invertebrates taken include red and green sea urchin, octopus, squid and sea cucumber, all harvested on the western side of the Strait of Georgia (PMV 2015).

Semiahmoo First Nation

Semiahmoo has reported that they once fished for salmon, sturgeon, halibut, eulachon, herring, smelts, sea mammals (including hair seals, sea lions, and porpoises), and a range of beach foods. Semiahmoo said that they practiced their fishing rights in the Fraser River in the summer season at *Tl'ektines*, in the vicinity of the north end of the George Massey Tunnel. Shellfish were also important to the Semiahmoo, and Boundary Bay has been characterized as formerly one of the most productive shellfish harvesting locations on the Pacific coast. Semiahmoo reports that sturgeon and eulachon once served as an important substitute for other fisheries; however, current conservation measures prohibit retention of these species.

Squamish Nation

While Squamish Nation territory reportedly extends south as far the South Arm of the Fraser River, Squamish Nation do not currently fish directly in the Fraser River for food, social or ceremonial (FSC) purposes based on information previously reported by Squamish Nation (SN 2014) and a review of Fisheries and Oceans Canada (DFO) records regarding “Lower Fraser River Fisheries” from the last few years (DFO 2016).

Tsawwassen First Nation

Tsawwassen report that they actively fish in the South Arm of the Fraser River and within the Project area, and that portions of the Project occur within the two subareas 29-13 (Canoe Pass to Deas Island) and 29-14 (Steveston to Pattullo Bridge) (TFN 2015). Canoe Pass and the waters in and around Rose-Kirkland Island (i.e., Ladner Reach, Woodward Reach), which lie about 1 km downstream of the Project area, have been previously described as particularly important fishing areas (VAFFC 2011, BC and PMV 2012). The right to harvest fish allows

designated members of the Tsawwassen First Nation to exercise the right for domestic purposes and to trade or barter those fish among themselves or with other Aboriginal people resident in BC (TFN et al. 2009a, Chapter 9). Domestic allocations for sockeye, chum, pink, chinook, and coho salmon, which are centrally important to the Tsawwassen First Nation, are calculated using formulas described in the TFNFA; generally, set at 625 Chinook, 15,226 sockeye, 2,500 pink (odd years only), 500 coho, and 2,576 chum (TFN et al. 2009b, Appendix J-2).

In 2015, Tsawwassen First Nation fished under communal licence for chinook, sockeye, and chum salmon. Fraser River eulachon are fished in Canoe Passage in limited quantities (up to 50 lbs (23 kg) on average) for specific domestic purposes, typically in April and May, and only after conservation goals have been met. Tsawwassen report that eulachon, once very abundant, in particular in Canoe Passage, is now only available for distribution to Elders.

Canoe Passage was once a key sturgeon harvesting area, but now sturgeon cannot be kept due to conservation concerns. Groundfish may also be harvested year-round for domestic purposes under the TFNFA, but this harvest has not occurred since the TFNFA came into effect. Since the TFNFA came into effect, four to five licences have been issued for the domestic crab harvest, targeting Dungeness, graceful, and red rock species; domestic harvests of crab are currently not subject to allocation limits and are permitted throughout the year.

Tsleil-Waututh Nation

Marine resources were and remain central to Tsleil-Waututh for subsistence and cultural life. Salmon was a food staple, supported by the harvest of the full range of shellfish, including bivalves and crustaceans, sturgeon, a variety of groundfish, eulachon, herring, and smelt, as well as aquatic plants, such as seaweeds. Seals, porpoises, and sea lions were also harvested. Tsleil-Waututh report they hold a close cultural and spiritual connection to salmon (TWN 2015). Tsleil-Waututh reports that they have an extensive Fraser River sockeye fishery each year. The largest fishing effort occurs in August. Tsleil-Waututh has also participated in, and continues to “reserve the right,” to a limited participation fishery for ceremonial purposes outside of the regular Tsleil-Waututh sockeye fishing season (TWN 2016).

Fraser River sockeye remain a primary traditional food source for Tsleil-Waututh families, and salmon, herring, and crab are among the species that still contribute to the contemporary economy of Coast Salish peoples (TWN 2015). Sturgeon, due to its decline, is no longer a component of Tsleil-Waututh diet. It is Tsleil-Waututh’s goal to participate in the recovery of these species and their habitats for future generations (TWN 2015).

Tsleil-Waututh may fish for FSC purposes under communal licences issued by DFO. In addition to communal licences issued by DFO, Tsleil-Waututh report that they may access food fish through other means, such as through cultural protocols and kinship ties with neighbouring communities, when DFO communal licences are unavailable to Tsleil-Waututh.

PFMA subareas to TWN FSC licences currently apply include 28-11, 28-12, 28-13, 28-14, 29-3, 29-4, 29-6, 29-7, 29-9, 29-10, 29-11, 29-12, 29-13, 29-14, and 29-17 (DFO and TWN 2013). Subareas within PFMA 28 apply to eastern Burrard Inlet and Indian Arm; the other subareas within PFMA 29 cover the Fraser River downstream of the Port Mann Bridge and into the Strait of Georgia (DFO 2016). Subareas 29-13 and 29-14 overlap the Project corridor. Tsleil-Waututh also report having access to PFMA 29 for communal crab licences, and have been working with DFO through an access request process to recognize the entirety of PFMA 28 and PFMA 29 for prawn and crab communal fisheries in the Tsleil-Waututh Nation's CFA (TWN 2016). TWN's access to Fraser River salmon extend beyond sockeye and include pink, chum, chinook, and coho (incidental). In addition to communal FSC access, TWN holds 10 to 15 Allocation Transfer Program (ATP) communal commercial fishing licenses. This includes two crab, 4 to 9 herring gill net licenses, one prawn, and three salmon gill net licenses.

TWN is also involved in commercial fisheries through Salish Seas Limited Partnership, a business owned jointly with Musqueam Indian Band and Sliammon First Nation. Species harvested commercially through this enterprise include halibut, sablefish, prawn, crab, herring, and salmon.

Recreational Navigation

The Fraser River is important for a wide range of water-based recreation (Environment Canada 1994), with the type of activity varying by location. Activities undertaken within the Fraser River include fishing, waterskiing, motor-boating, canoeing, sailing, windsurfing, river rafting, and kayaking.

Recreational boating is prevalent throughout the LAA. Marine use in Deas Slough is dominated by recreational vessels with recreational water-sports including pleasure boating, paddle sports (kayaks, dragon boats, rowing shells, canoes), and waterskiing. Metro Vancouver manages recreational use of the slough year-round to ensure that paddle sports use the slough at separate times from water skiers by establishing a recreational uses schedule (Metro Vancouver 2016).

Two marinas (i.e., River House marina and Captain's Cove marina) occupy approximately one-third of the shore of the slough's south bank. River House marina is located north of Deas Slough Bridge and has 140 boat slips. Captain's Cove marina is located south of Deas Slough Bridge and has 350 boat slips. Boat slips are used year-round, however, usage increases in summer and decreases in winter.

In addition to the two marinas, the Delta Deas Rowing Club is located along the shoreline at the upstream end of slough, near the north end of Deas Island, within Deas Island Regional Park. Rowing from this club takes place within Deas Slough and the rowing club operates year-round.

A boat ramp, operated by the Corporation of Delta Parks and Recreation Department, provides public access to Deas Slough and the Fraser River South Arm. The boat ramp is located at the northern end of Ferry Road, immediately west of Captain's Cove marina. Dredging was initiated in February 2014 in lower Deas Slough to re-establish the depth and width of the local channel, and to remove materials around the Ferry Road boat ramp that had been affecting recreational boating activity (PMV 2014b).

5.2.3 Potential Effects

This section discusses potential interactions of Project components and activities with marine use, and potential effects of such interactions on commercial navigation, CRA fisheries, and recreational navigation. Changes in marine use are of interest to local industry located along the Fraser River including port-related businesses that rely on marine access, Aboriginal Groups, and the general public. Potential effects on marine use have been identified through consultation with potentially affected marine users, publicly available information sources, and experience gained by the Ministry in addressing marine use considerations on other projects (i.e., construction of the new Port Mann Bridge). Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 5.2.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 5.2.4**. A discussion of potential cumulative effects on marine use is presented in **Section 5.2.6**.

For further analysis of potential Project-related effects on Aboriginal Interests, including fishing, and measures to address those potential effects, see **Section 10.1.3 Aboriginal Interests Assessment**.

5.2.3.1 Project Interactions

An overview of potential interactions between Project activities and marine use during the construction and operation of Project components is provided in **Appendix A**. A preliminary evaluation of the potential effects of Project interactions on marine use, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Project-related construction activities in the Fraser River South Arm that have the potential to affect access to waterways include marine-based equipment working in or transiting the Project area and marine-based construction activities including Tunnel decommissioning.

Project-related construction activities that have the potential to affect the frequency and volume of marine traffic in the Project area include marine-based equipment working within the Fraser River South Arm or Deas Slough and marine-based equipment transiting through the Fraser River South Arm or Deas Slough. **Construction:** Construction of the new clear span bridge and Tunnel decommissioning has the potential to temporarily affect marine use in the Fraser River South Arm, including commercial navigation, navigation for CRA fisheries, and recreational navigation. Marine-based equipment will transit the Project area and, in some cases, will remain in the Project area in order to undertake construction activities including bridge construction and Tunnel decommissioning. Both the transit of marine-based equipment and the presence of such equipment to support construction activities could affect marine use during Project construction and Tunnel decommissioning activities.

Marine-based equipment is expected to include tug and barges used to support transporting construction materials including bridge components as well as Tunnel segments. More detail on the Project components and associated construction activities is provided in **Section 1.1 Description of Proposed Project** of the Application. Project construction is also assumed to require marine-based equipment to support localized instream work along the edge of Deas Slough and removal of Deas Slough Bridge and in-stream works associated with Tunnel decommissioning. Project-related construction activities in Deas Slough that have the potential to affect access to marine use include bridge foundation installation in localized areas along Deas Slough, overhead construction of the clear span over Deas Slough and removal of the Deas Slough Bridge. These activities could temporarily affect navigation for CRA fisheries and recreational navigation. Activities associated with decommissioning of Tunnel are expected to result in temporary impacts to CRA fisheries and recreational navigation.

Operation: The new crossing will be a clear span bridge, with support towers located on land, thereby avoiding effects on the river mainstem. Navigation clearances associated with the new bridge have been established with VFPA taking into account long-term marine use considerations and Transport Canada requirements. Interactions between the Project and marine use in the Fraser River South Arm during operation are not anticipated.

Removal of the Deas Slough Bridge will eliminate structures in the slough that currently infringe on the local navigation channel. The current available air draft of approximately 2.5 metres will be increased to approximately 20 m. The existing three span bridge will be replaced by a single, longer span structure. Interactions between the new bridge and marine use in Deas Slough during operations are anticipated to be positive.

5.2.3.2 Potential Effects

Construction:

During the construction of the new bridge, decommissioning of the Tunnel, foundation construction along the edge of Deas Slough and removal of the existing Deas Slough Bridge, interaction between the Project and marine use will be managed to ensure safety and to maintain the navigation needs and marine use of the river and Deas Slough.

As described in **Section 1.1.7 Project Activities by Phase**, construction of the new bridge is assumed to involve lifting of pre-fabricated deck segments from barges in the river followed by the sequential connection of each segment to cables suspended from the land-based towers. When the central segments of the bridge deck need to be installed, a temporary, one-directional navigation would allow construction and marine traffic to proceed safely. A similar approach could be used for Tunnel removal as described in **Section 1.1.7 Project Activities by Phase** when barge-based equipment will need to be located over the four central segments of the Tunnel to remove them.

Either barge or land based equipment will be required to install the stone columns and piles along the edge of Deas Slough. In addition, construction over top of Deas Slough to construct the south approaches to the new bridge and barge-based work to remove the existing Deas Slough Bridge will be required. Transiting of recreational vessels under the Deas Slough Bridge will be temporarily affected by these operations.

Commercial Navigation

Change in Access

During construction activities based within the Fraser River South Arm, some commercial navigation may be temporarily affected by the requirement to establish a temporary, one-directional navigation channel to allow construction and marine traffic to proceed safely.

This requirement may result in a temporary infringement on access for some vessels, including those requiring the maximum draft, where such vessels would have a smaller timing window during which they would be able to move through the Project area. Smaller vessels, with a reduced draft requirement, would be less affected by this restriction. Full closures of the deep water navigable zone are expected to be limited and undertaken with substantial advanced notice.

Change in Marine Traffic Volume and Frequency

While the use of marine-based equipment will be limited to the extent possible, where possible and practical, bridge construction and Tunnel decommissioning will result in temporary increases in the volume and frequency of marine-based vessels transiting the Fraser River South Arm. These anticipated increases in the volume and frequency of marine traffic may result in temporary effects on navigability within the Project area.

Commercial, Recreational, and Aboriginal (CRA) Fisheries

Change in Access

During construction activities taking place within the Fraser River South Arm, navigation for CRA fisheries may be temporarily affected by the requirement to establish a temporary, one-directional navigation channel to allow construction and marine traffic to proceed safely.

While this requirement may result in a temporary infringement on access for some vessels, including those requiring the maximum draft, it is assumed that vessels used to support CRA fisheries, which would have a reduced draft requirement compared to larger commercial vessels, would be less affected by this infringement.

In addition to temporary infringements on access to the main stem of the Fraser River South Arm, construction activities within or along Deas Slough may result in temporary infringements on access to these areas.

Full closures of the deep water navigable zone of the Fraser River South Arm and full closures of Deas Slough are expected to be limited and undertaken with substantial advanced notice.

Change in Marine Traffic Volume and Frequency

While the use of marine-based equipment will be limited to the extent possible, where possible and practical, bridge construction and Tunnel decommissioning will result in temporary increases in the volume and frequency of marine-based vessels transiting the Fraser River South Arm. These anticipated increases in the volume and frequency of marine traffic may result in effects on navigability support CRA fisheries within the Project area.

Recreational Navigation

Change in Access to Waterways

During construction activities taking place within the Fraser River South Arm, recreational navigation may be temporarily affected by the requirement to establish a temporary, one-directional navigation channel to allow construction and marine traffic to proceed safely.

While this requirement may result in a temporary infringement on access for some vessels, including those requiring the maximum draft, it is assumed that smaller recreational vessels, which would have a reduced draft requirement compared to larger commercial vessels, would be less affected by this infringement.

In addition to temporary infringements on access to the main stem of the Fraser River South Arm, construction activities within or along Deas Slough may result in temporary infringements on access to these areas.

Full closures of the deep water navigable zone of the Fraser River South Arm and full closures of Deas Slough are expected to be limited and undertaken with substantial advance notice.

Change in Marine Traffic Volume and Frequency

While the use of marine-based equipment will be limited to the extent possible, where possible and practical, bridge construction and Tunnel decommissioning will result in temporary increases in the volume and frequency of marine-based vessels transiting the Fraser River South Arm. These anticipated increases in the volume and frequency of marine traffic may result in effects on navigability for recreational navigation within the Project area.

Operation

Change in Access to Waterways

Given that the Reference Concept includes a clear span over the Fraser River and Deas Slough, Project-related effects to marine use in the Fraser River South Arm are not anticipated during operation. Vertical and horizontal clearance dimensions of the navigation channel of the Fraser River crossing will be similar to those at the Alex Fraser Bridge and have been established in consultation with VFPA. The Project is not expected to result in a change in marine access in the Fraser River South Arm during Project operation.

The Project will improve navigation opportunities within Deas Slough during operation. Removal of the Deas Slough Bridge, including removal of in-water piers and replacement of the existing three span bridge with a longer single span, will eliminate structures in the slough that currently constrain the local navigation channel. The current available air draft of 2.5 metres will be increased to approximately 20 m. The horizontal clearance available for navigation at Deas Slough will be increased with the provision of a clear span. This is considered to be a positive change in marine access within Deas Slough.

Change in Marine Traffic Frequency and Volume

The temporary increase in marine-based traffic associated with the Project will be limited to the construction phase (i.e., bridge construction and Tunnel decommissioning). No Project-related marine-based vessels or equipment within the Fraser River South Arm or Deas Slough during Project operation. As such, changes in marine traffic frequency and volume are not expected during Project operation.

5.2.4 Mitigation Measures

5.2.4.1 Avoidance

Navigation clearances for the new bridge have been established in consultation with the VFPA and Transport Canada and match the navigation clearance envelope provided by the upstream Alex Fraser Bridge (**Appendix 16.1 Reference Concept**). The vertical clearance of the new bridge in the Fraser River South Arm will provide:

- 57 m above high water at 2.0 m high water datum (GSC) for a two-directional, 200-m wide channel
- 59.6 m above high water at 2.0 m high water datum (GSC) for a central, one-directional, 130-m wide channel

Horizontal clearance of the new bridge within the Fraser River South Arm will provide a 200-m navigation channel with two 61-m safety zones on either side of the navigation channel. This will support existing and future use.

The towers that will support the new clear span bridge will be land-based and will not interfere with navigation. The final design for the bridge will also take into account the lighting and marking requirements of the *NPA* for safe navigation.

In Deas Slough, vertical clearance in the local channel will be approximately 20 m above high water. The existing Deas Slough Bridge and piers will be removed to the mud line and be replaced by a longer, single span. This will support future use and will result in an improvement to marine use compared to existing conditions.

Implementation of the above measures will avoid potential effects on marine use during Project operation.

5.2.4.2 Minimization

Submission of a Notice of Works: The Ministry will submit a Notice of Works form addressing the Section 4 (a through e) requirements of the *NPA* for construction activities (i.e., construction of the new bridge and Tunnel decommissioning) that may interfere with marine use. The effects of the works, as per Section 4d of the Act, will include measures proposed by the Ministry to ensure maintenance of the navigation channel during construction. These mitigation measures will include the establishment of navigation protection zones that will be maintained during marine-based construction activities. Navigation protection zones will be established in consultation with the Marine Users Group to designate areas where navigation can occur safely during construction. These areas will be delineated by navigational aids such as lighting or signage.

Development of a Marine Access Management Plan: A Marine Access Management Plan (MAMP) will be developed (see **Section 12.0 Management Plans**) and will describe the measures to be implemented to minimize potential construction-related access effects on marine use. The MAMP will outline communications protocols to establish and advise of instream construction activities, including periods of vessel restrictions and is anticipated to include:

- An outline of all marine consultation and media-related activities being undertaken by the Project.
- Processes and procedures to inform marine users of any instream activities that may affect access to the navigation channel and other areas frequented by marine users.

- Specific information on construction phasing, work scheduling, and location of instream staging areas required for Project construction and decommissioning activities.
- Issuance and posting of notices regarding construction schedules, as well as updates on access and instream construction activities.
- Establishment of a 24-hour telephone line available to the marine community during new bridge construction and Tunnel decommissioning.
- The MAMP will be reviewed and approved by Transport Canada and will form part of the *NPA* approval for new bridge construction.
- Use BMPs and comply with regulatory requirements, including those related to construction timing windows, notifications, specific mitigation measures.

The Reference Concept for Tunnel decommissioning currently assumes that the four Tunnel elements will be removed over the course of one construction season (i.e., between freshets) and during a window where effects on fish and marine mammals can be minimized (**Section 4.4 Fish and Fish Habitat** and **Section 4.6 Marine Mammals**). The process for removing the Tunnel segments is outlined in **Table 1.1-5**. Tunnel segments will be removed sequentially starting at either the north or south side. During this time, vessel movement will be maintained although may require the establishment of a temporary, one-directional navigation channel with tug-assisted access to allow construction and marine traffic to proceed safely.

Discussion with the Marine Users Group has indicated that a closure of the deep draft navigation channel for four to six hours would not adversely impact shipping scheduling. Communication with the harbour master will minimize scheduling conflicts and ensure that the commercial navigation schedule is maintained as much as possible throughout the construction phase.

Engagement with Marine Users: As discussed in Section 5.2.2.1, the Ministry has continued to engage with commercial and recreational users of the Fraser River South Arm and Deas Slough since March 2014. A marine users group has been established and includes marine stakeholders (e.g., VFPA, Transport Canada, Canadian Coast Guard); marine users potentially affected by Project construction; commercial, recreational, and Aboriginal marine users; Ministry representatives; construction contractors; and representatives of marine communications and traffic services. Ongoing consultation with the marine users group, will support the development and implementation of the MAMP and will help further refine the mitigation measures to be implemented to facilitate construction of the Project while maintaining commercial navigation, navigation for CRA fisheries, and recreational navigation within the Project area.

The marine users group will meet regularly prior to and during Project construction to identify potential access conflicts. The group will also participate in the establishment of processes and procedures to avoid potential conflicts such as construction phasing and scheduling, communications protocol, and frequency of notices. Consultation with the Marine Users Group will continue throughout Project construction.

Implementation of the above measures will minimize potential effects on commercial navigation, navigation for CRA fisheries, and recreational navigation as a result of temporary interruptions of passage through, use of, or access to a section of the Fraser River South Arm and Deas Slough during Project construction.

Timing:

Tunnel decommissioning: Decommissioning of the Tunnel is proposed to occur between July 16 and February 28, the least-risk timing window for the protection of juvenile salmon and eulachon (FREMP 2006), and may occur over two seasons. Adherence to this timing window will allow the navigation channel to be fully open from March 1 to July 15 each year.

Deas Slough Bridge removal: To limit restrictions to navigation within Deas Slough as much as possible, removal of the Deas Slough Bridge is proposed to occur primarily at night. In order for works to proceed safely, this may require temporary full closures of Deas Slough. It is assumed that the majority of Deas Slough use would be daytime and this will have a minimal effect on marine use within Deas Slough.

Aboriginal Group Consultation: Maintaining fishing opportunities for Aboriginal Groups to exercise cultural, economic, and social fishing rights during construction is a key objective of the Marine Access Management Plan that will be developed to support ongoing use of the Fraser River South Arm by all interests throughout the Project construction phase. As discussed in **Section 5.2.2.1** and **Section 10.1.3 Aboriginal Interests Assessment**, the Ministry is continuing to work with Schedule B Aboriginal Groups to facilitate participation in the development and implementation of mitigation measures to avoid, reduce, or otherwise manage potential Project-related effects on Aboriginal Interests, including Aboriginal fisheries activities.

5.2.5 Residual Effects and their Significance

Residual effects on marine use were characterized by qualitatively assessing the direction, magnitude, geographic extent, duration, frequency, and reversibility of the effects. Definitions for the ratings applied to the residual effect are presented in **Table 5.2-5**. These ratings were developed with specific reference to marine use in the LAA and RAA, and reflect the importance

of commercial navigation, CRA fisheries navigation and recreational navigation within the Fraser River South Arm and Deas Slough. Context for the characterization of residual effects, i.e. sensitivity/resilience of marine use in the Fraser River South Arm and Deas Slough to potential Project-related effects, based on existing conditions, has been taken into account in characterizing the residual effects.

Table 5.2-5 Criteria Used to Characterize Residual Effects on Commercial Navigation, Navigation for CRA Fisheries, and Recreational Navigation

| Criteria | Description | Definition of Rating | |
|-----------|---|----------------------|---|
| Direction | Overall nature of the residual effect | Adverse | Measureable negative effect on marine use |
| | | Positive | Measureable positive effect on marine use |
| | | Neutral | No or non-detectable effect on marine use |
| Magnitude | Amount of the effect relative to natural or baseline conditions | Negligible | <ul style="list-style-type: none"> Fraser River South Arm: No restriction Deas Slough: No restriction |
| | | Low | <ul style="list-style-type: none"> Fraser River South Arm: maintenance of two-way navigation channel with tug assisted access Deas Slough: periodic nightly closure |
| | | Moderate | <ul style="list-style-type: none"> Fraser River South Arm: maintenance of one-way navigation channel with tug assisted access Deas Slough: multi-day closure |
| | | High | <ul style="list-style-type: none"> Fraser River South Arm: full closure of navigation channel Deas Slough: multi-week closure |
| Extent | Geographic extent / distribution of the residual effect | Site | Project area |
| | | Local | <ul style="list-style-type: none"> Fraser River South Arm: 2.5 km downstream and 5 km upstream of the Tunnel Deas Slough: 500 m on either side of Deas Slough |
| | | Regional | Fraser River South Arm from approximately three kilometers southwest of the Alex Fraser Bridge to the river mouth |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Duration | Length of time over which the residual effect is expected to persist | Negligible | Effect is expected to last less than 1 month |
| | | Short-term | Effect is expected to last less than 6 months |
| | | Moderate | Effect is expected to last between 6 to 18 months |
| | | Severe | Effect is permanent |
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor impacts marine use) | Isolated | Single occurrence or unexpected event |
| | | Rare | Up to twice per week |
| | | Occasional | Two to four occurrences per week |
| | | Continuous | Daily occurrence |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or following a period of time after the disturbance has ceased) | Reversible | Existing conditions will be restored after effect has ceased |
| | | Irreversible | Existing conditions will not be restored after effect ceases |
| | | Change | Effect may fluctuate between positive and adverse for the duration |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 25%. |
| | | Moderate | Likelihood of residual effect is between 25% and 75%. |
| | | High | Likelihood of residual effect is greater than 75%. |

5.2.5.1 Construction

As described in **Section 5.2.3**, the Project has the potential to temporarily affect marine access, and the volume and frequency of marine traffic, during construction activities such as bridge construction, removal of Deas Slough Bridge, and Tunnel decommissioning. With the implementation of mitigation measures discussed in **Section 5.2.4**, it is expected that these effects can substantially be mitigated; however, short-term effects during construction cannot be avoided, and Project construction is anticipated to have the following temporary residual effect:

- Changes in commercial navigation, navigation for CRA fisheries, and recreational navigation in Fraser River South Arm and Deas Slough during marine-based construction activities

A detailed characterization of the above construction-related residual effect is provided below, and a summary of the criteria ratings presented in **Table 5.2-6**.

Context: The Fraser River South Arm supports a variety of marine uses, including international and domestic shipping; commercial, recreational and Aboriginal (CRA) fishing; and recreational boating and moorage. Given the importance of these activities to provincial and federal economies, Aboriginal Groups, many businesses, and the general public, sensitivity of marine use in the Fraser River South Arm to changes or access limitations to the navigation channel can be considered to be relatively high. Mitigation measures identified in **Section 5.2.4**, which include maintaining continued access to the navigation channel during construction, have been proposed, taking this sensitivity into account. Sensitivity of marine use to post-mitigation construction-related effects is, therefore, considered to be low.

Table 5.2-6 Summary of Criteria Ratings for Changes to Commercial Navigation, Navigation for CRA fisheries, and Recreational Navigation

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|-----------|-----------------|--|
| Direction | Adverse | Effect on marine use anticipated due to changes in access to waterways or marine traffic frequency and volume. |
| Magnitude | Low to Moderate | <ul style="list-style-type: none"> • Fraser River South Arm: Maintenance of one or two-way navigation channel with tug assisted access • Deas Slough: periodic nightly closure |
| Extent | Local | <ul style="list-style-type: none"> • Fraser River South Arm: 2.5 km downstream and 5 km upstream of the Tunnel • Deas Slough: 500 m on either side of Deas Slough |

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Duration | Short term | Effect will be short-term, temporary, and limited to Project construction activities requiring marine-based vessels or equipment. |
| Frequency | Occasional | Effect is anticipated to occur two to four times per week |
| Reversibility | Reversible | Effect will be reversed following completion of Project construction. |
| Likelihood | High | The likelihood of temporary changes in marine use during Project construction activities requiring marine-based vessels and equipment is anticipated to be greater than 75% |

During construction of the new bridge and decommissioning of the Tunnel, low to moderate adverse effects could be expected within the navigation channel of the Fraser River South Arm. The navigation channel will remain open at all times. As described in **Section 5.2.3 Potential Effects**, partial restriction of the navigation channel may be required during construction of the bridge portion that spans over the central portion of the Fraser River South Arm, and during decommissioning of the Tunnel. This may require a one-way navigation channel. Vessels traveling through the channel during this time will be assisted by tug boats. It is anticipated that a two-way navigation channel will be maintained during construction of the northern and southern most portions of the bridge spans. During this time, vessels would be able to travel in both directions, assisted by tug boats as required. The extent of the effect of Project construction on marine use is considered to be local. Marine-based construction activities will occur primarily within the Project area, and with mitigation, associated effects on marine use are not expected to extend beyond the LAA. Construction of the new bridge and decommissioning of the Tunnel are expected to be moderate in duration. Decommissioning of the Tunnel will be of shorter-term duration, occurring between July and February. Construction of the new bridge is anticipated to involve installation of a new section of the bridge deck one or two times per week, working from the abutments and approaches outward toward the center of the Fraser River South Arm. Decommissioning of the Tunnel is anticipated to involve removal of the four in-river segments of the Tunnel, requiring restrictions to the navigation channel on an intermittent (two to four times per week) basis. Given this, the frequency of potential construction-related effects on marine use is considered to be occasional. Following completion of construction, marine use within and adjacent to the Project area will be restored to baseline conditions, and Project-related effects to marine use are fully reversible.

As described in **Section 5.2.3 Potential Effects**, construction of the south approach to the new bridge and removal of the Deas Slough Bridge has the potential to affect marine activity within/along Deas Slough temporarily. Although full closure of Deas Slough will be required during some activities (such as decommissioning the Deas Slough Bridge and construction the new bridge approach and foundations at this location), such work will be of short duration and will be scheduled for nights whenever possible. Nighttime closures will minimize the effect on marine users within Deas Slough as it is understood that most activity within Deas Slough is daytime recreational use. The extent of the effect is expected to be local. Construction activities within Deas Slough will be limited to Project area, and with the mitigation applied, the effect is not expected to extent past 500 m on either side of Deas Slough. The duration is expected to be short-term and it is expected that nighttime closures would occur occasionally during construction of the new bridge component spanning Deas Slough, and decommissioning of the Deas Slough Bridge. Construction-related effects on marine use within Deas Slough are fully reversible. Removal of the Deas Slough Bridge will result in an increase in air draft from 2.5 metres to 20 metres, which will result in an improvement in navigation conditions within Deas Slough following completion of Project construction.

Potential construction-related residual effects of the Project on marine use are considered to be adverse in direction, low to moderate in magnitude, local in extent, short-term in duration, occasional in frequency, and reversible.

5.2.5.2 Operation

The new bridge has been designed in a manner that avoids the potential for interaction between the Project and marine use in the Fraser River South Arm, and no post-construction Project-related effects are anticipated.

Removal of the Deas Slough Bridge will eliminate structures in the slough that currently infringe on the local navigation channel. With the replacement of the Deas Slough Bridge, current available air draft of approximately 2.5 metres will be increased to approximately 20 metres, and the existing three span crossing will be replaced by a single, longer span structure. These Project-related changes are expected to have a positive effect on marine use in Deas Slough during the operational phase.

5.2.5.3 Proponent's Determination of Significance

Definition of significance: A residual effect on marine use, specifically, access to the Fraser River South Arm and Deas Slough, would be considered significant where Project works require a closure of the entire navigation channel for more than 12 hours, or the deep draft channel for more than 24 hours. This significance threshold relating to marine use is based on the Ministry's understanding of existing marine uses and is informed by consultation with marine users and Aboriginal Groups to-date. Based on such consultation, it is assumed that constraints on access more substantive than those noted above would result in potential economic impacts on commercial marine operators and/or prevent access to CRA fisheries opportunities.

Significance determination: There will be no full closures of the navigation channel during the construction phase and no change in access during the operations phase. The most notable constraints on access during construction will be limited to:

- Occasional closures of the deep draft channel (8-10 hours, up to twice per week) during Tunnel decommissioning.
- The need for occasional (2-4 times per week) tug-assisted transit through the navigation protection zone during Tunnel removal.

Since Project works do not require a closure of the entire navigation channel for more than 12 hours or the deep draft channel for more than 24 hours, Project-related residual effects on marine use are not considered significant.

5.2.5.4 Confidence and Risk

Prediction of confidence was based on the assumption that the anticipated construction activities are reasonably accurate and that the recommended mitigation measures will be implemented. With respect to mitigation measures, the confidence associated with the effectiveness of the mitigation measures is that they have been successfully implemented by the Ministry on other projects in B.C.

Low, moderate, or high confidence reflects the level of uncertainty associated with determinations of likelihood and significance. The level of confidence in the effects prediction for marine use, associated with both the significance determination and the likelihood, is high.

Given the confidence level in the effects prediction and the anticipated moderate residual effects, risk is determined to be low and risk analysis is not required (see methods **Section 3.9 Confidence and Risk**).

5.2.6 Cumulative Effects and their Significance

During construction, no temporal or spatial effects of other Projects are anticipated to overlap with the temporary effects associated with the Project. During operation, no residual effects are anticipated. An assessment of cumulative effects is not required.

5.2.7 Follow-up Strategy

Project-related effects are anticipated to be limited to those associated with marine-based construction activities. During construction, monitoring will include assessment of the implementation and effectiveness of the mitigation applied, including compliance with the Notice of Works and the MAMP. A post-construction follow-up strategy is not proposed.

5.2.8 References

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APPENDIX A

Overview of Potential Project Interactions with Marine Use

Table 1 Overview of Potential Project Interactions with Marine Use

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Marine Use | | | |
| Pre-construction / Site Preparation | | | |
| Pre-construction / Site preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Clearing and grubbing within the existing Highway 99 ROW • Installing temporary drainage structures and diversions • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction • Acquiring property for the Project • Restoration of Green Slough to its original location | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Proposed activities will be land-based. If marine site investigations are required, geotechnical drilling will not require interruptions of the river mainstem.</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Installing temporary bridges and barging facilities | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • A temporary infringement or obstruction of marine use during instream works. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Proposed activities will be land-based. Ground improvements in Green Slough will not require closure of the local navigation channel.</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Installing in-stream piers in Deas Slough and Green Slough, including pile installation | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • A temporary infringement or obstruction of marine use during instream works |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: No interaction anticipated.</p> <p>Rational: Proposed activities will be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|---|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Backfilling of onshore portions of Tunnel approaches • Removing of four Tunnel segments and associated scour protection • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • A temporary infringement or obstruction of marine use during instream works. |
| Decommissioning of Deas Slough Bridge | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • A temporary infringement or obstruction of marine use during instream works. |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|---|---|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Proposed activities will be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> N/A | N/A |
| New bridge | No interaction | <ul style="list-style-type: none"> Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Proposed activities will be land-based.</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> Operating the new bridge | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> Changes to the navigability of the Fraser River South Arm. |

"N/A" indicates that no Project works and/or activities are applicable to the category

5.3 Land Use Assessment Highlights:

- The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way.
- Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill.
- The Project is consistent with local and regional land use plans, and aligns with and serves adjacent land uses that have evolved along the Highway 99 corridor. It will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans.
- The Project is not anticipated to affect the planned distribution of regional population and employment growth predicted in Metro Vancouver’s regional growth strategy, overall regional population growth and distribution trends or current trends in industrial land use and development.
- Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to:
 - Improved connectivity across Deas Island Regional Park resulting from removal of the Tunnel portals.
 - Improvements in local air quality, Deas Island shoreline restoration and revegetation of areas that currently support highway infrastructure.
 - Shading adjacent to the bridge, overhead noise, and changes in local viewscales.
- The Project will not result in changes to existing land use beyond the small amounts of land that are required outside of the existing right-of-way.
- Potential temporary effects on existing land use during construction will be addressed by developing and implementing a Construction Traffic Management Plan.
- No significant Project-related residual effects or cumulative effects on land use are expected.

5.3 Land Use

This section presents the results of the assessment of potential effects of the Project on land use and includes a description of existing conditions, potential Project-related effects and proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects.

5.3.1 Context and Boundaries

This section describes the context for assessing Project-related effects on land use, and defines the spatial, temporal, administrative and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

5.3.1.1 Assessment Context

The Project involves upgrades to an existing transportation corridor. The majority of the Project works will occur within the existing Highway 99 right-of-way (ROW), and is consistent with that existing land use; however, a limited area of private land, outside the Highway 99 ROW, may be required. Project construction may also lead to temporary changes in land and resource use within and adjacent to the Project alignment.

Regional growth strategies support the development of policies for managing anticipated population growth and its distribution within the region, within designated land uses, in coordination with local government planning. These land use planning and development policies are supported by, and to an extent implemented by, regional and provincial transportation policies and initiatives. Therefore, while the Project has been proposed in response to local, regional, and provincial transportation planning objectives and congestion concerns, it may also have the potential to influence regional growth rates and growth distribution.

5.3.1.2 Methodology

The assessment of land use follows the general methodology that is applied to all VCs, as described in **Section 3.0 Assessment Methodology**. Building on this approach, the assessment of land use focuses on two subcomponents: land use and regional growth.

The Ministry's pre-application consultation with local and regional governments between 2012 and 2015 identified concerns related to potential Project-related effects on local/site-specific land use as well as broader regional growth considerations. In response to these concerns, the Ministry identified two subcomponents to support the assessment of the land use VC – **land use** and **regional growth**. Following is a description of these two sub-components and the supporting rationale for their selection.

The **land use subcomponent** considers potential Project-related effects pertaining to local land use within the LAA. These include site specific potential effects as reflected in the indicators presented in **Table 5.3-1**. The indicators are representative of potential site-specific land use effects such as:

- The ability of land use designations to support the proposed Project
- The proposed Project's ability to complement or adversely interact with adjacent land uses

- The extent to which existing land uses could potentially be displaced as a result of the Project
- The extent to which adjacent existing land uses could potentially be disturbed during construction and operations

The **regional growth subcomponent** focuses on considerations related to the extent to which the Project complements measures proposed, by local and regional governments to manage predicted population growth.

The regional growth subcomponent was developed in response to a concern, raised by local and regional governments, that increased capacity on the Highway 99 corridor could result in induced land use effects such as increased pressure for developable land and changes in the way regional growth is accommodated. To address these concerns, this sub-component considers how improvements in access associated with the Project may result in potential changes in land use, within the context of regional growth management considerations.

The regional growth subcomponent is reflected in the indicators presented in **Table 5.3-1**. The indicators are representative of potential regional land use considerations related to improving access along the Highway 99 corridor south of the Fraser including:

- Potential changes to how predicted growth in population and employment will be accommodated within municipalities adjacent to the Highway 99 corridor
- Potential changes in land use adjacent to the Highway 99 corridor including in areas protected by the Urban Containment Boundary and Agricultural Land Reserve.

The rationale for the indicators selected is provided in **Table 5.3-1**. The qualitative thresholds for these indicators are described in the effects characteristics definitions presented in **Table 5.3-2**.

Table 5.3-1 Indicators for Land Use

| Indicator | Rationale for Selection |
|--|---|
| Land Use Subcomponent | |
| Consistency with land use plans and designations | The Project requires small amounts of land, not currently zoned for transportation. The indicator supports the assessment of consistency between existing land uses and those potentially required for the Project. |
| Compatibility with adjacent or proximal land uses | Changes to existing transportation infrastructure have the potential to change the compatibility between land use within the existing right-of-way and adjacent land uses. The indicator supports consideration of the extent to which the Project is aligned with or complementary to adjacent land uses. |
| Spatial area (ha) of change in existing land uses | Describing the spatial area of changes in land use, resulting from the Project, provides an indicator of the extent to which the Project may result in changes to land uses beyond the existing ROW. |
| Disturbance to other land uses from Project-related activities, including disturbance to: <ul style="list-style-type: none"> • Residential, commercial and industrial uses • Recreational use of Deas Island Regional Park | The Project may result in a disturbance to adjacent land uses. The indicator focuses on identifying where Project construction and operation may result in disturbance effects, including noise, visual and access, on specific land uses, even if these land uses are compatible with land use in the Project right-of-way. |
| Regional Growth Subcomponent | |
| Change in regional population growth and distribution | Considering potential changes in the distribution of planned population and employment growth relative to established targets provided in local and regional land use plans, provides a measure for assessing the extent to which the Project complements these plans' objectives for managing predicted growth adjacent to Highway 99 and in the broader region. |
| Change in non-residential land (industrial and commercial) development and distribution | The indicator provides a focus for considering the extent to which the proposed Project may further increase demand for industrial and commercial land in the region. |

5.3.1.3 Assessment Boundaries

Spatial, temporal, administrative, and technical boundaries identified for the assessment of Project-related effects on land use, and the rationale for selecting them are discussed below.

Spatial Boundaries

The local assessment areas (LAA) and regional assessment areas (RAA) for land use are described in **Table 5.3-2**. The spatial boundaries for the both the land use and regional growth subcomponents are shown in **Figure 5.3-1** and **Figure 5.3-2**.

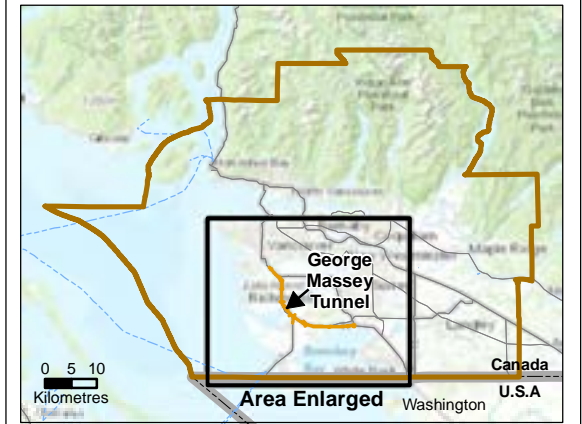
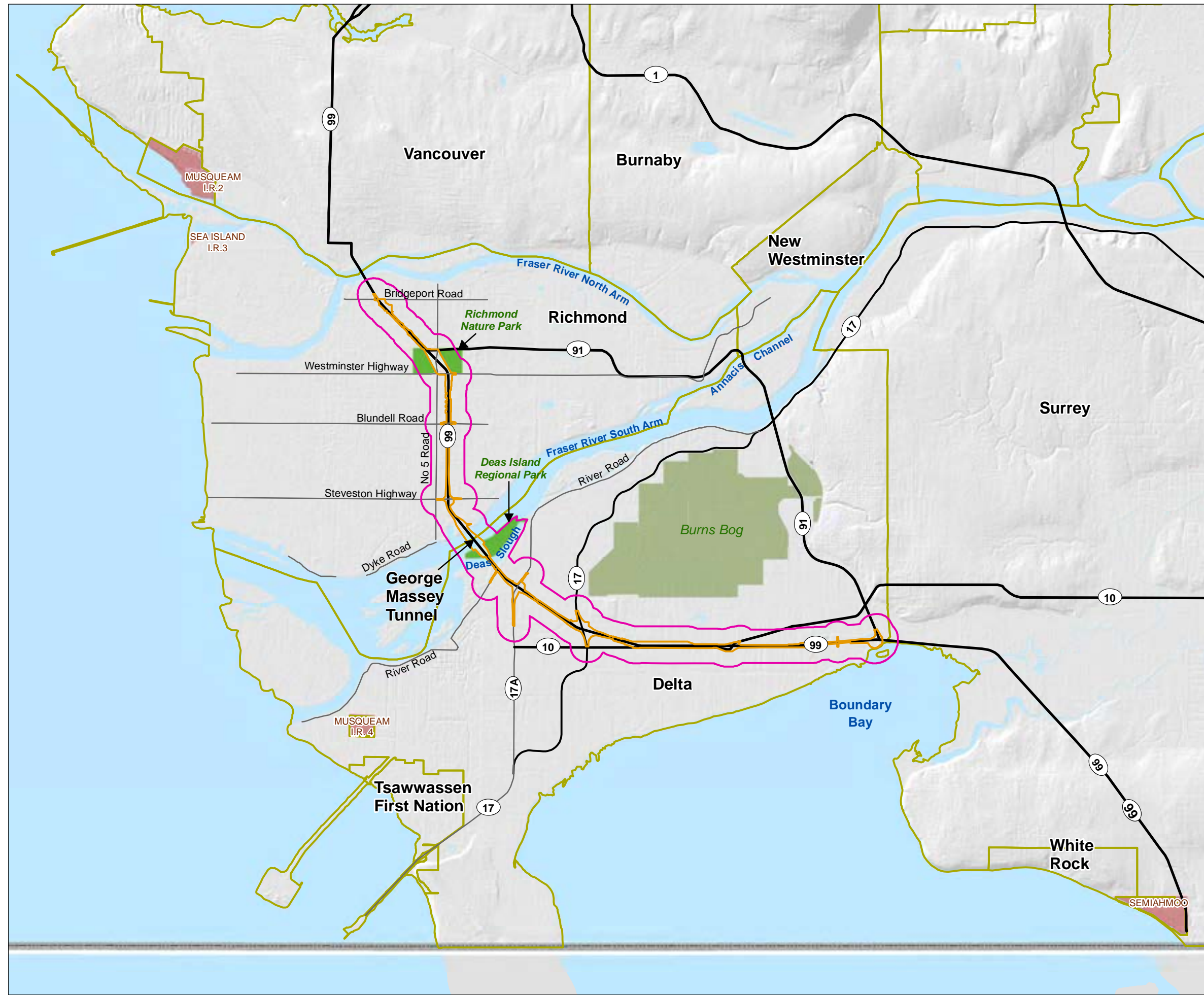
Table 5.3-2 Spatial Boundary for Land Use Assessment

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Land Use Subcomponent | |
| Local assessment area (LAA) | Project alignment plus 500 m on either side of the Project alignment, expanded in the vicinity of the new bridge to include Deas Island and Deas Slough. |
| Regional assessment area (RAA) | The boundary of Metro Vancouver. |
| Regional Growth Subcomponent | |
| Local assessment area (LAA) | The boundaries of City of Richmond (Richmond), Corporation of Delta (Delta), and City of Surrey (Surrey). |
| Regional assessment area (RAA) | The boundary of Metro Vancouver. |

LAAs were established to encompass the area within which the Project could potentially have an effect on either the subcomponents, interact with other values, or both. In determining LAA boundaries, the nature and characteristics of the existing land use plans and regional growth characteristics and the maximum extent of potential effects were considered.

An RAA was established to provide a regional context for the assessment of Project-related effects. The RAA was also used to determine which other potential projects would be relevant in considering project interactions for the cumulative effects assessment. For both subcomponents, the RAA is defined as the geographic area that comprises the Greater Vancouver Regional District, as managed by Metro Vancouver, which is an entity designated by provincial legislation (*Local Government Act*, R.S.B.C. 1996, c. 323) as a regional district. It encompasses the communities included in **Figure 5.3-1** and **Figure 5.3-2**.

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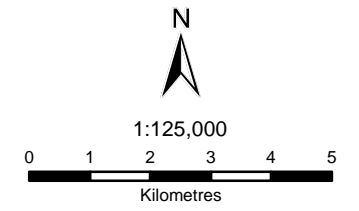
Legend

- Land Use Subcomponent Local Assessment Area
- Land Use Subcomponent Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

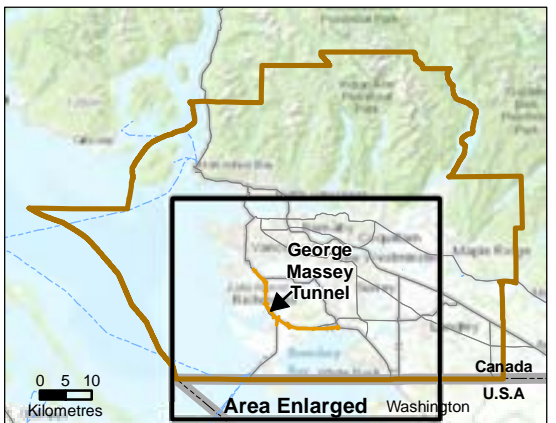
¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



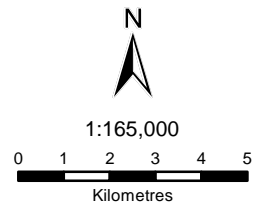
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|--|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| LAND USE SUBCOMPONENT LOCAL AND REGIONAL ASSESSMENT AREAS | |
| Figure 5.3-1 | 13/05/2016 |
| | |



- Legend**
- Regional Growth Subcomponent Local Assessment Area
 - Regional Growth Subcomponent Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

REGIONAL GROWTH SUBCOMPONENT LOCAL
AND REGIONAL ASSESSMENT AREAS

| | |
|--------------|------------|
| Figure 5.3-2 | 13/05/2016 |
|--------------|------------|

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on land use were established based on the potential for each phase of the Project to interact with and have an effect on land use. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, the construction and operational phases of the Project include components and activities that could affect land use within the Project alignment; therefore, the following temporal boundaries were defined for land use assessment:

- Existing conditions
- Project construction:
 - Site preparation and pre-construction activities
 - Highway upgrades
 - Construction of the new bridge
 - Decommissioning and removal of existing highway infrastructure replaced by the Project, including underpasses and the Deas Slough Bridge
 - Decommissioning of the Tunnel and removal of four in-river tunnel segments
- Project operation (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.1.4 Project Phases and Schedule**. Specific temporal considerations for the land use assessment are discussed in the context of Project interactions and potential effects in **Section 5.3.3**.

Administrative Boundaries

The LAA for the regional growth subcomponent and the RAAs for subcomponents are defined by the administrative boundaries for local and regional governments (**Figure 5.3-1** and **Figure 5.3-2**). These boundaries support the assessment of compatibility with local government land use designations, and provide context for these and other non-local government designations pertaining to the Highway 99 corridor and for regional growth predictions.

Technical Boundaries

No constraints, such as accessibility or gaps in data that could limit the ability to predict the effects of the Project on land use, have been identified; therefore, no technical boundaries were defined.

5.3.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of land use within the assessment areas. An overview of the regulatory context as relevant to land use is also provided. Information on existing conditions, presented in the following sections, supports the sub-components, land use and regional growth.

Section 10.0 Aboriginal Consultation assesses potential effects on Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, including those that relate to potential changes in land use. While a detailed assessment of potential effects on the exercise of Aboriginal Interests, including those with a land use aspect, are provided in **Section 10.0**, an overview of such information is provided below to acknowledge Aboriginal land use considerations in the context of the assessment.

Based on information presented in **Section 10.0 Aboriginal Consultation**, the Project area has and continues to support land uses related to the continued exercise of Aboriginal Interests. Traditional use and traditional knowledge information that was gathered to support the assessment of Aboriginal Interests, described in **Section 10.0 Aboriginal Consultation**, includes activities such as fishing, hunting/trapping, and gathering, as well as related interests, such as language and culture (e.g., as represented by named places), cultural sites (e.g., habitation sites, sacred or spiritual areas, transportation routes), and cultural landscapes.

5.3.2.1 Baseline Data Collection

As part of early Project planning in 2012 and 2013, the Ministry reviewed Metro Vancouver's then newly updated regional growth strategy and municipal land use plans. To support ongoing Project planning, and subsequently, this assessment, more detailed technical studies on land use commenced in 2014. Building on available information, these studies were designed to address known data gaps. Specific desktop studies conducted for the land use assessment are as follows:

- Review of land ownership and Crown land tenures in the provincial and municipal databases.
- Review of regional and community planning documents and bylaws including but not limited to:
 - Metro Vancouver's Regional Growth Strategy (RGS) (2011 and 2015)

- Official Community Plans of Richmond (2016), Delta (2014), and Surrey (2013)
- TransLink's Regional Transportation Strategy Strategic Framework (2013)
- TransLink's 2014 Base Plan and Outlook (2014)
- Port Metro Vancouver Land Use Plan (2014)
- Review of information gathered through public and stakeholder consultation processes (**Section 10.0 Aboriginal Consultation** and **Section 11.0 Public Consultation**).
- Review of satellite images and aerial photographs to determine existing land uses.

These desktop studies provided appropriate information at a sufficient level of detail needed to carry out the assessment.

Preliminary consultation identified concerns from Aboriginal Groups and Metro Vancouver regarding recreational use of Deas Island Regional Park and the Millennium Trail, and the potential long term effects on land use related to potential changes in regional growth as a result of the Project (note that agriculture is considered in **Section 5.4 Agricultural Use**). Accordingly, the LAA for the land use subcomponent has been expanded to include the entirety of Deas Island Regional Park, and information on potential effects to recreation in Deas Island Regional Park and vicinity have been considered in further detail. A regional growth subcomponent has also been introduced to this section, to assess potential effects of improved access in relation to regional growth and distribution of growth within the region

5.3.2.2 Regulatory Context

Land use along the Project alignment is regulated through federal and provincial legislation, or municipal bylaws, primarily through the following:

- *Canada Marine Act*, S.C. 1998, c. 10, which establishes federal navigation jurisdiction by Port of Vancouver in the Fraser River.
- *Navigation Protection Act*, (R.S.C., 1985, c.N-22) establishes authorization for works in navigable waters, including the Fraser River.
- *Agricultural Land Commission Act*, S.B.C. 2002, c. 36, which establishes the provincial Agricultural Land Reserve (ALR) and permitted uses within them.
- *Land Act*, R.S.B.C. 1996, c. 245, which establishes tenure policies for provincial Crown land.

- *Wildlife Act*, R.S.B.C. 1996, c. 488, which establishes Wildlife Management Areas (WMAs) for conservation purposes.
- *Community Charter*, S.B.C. 2003, c. 26, which establishes the legal framework for core municipal powers.
- *Local Government Act*, R.S.B.C. 1996, c. 323, which establishes the legal framework for regional districts, the authority for regional growth strategies and regional parks, and local government planning and zoning bylaws.

5.3.2.3 Land Ownership

This section describes land ownership, applicable land use plans and regulations, and current uses and tenures, as well as projects and activities that are occurring within and near the Project alignment.

The Project is sited largely on provincial Crown land within Richmond and Delta, and straddling the Fraser River South Arm, and the alignment follows the existing Highway 99 alignment (**Figure 5.3-3**).

Richmond, Delta, and Surrey

Land within the communities most likely to experience direct Project effects (i.e., Richmond, Delta, and Surrey) is owned by federal, provincial, or local governments; First Nations; or is privately held. The federal government owns the submerged land in the Fraser River North and Middle Arms, the portion of submerged land under the Fraser River west of Tilbury Island and several parcels of foreshore and upland areas in Richmond and Delta. Submerged land in the Fraser River South Arm east of Tilbury Island is owned by the Province (including the submerged land in the Project alignment), which also manages tenures for uses within this area. Vancouver Fraser Port Authority (VFPA, doing business as Port of Vancouver), has jurisdiction over navigation in the Fraser River and owns several upland properties (VFPA 2014).

Provincial land holdings in these cities include the BC Ferries fleet maintenance facility (Deas Pacific Marine) in south Richmond, portions of the South Arm Marshes Wildlife Management Area (WMA), and smaller parcels in upland areas of Delta. Ownership of the Burns Bog Ecological Conservancy Area is shared between the Province and a partnership between Metro Vancouver and Delta. The City of Vancouver owns the Vancouver Landfill, situated between Highway 99 and the southwest corner of Burns Bog. Delta owns the land

base for the Boundary Bay Airport, as well as several parks and recreational corridors. Richmond and Delta own the land base for their respective arterial and local roads, community centres, local parks and public works facilities. The remainder of land, which includes a Canadian National (CN) rail corridor in Richmond and a Burlington Northern Santa Fe rail corridor in Delta, is privately owned.

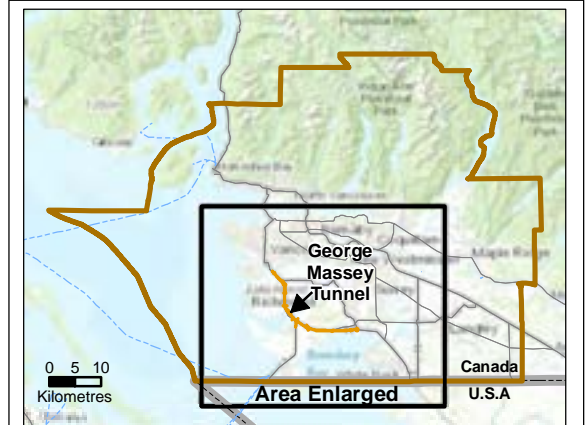
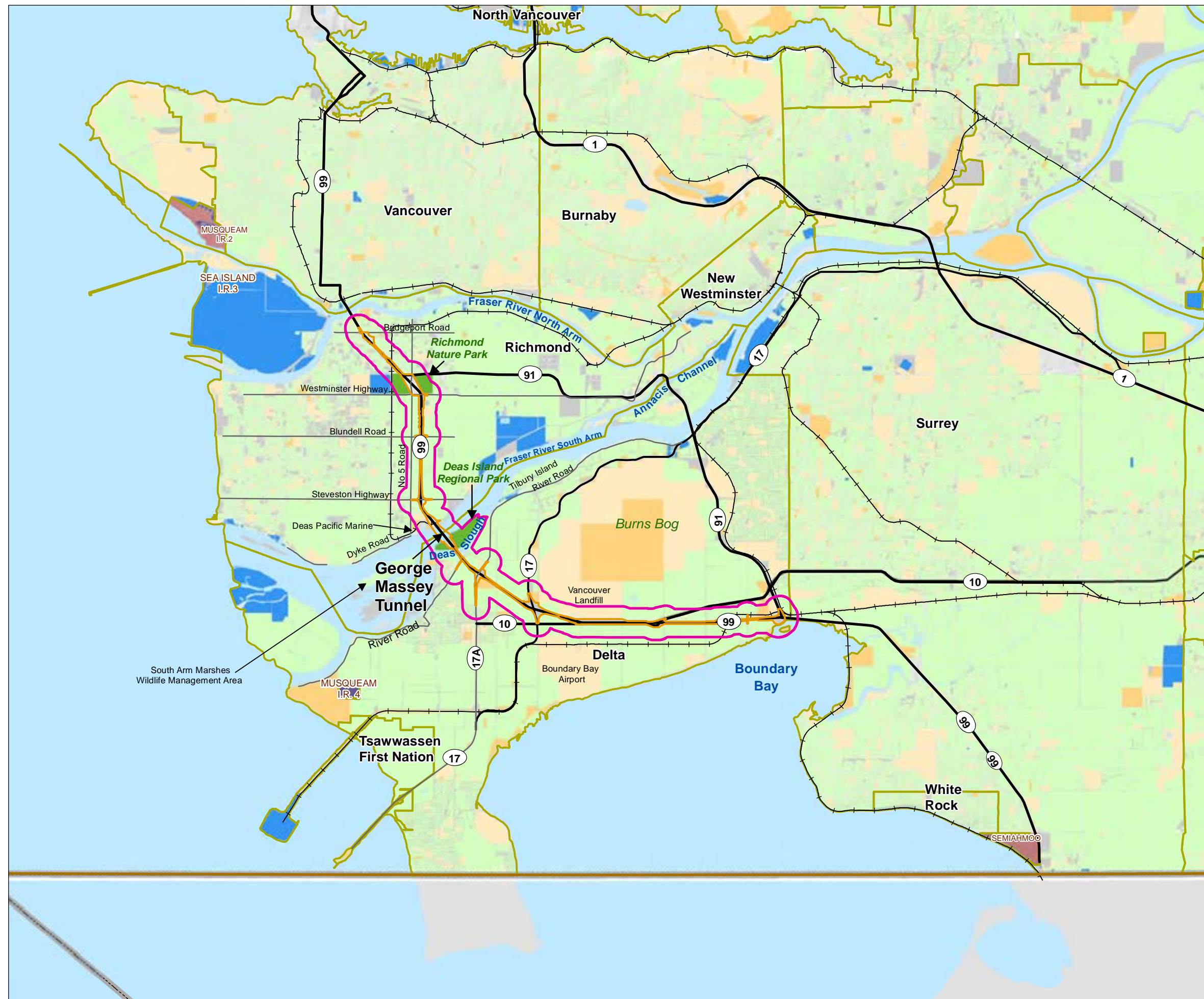
Tsawwassen First Nation Lands, as defined by the *Tsawwassen First Nation Final Agreement* (2009), are located within the RAA, approximately six kilometres southwest of the Project alignment, adjacent to Roberts Bank. Musqueam Indian Reserve No. 4 is located within the RAA, approximately five kilometres northwest of the Project alignment (**Figure 5.3-3**). Information on First Nation Treaty lands and Indian Reserves is provided in **Section 10 Aboriginal Consultation**.

Land Use Subcomponent Local Assessment Area

In the LAA, the majority of land adjacent to the Project is privately held. Outside of the Highway 99 ROW (**Figure 5.3-3**), the Province owns some upland parcels and submerged lands adjacent to the Project alignment. Metro Vancouver owns Deas Island Regional Park, which is situated on both sides of the south approach to the Tunnel. Richmond owns several parcels, in addition to the Richmond Nature Park. Delta owns several parcels adjacent to the ROW. The northeast corner of the federally owned (Department of National Defense), approximately 60 ha, parcel to the west of the Richmond Nature Park is within the LAA. The Vancouver Landfill, partially within the LAA, is owned by the City of Vancouver, which operates it under agreement with Delta and Metro Vancouver. Lands to the south of the Landfill within the LAA are municipally owned.

Project Alignment

The majority of the proposed Project alignment is provincial Crown land, including submerged land in the Fraser River. The support structures for the new bridge, on Deas Island, will be within the Highway 99 ROW (i.e., on Crown land) and not in Deas Island Regional Park. The Project will improve connectivity across the Park through removal of the Tunnel portals, although the ROW will continue to bisect the Park. In Richmond, just south of Rice Mill Road, the Highway 99 ROW crosses the CN rail line, which is private land. In Delta, the alignment also crosses privately held rail land.



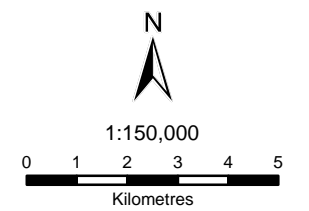
Legend

- Land Use Subcomponent Local Assessment Area
- Land Use Subcomponent Regional Assessment Area
- Crown Federal
- Municipal
- Provincial
- Private
- Unknown
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Waterbody
- Canada - U.S. Border
- Highway
- Railway Corridors
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| LAND OWNERSHIP IN THE LAND USE SUBCOMPONENT LOCAL ASSESSMENT AREA | |
| Figure 5.3-3 | 26/05/2016 |
| | |

5.3.2.4 Land Use Planning

This section describes the planning context for the Project, noting policies that pertain to the Project. Land use designations associated with relevant regional and local plans are described.

Overview

Regional land use planning is undertaken by Metro Vancouver, and regional transportation planning by TransLink, with coordination shared between the agencies. The regional priorities, goals, and policies of these two organizations are specified in strategic plans: *Metro Vancouver 2040 Shaping Our Future* (Metro Vancouver 2015) and *Regional Transportation Strategy Strategic Framework* (TransLink 2013). Within these frameworks, local governments prepare Official Community Plans (OCPs) that specify local goals and policies and include regional context statements to demonstrate how the municipality will comply with Metro Vancouver's RGS.

Regional and local land use planning processes recognize the authority of senior levels of government by incorporating federal and provincial land use designations, such as National Wildlife Areas, and zoning, such as the provincial Agricultural Land Reserve (ALR), into their plans. VFPA is a federal entity that has land holdings and authority to develop a land use plan for its holdings (Port Metro Vancouver 2014). Provincial transportation improvements are also planned separately in consideration of the regional context.

Federal and Provincial Lands

VFPA manages designated federal lands at Fraser Wharves, located in Richmond to the northeast of the new bridge, as a port terminal. The westernmost portion of this area, situated along the Fraser River South Arm, is partially within the Land Use Subcomponent LAA (VFPA 2014). The port terminal is designated for deep-sea and marine terminals, which handle a variety of commodities. VFPA maintains navigational jurisdiction in the Fraser River South Arm in the vicinity of the new bridge. However, the submerged lands are under provincial jurisdiction and not managed by VFPA.

Indian Reserves (I.R.) are designated as federal land under the *Indian Act, R.S.C., 1985, c. 1-5*. As shown on **Figure 5.3-3**, three Indian Reserves occur within the boundaries of Richmond, Delta, and Surrey: Sea Island I.R. 3, Musqueam I.R. 4, and Semiahmoo I.R. Information on First Nation Treaty lands and Indian Reserves is provided in **Section 10 Aboriginal Consultation**.

The ALR is a provincial designation in which agriculture is recognized as the priority use. Farming is encouraged and non-agricultural uses are controlled within the ALR (Agricultural Land Commission 2002). The ALR within Richmond, Delta, and Surrey is shown in **Figure 5.3-4**. Local and regional governments, as well as provincial agencies, are expected to plan in accordance with the provincial policy of preserving agricultural land. An application must be made to the Agricultural Land Commission for exclusion of land from the ALR and permission for non-farm uses. Further information on the ALR and agricultural use is presented in **Section 6.4 Agricultural Use**.

Treaty and First Nations Lands

As part of Tsawwassen First Nation's (TFN) *Final Agreement*, a TFN Land Use Plan (AECOM, 2009) was prepared to support TFN's mandate to manage the development of their treaty lands. A detailed land use planning process started in 2007, and included research, analysis and consultation. The resulting plan identified industrial, commercial, agricultural, residential and other land uses, and was approved by TFN government in 2009.

The existing or proposed land uses on TFN Lands include the TFN industrial (135 ha) area and the mixed use/commercial (71 ha) area. To support the Plan, the TFN *Land Use Planning and Development Act* was passed and a *Zoning Regulation* was enacted. The Industrial Lands and Commercial Lands are within a designated Development Permit area under the TFN *Development Permit Area Regulation*. TFN also adopted an Industrial Lands Master Plan (Parsons Brinckerhoff 2009), that evaluated a range of possible industrial activities for the Industrial Lands.

In addition to Tsawwassen First Nation, other Aboriginal Groups listed in Schedule B of the Section 11 Order have land use plans or objectives for reserve lands and lands outside reserves. Information on land use planning and objectives has been described in **Section 10.1.1 Background Information** and **Section 10.1.3 Aboriginal Interests Assessment**, where this information was provided by Schedule B Aboriginal Groups or otherwise available from public sources.

Federal, Provincial, Regional, and Municipal Parks and Protected Areas

Federally protected National Wildlife Areas and Migratory Bird Sanctuaries within Richmond, Delta and Surrey (**Figure 5.3-4**) are:

- Alaksen National Wildlife Area, established under the authority of the *Canada Wildlife Act, R.S.C. 1985, c. W-9*, managed for wildlife conservation, research, and interpretation (Environment Canada 2013). The federal government owns this land and no other uses, other than those previously stated, are permitted.
- George C. Reifel Migratory Bird Sanctuary, which overlaps the Alaksen National Wildlife Area, is managed under the authority of the *Migratory Birds Convention Act (MBCA), S.C. 1994, c.22*, for the protection and conservation of migratory birds (Environment Canada 2014). Public access is not restricted, although standard prohibitions under the *MBCA* apply. The Canadian Wildlife Service and the Province of British Columbia own this land.

Provincial WMAs are the primary designation tool for conservation lands under Section 4 of the *Wildlife Act*. WMAs are created for the purposes of managing wildlife habitat, although other compatible land uses may also be accommodated (Ministry of Forests, Lands and Natural Resource Operations). WMAs within or offshore of the cities of Richmond, Delta, and Surrey (**Figure 5.3-4**) are:

- Boundary Bay Wildlife Management Area
- Serpentine Wildlife Management Area
- South Arm Marshes Wildlife Management Area
- Roberts Bank Wildlife Management Area
- Sturgeon Bank Wildlife Management Area

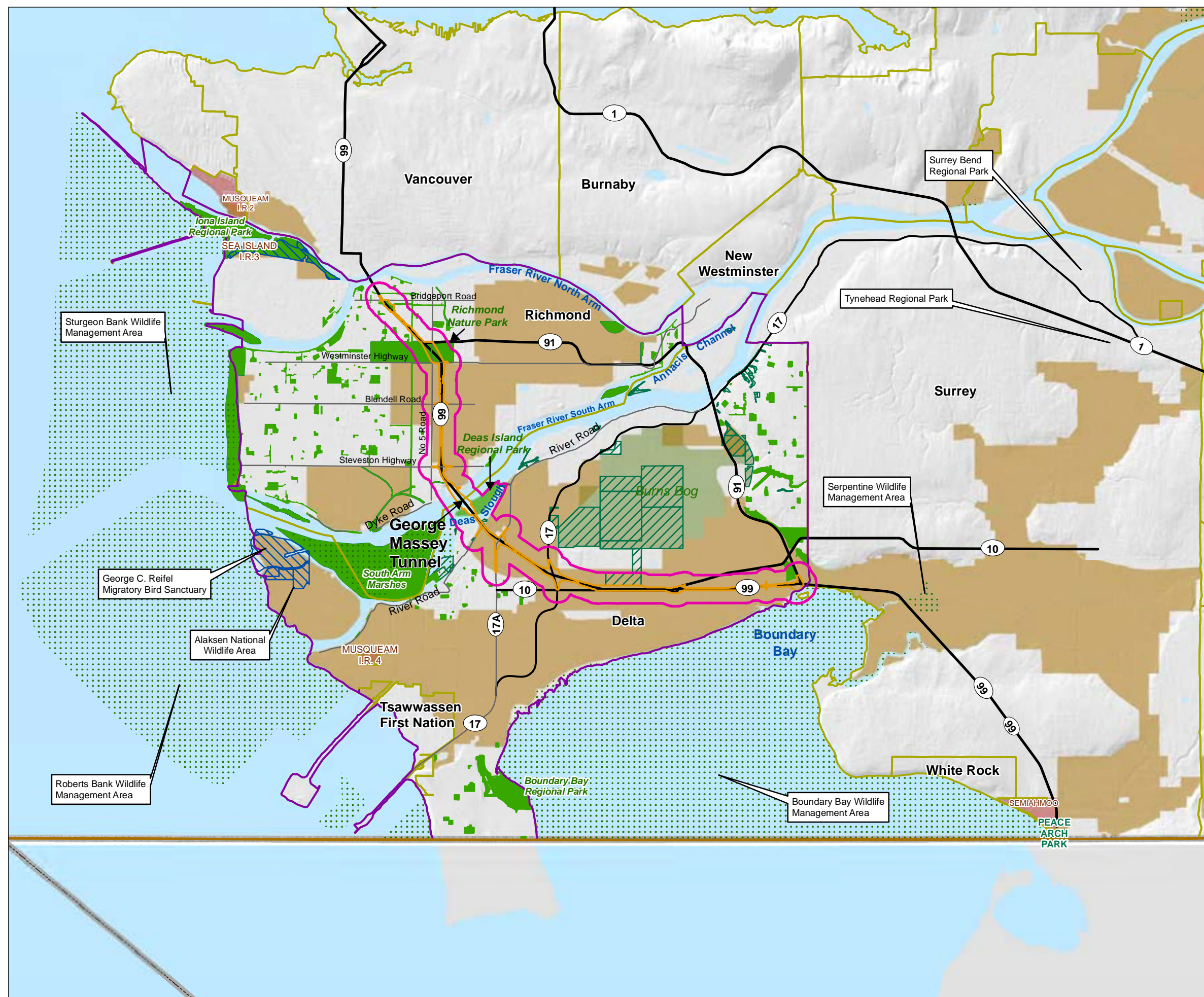
Metro Vancouver manages a system of regional parks, regional park reserves, ecological conservancy areas, and regional greenways. The system protects the region's important natural areas and ecosystems and allows Metro Vancouver's regional population to connect with, enjoy, be active within and learn about the region's environment (Metro Vancouver 2015). Metro Vancouver has designated the following parks or protected areas within Richmond, Delta, and Surrey (**Figure 5.3-4**):

- Deas Island Regional Park
- Iona Beach Regional Park

- Boundary Bay Regional Park
- Surrey Bend Regional Park
- Tynehead Regional Park
- Burns Bog Ecological Conservancy Area
- Delta-South Surrey Regional Greenway

Richmond, Delta, and Surrey have designated Environmentally Sensitive Areas and nature parks in their OCPs (**Section 5.3.2.3**).

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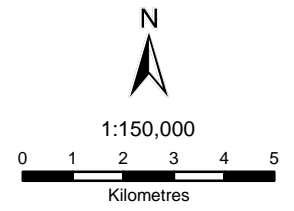
Legend

- Land Use Subcomponent Local Assessment Area
- Land Use Subcomponent Regional Assessment Area
- Agricultural Land Reserves
- Federal Protected Areas
- Environmentally Sensitive Area
- Local Government Parks and Nature Reserves
- Provincial Wildlife Management Areas (WMA)
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AGRICULTURAL LAND RESERVES, PARKS, AND PROTECTED AREAS | |
| Figure 5.3-4 | 26/05/2016 |
| | |

Plans and Policies Relevant to the Project

A summary of land use planning at the federal, provincial, regional and local contexts relevant to the Project is provided in **Table 5.3-3**.

Table 5.3-3 Land Use Planning Context at Federal, Provincial, Regional and Local Levels

| Jurisdiction | Responsible Agency or Municipality | Land Use Planning Context |
|--------------|---|--|
| Federal | Vancouver Fraser Port Authority | <p>VFPA's updated <i>Land Use Plan</i> (2014) articulates policies on land use and development and identifies the types of uses that are appropriate on land and water for the federal lands it manages. Policy directions relevant to the proposed Project include:</p> <ul style="list-style-type: none"> • Intensifying use and development of certain Port of Vancouver lands within the existing land base. • Considering the impacts that intensified use may have on adjacent communities, transportation networks, and the environment. • The management of new port development to create synergies and efficiencies between adjacent activities and uses. |
| Provincial | Ministry of Transportation and Infrastructure | <p>The Province has planned for improvements along Highway 99 and the George Massey Tunnel since 1991 (Ward Consulting Group 1991, Reid Crowther and Partners Ltd. and Ward Consulting Group 1995, B.C. MOTI 2006b). The <i>Gateway Program Definition Report</i> (B.C. MOTI 2006b) identified the Tunnel as a potential longer-term priority to meet transportation goals. The Project also is consistent with objectives of the <i>Pacific Gateway Transportation Strategy 2012 to 2020</i> (Government of B.C. 2011) to increase major road capacity and upgrade transportation trade corridors, and with the provincial <i>B.C. on the Move</i> transportation strategy (Government of B.C. 2015) which confirms the Project as a priority to improve highway safety, capacity, and reliability.</p> |

| Jurisdiction | Responsible Agency or Municipality | Land Use Planning Context |
|--------------|------------------------------------|---|
| Regional | Metro Vancouver | <p>Metro Vancouver’s RGS (Metro Vancouver 2015) sets out goals, strategies, and policies to guide the future growth of the region and provides the land use framework for transportation, economic, housing, utility, environmental, and climate change planning. It presents a vision for how the region will accommodate the forecast one million people and over 500,000 jobs expected in the next 25 years.</p> <p>In alignment with the RGS, municipalities prepare and adopt Regional Context Statements (RCS), which must be accepted by the Greater Vancouver Regional District (GVRD) Board. RCSs describe how local aspirations, as expressed in the OCP, support and align with Metro Vancouver’s 2040 goals and policies.</p> <p>The RGS acknowledges TransLink’s mandate for the regional transportation system and communicates to TransLink its objectives to implement strategic transportation plans that support focused growth in urban centres, frequent transit development areas, and other appropriate areas in the frequent transit network (Metro Vancouver 2015). The RGS also requests that TransLink and the province seek, as appropriate and in collaboration with municipalities, to minimize impacts on the environment and public health, from within-and-through vehicle movements for passengers, goods, and services, which affect the region and areas within the lower Fraser Valley airshed.</p> |
| Regional | TransLink | <p>The strategic framework of TransLink’s <i>Regional Transportation Strategy</i> (RTS)(TransLink 2013) identifies a goal to work with the Province to ensure the Project is integrated with the regional network in a way that is consistent with the RGS (Metro Vancouver 2015). The RTS guided the development of TransLink’s <i>2014 Base Plan and Outlook</i> (2013). While this plan does not specifically refer to the Tunnel or its replacement, the plan identifies a goal to strategically maintain and grow the existing transportation system, including the major road network, with partners.</p> <p>The Mayors’ Council on Regional Transportation presents a transportation vision for Metro Vancouver that identifies priorities for roads, rail transit, bus and SeaBus service, and cycling and walking (2015). A primary objective of the vision is to support the region’s land use vision in the RGS by delivering transportation initiatives. It recognizes the importance of a compact urban area that places affordable housing, industrial land, jobs, and major destinations in the right locations such that walking, cycling, and transit are convenient transportation choices and goods movement trips are efficient.</p> |

| Jurisdiction | Responsible Agency or Municipality | Land Use Planning Context |
|--------------|------------------------------------|--|
| Local | Richmond | <p>Richmond’s OCP (2012) notes the existing Highway 99 corridor and identifies a proposed interchange at Steveston Highway, which has been included as a component of the Project. Relevant area and sub-area plans are discussed below:</p> <ul style="list-style-type: none"> • Shellmont Area Plan: A future neighbourhood centre is planned to the west of the Steveston Highway interchange, which is detailed in the Ironwood sub-area plan within the Shellmont area plan. The Ironwood sub-area plan provides development permit guidelines to support a special character within an area around No. 5 Road and Steveston Highway (City of Richmond 2012). One objective of that sub-area plan is to provide measures to manage the high traffic volumes and proximity to Highway 99. • East Richmond Area Plan: The McLennan sub-area plan, within the East Richmond area plan, encompasses the area from Highway 99 west to No. 4 Road, and from Francis Road to Westminster Highway. It focuses on policies for urban/agriculture interfaces. • East Cambie Area Plan: includes an objective to improve transportation access to facilities and services while minimizing the social and environmental impacts of traffic as well as a policy to accommodate smooth traffic flows on arterial streets by improving arterial capacities. • West Cambie Area Plan: This plan contains an objective to provide a circulation system for West Cambie area that allows for vehicle connectivity within and beyond the area • City Centre Area Plan: Land use adjacent to the Project alignment within this sub-area plan is primarily designated as industrial and commercial mixed-use. This sub-area plan includes a policy to ensure industrial land is well served by highway, airport, port, and transit access. |

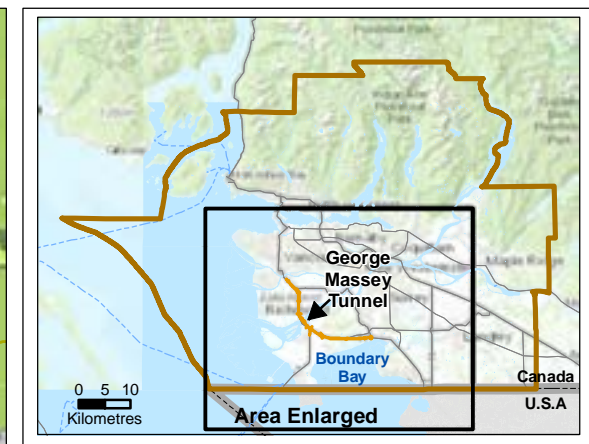
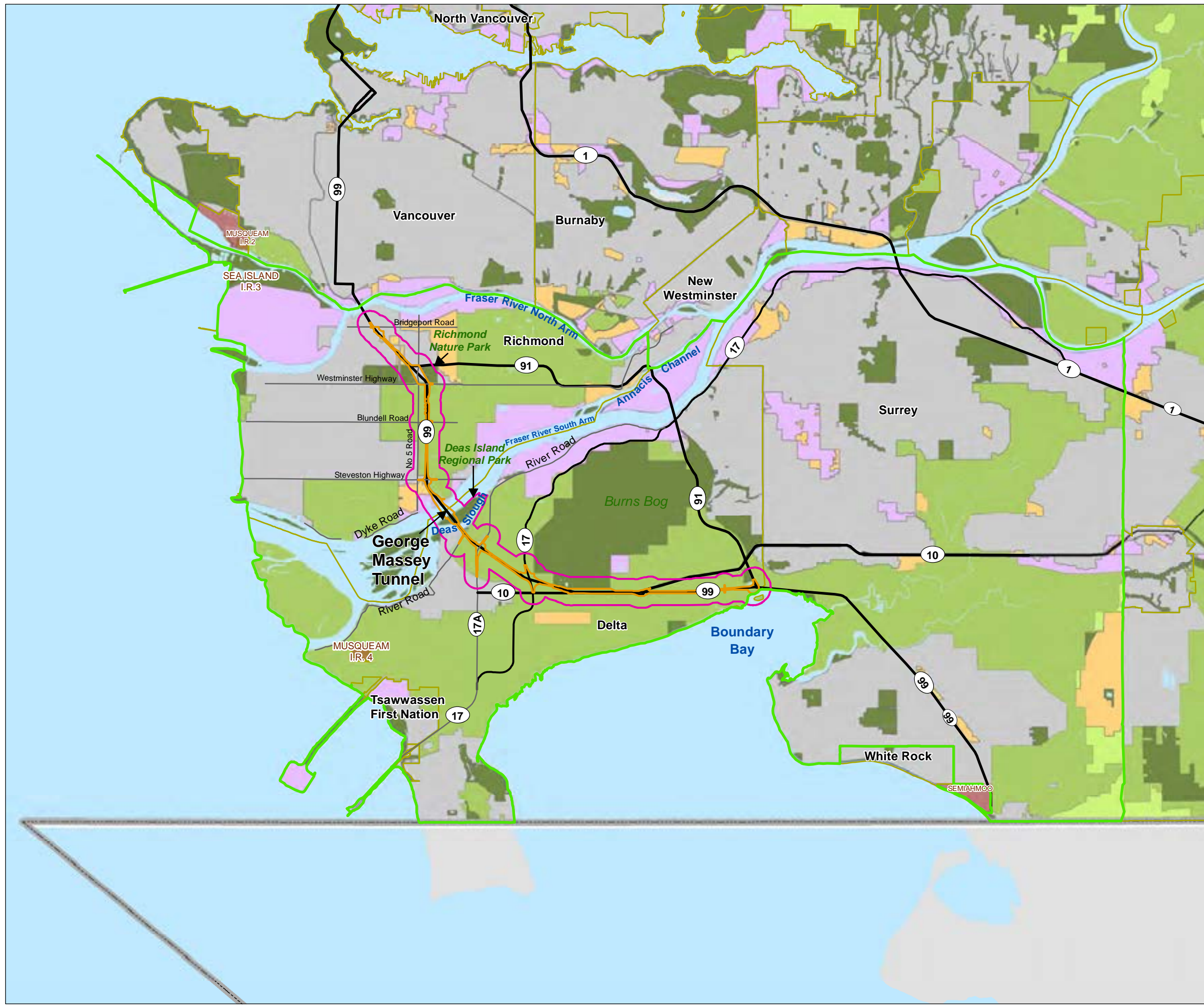
| Jurisdiction | Responsible Agency or Municipality | Land Use Planning Context |
|--------------|------------------------------------|--|
| Local | Delta | Delta’s OCP (2014) has an objective of reducing traffic congestion and mitigating its effects, working with provincial and federal governments and agencies to secure improvements to transportation systems and maximize the capacity of existing corridors, wherever possible, before building new corridors to accommodate increasing traffic demand. |
| | Surrey | Surrey’s OCP (2014) has objectives to develop efficient and adaptable infrastructure systems and provide a comprehensive transportation network that offers reliable, convenient, and sustainable transportation choices. The OCP defines several relevant policies under this objective which include efficiently managing, maintaining, and improving a transportation system for all modes of transportation, reducing congestion, and coordinating with strategic operational plans of the Ministry. |

Metro Vancouver Regional Growth Strategy

Metro Vancouver’s regional growth strategy identifies several regional land use designations. The designations that apply within Surrey, Delta, and Richmond (i.e., those communities with the potential to be directly affected by the Project) are listed and described in **Table 5.3-4** and shown in **Figure 5.3-5**.

Table 5.3-4 Metro Vancouver Regional Growth Strategy land use designations within the land use subcomponent LAA

| Land Use Designation | Description |
|-----------------------------|---|
| Agricultural | Includes majority of land use adjacent to the Project alignment in Richmond, Delta, and Surrey. |
| Conservation and Recreation | Includes Deas Island Regional Park, the South Arm islands, Burns Bog Ecological Conservancy Area, Richmond Nature Park, the foreshore of Lulu Island and the Strait of Georgia, the north shore of Sea Island, Watershed Park, Tynehead Regional Park, Sunnyside Acres Urban Forest, Crescent Park, Surrey Bend Regional Park, and several other smaller parcels of land scattered throughout Delta, Richmond, and Surrey. |
| General Urban | <p>Includes Ladner, the Tsawwassen lands south of Deltaport Way, North Delta, Tsawwassen and portions of Richmond (neighbourhoods or town centres including Blundell, Bridgeport, Broadmoor, East Cambie, West Cambie, City Centre, Seafair, Shellmont, Steveston, and Thompson). Lands surrounding the Surrey Metro Centre, Guildford, Fleetwood, Newton, Cloverdale and Semiahmoo urban centers are also designated as general urban and future development outside of these areas is constrained by an Urban Containment Boundary. A small portion to the south of the Highway 99 corridor in Ladner is designated as general urban, and borders the Urban Containment Boundary.</p> <p>Urban Centres within the Project alignment (i.e., Metropolitan Cores, Regional City Centres, and Municipal Town Centres) include Richmond Centre (a Regional City Centre), Ladner, Newton, Guilford, Fleetwood, Newton, Cloverdale, and Semiahmoo (Municipal Town Centres), and Surrey Metro Centre, which has its own urban centre designation.</p> |
| Industrial | In Richmond, areas designated for industrial land use are concentrated along the north shore of the Fraser River South Arm, the north shore of Richmond, and on Sea Island Way. In Delta and Surrey, these areas are concentrated along the south shore of the Fraser River South Arm from Tilbury Island east to the boundary with Langley Township, as well as at Roberts Bank. In Surrey, lands surrounding portions of the CN rail line that bisects Surrey are designated industrial. |
| Mixed Employment | Includes portions of northern Richmond between Highway 99 and Knight Street, an area of Richmond north of Kirkland Island and Barber Island, an area on the south east border of Surrey, an area in Surrey between the South Fraser Perimeter Road and King George Boulevard, and in Delta adjacent to the Highway 99 corridor near the Boundary Bay Airport. |

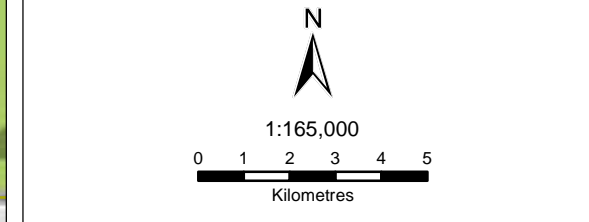


Legend

- Land Use Subcomponent Local Assessment Area
- Regional Growth Subcomponent Local Assessment Area
- Land Use Subcomponent Regional Assessment Area
- Agricultural
- Conservation Recreation
- Industrial
- Mixed Employment
- Rural
- Urban
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Metro Vancouver regional growth strategy provided by Metro Vancouver's Open Data Catalog Metro 2040 Land Designation dataset - <http://www.metrovancouver.org>



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

METRO VANCOUVER LAND USE DESIGNATIONS

Figure 5.3-5 26/05/2016

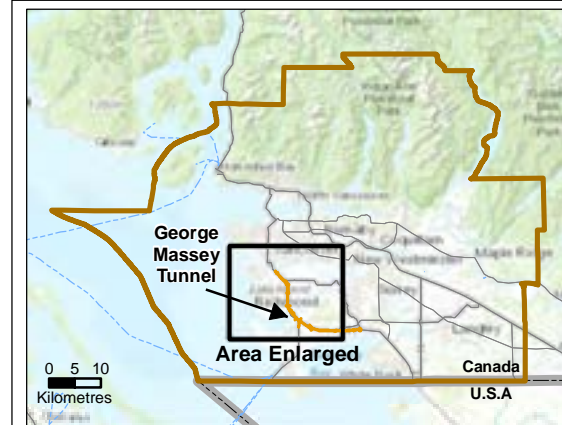
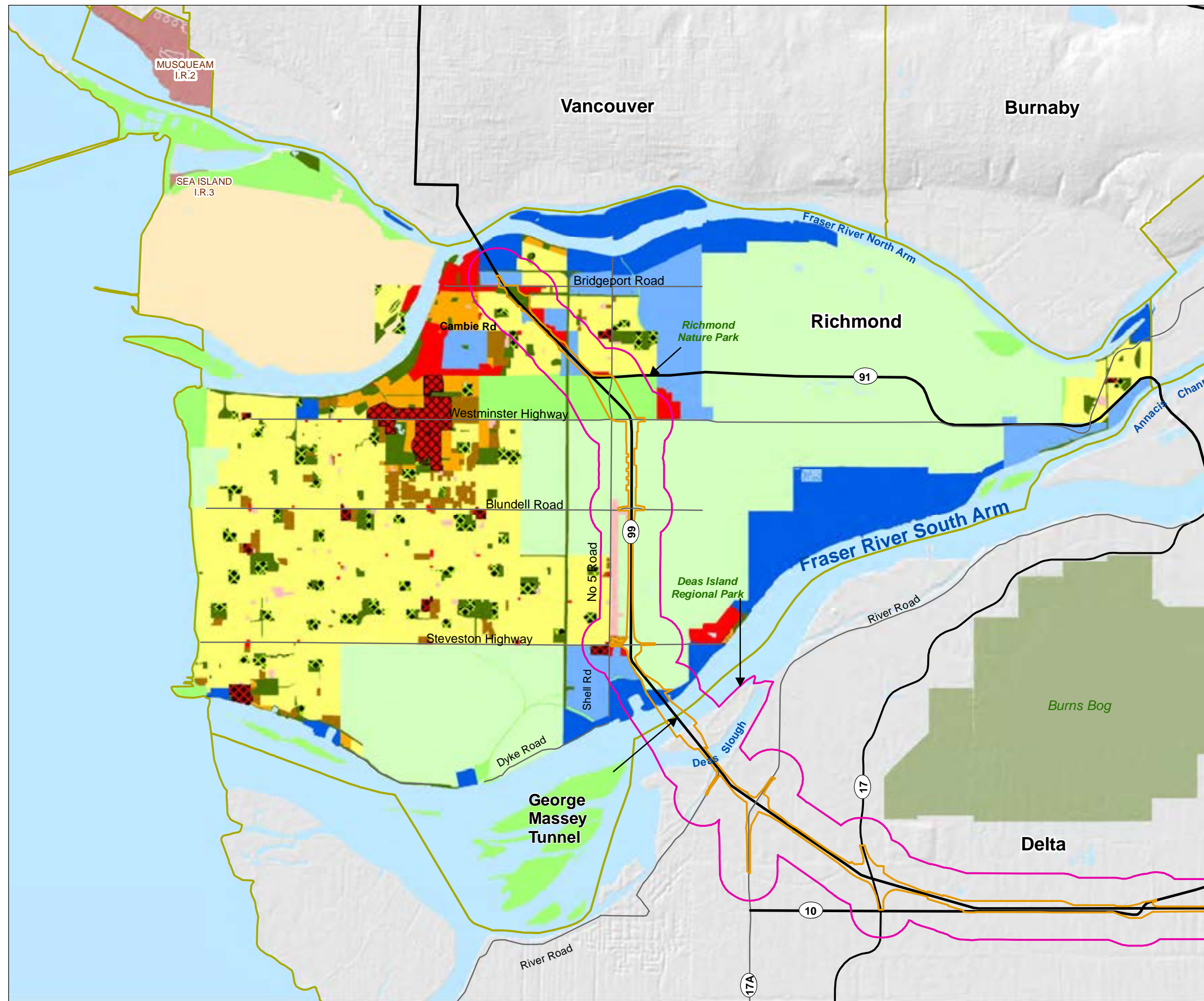
Richmond Official Community Plan

Richmond’s OCP (2012) land use designations are shown in **Figure 5.3-6** those that occur within the land use subcomponent LAA are described in **Table 5.3-5**.

Table 5.3-5 Richmond Official Community Plan designations within the land use subcomponent LAA

| Land Use Designation | Description |
|--------------------------------|--|
| Agriculture | Includes the majority of land adjacent to the Project alignment from Westminster Highway to the Tunnel. |
| Apartment Residential | Includes a small area that occurs in the northern portion of the LAA, east of Shell Road, northeast of the Project alignment. |
| Commercial | Includes retail and other services. Within the LAA, commercial lands are located east of the Westminster Highway interchange, at the edge of the LAA. Additional commercial areas are located to the west of the Steveston Highway interchange and east of the Project alignment south of Bridgeport Road. |
| Community Institutional | This designation includes schools and religious institutions and is primarily situated to the west of the Project alignment, along No. 5 Road, between Blundell Road and Steveston Highway. |
| Conservation Area | Includes Richmond Nature Park, areas of land on either side of Highway 99. The Fraser River South Arm islands are to the west of the LAA. |
| Industrial | Includes a broad range of general and heavy industrial as well as other compatible uses. Within the LAA, industrial land is primarily located on the north shore of the Fraser River South Arm, with some areas in the northern section of Richmond, along the Fraser River North Arm. |
| Limited Mixed Use | Includes lands where a small range or mix of uses is permitted. Within the LAA, limited mixed-use land is designated at the northwest corner of the Steveston Highway/Highway 99 interchange. |
| Mixed Employment | Includes residential, commercial, and some light industrial land uses. Mixed employment lands that overlap the LAA are located near the Steveston Highway interchange, and between Alderbridge Way and Bridgeport Road. |

| Land Use Designation | Description |
|-------------------------------------|---|
| Mixed Use | Includes commercial buildings having housing located above, inclusive of residential and non-residential uses. There is an area partially within the LAA, located south of Bridgeport Road and west of the Project alignment. |
| Neighbourhood Residential | Includes areas adjacent, or within close proximity, east and west of the Project alignment and north of Bridgeport Road to Highway 91 as well as a proposed neighbourhood along No. 5 Road west of the Steveston Highway interchange. |
| Neighbourhood Service Centre | Includes mixed-use hubs such as shopping centres and gas stations and within the LAA, west of the Steveston Highway interchange. |
| Park | This designation is intended for outdoor land, specifically for passive or active recreation including open space, par-3 golf courses, playgrounds, environmentally sensitive areas, conservation areas, and sports fields. Within the LAA, they include the Kilby Park and an area to the southeast of the Bridgeport Road and Highway 99 interchange. |
| School | Includes existing schools: the Talmey Neighbourhood School, located between Bridgeport and Cambie Roads, on the west side of Highway 99 and a portion of the Tomsett Elementary School are located in the LAA. |



Legend

- Land Use Subcomponent Local Assessment Area
- Land Use Subcomponent Regional Assessment Area
- Agriculture
- Airport
- Apartment Residential
- Commercial
- Community Institutional
- Conservation Area
- Downtown Mixed Use
- Industrial
- Limited Mixed Use
- Mixed Employment
- Mixed Use
- Neighbourhood Residential
- Neighbourhood Service Centre
- Park
- School
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. City of Richmond OCP Land use Provided by The City of Richmond



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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

CITY OF RICHMOND OFFICIAL COMMUNITY
PLAN LAND USE DESIGNATIONS

Figure 5.3-6

26/05/2016

Delta Official Community Plan

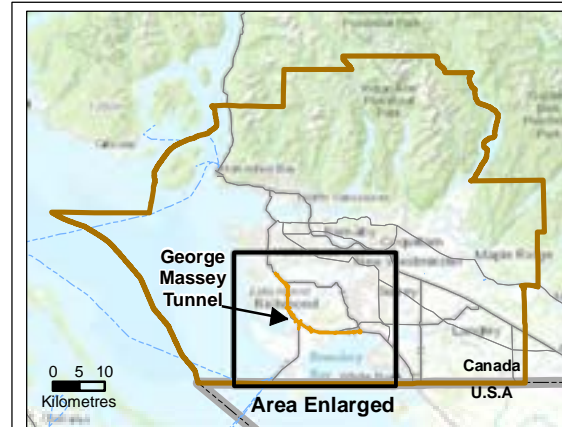
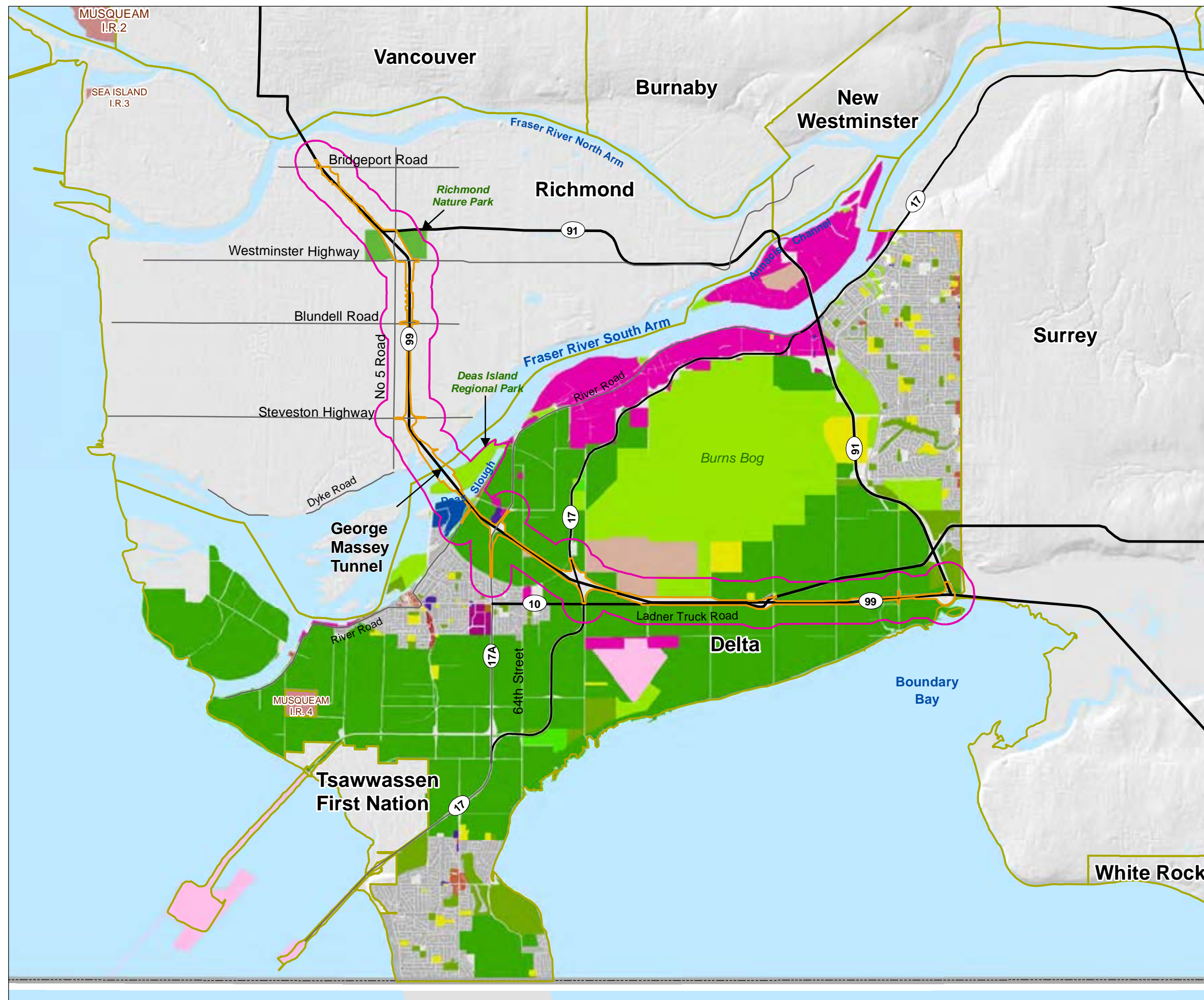
Delta’s OCP (2014) land use designations are shown in **Figure 5.3-7** and those that occur within the land use subcomponent LAA are described in **Table 5.3-6**.

Table 5.3-6 Delta Official Community Plan designations occurring within the land use subcomponent local assessment area

| Land Use Designation | Description |
|---------------------------------------|--|
| Agriculture | Intended for both general and intensive land use, this designation also includes ALR lands. The majority of land within the Delta portion of the LAA is classified as agriculture. |
| Commercial | Includes general commercial, service commercial, and neighbourhood commercial developments. Limited residential uses, such as dwelling units above a commercial use, are permitted. Within the LAA, commercial designations are located at the northwest corner of Highway 99 and Highway 17A interchange, and north of the Highway 99 and Highway 10 interchange. |
| Environmentally Sensitive Area | Deas Island Regional Park and portions of Burns Bog Conservation Area and Green Slough overlap the LAA. With conservation as a primary objective, principal uses include preserving, enhancing, and managing vegetation, wildlife, and habitats with the aim to maintain natural conditions, features and ecological functions as much as possible. |
| Industrial | Includes light, heavy, and water-related industrial uses. Where industrial lands are included within the ALRs, agricultural uses are also permitted. Within the LAA, there are areas located north east of the Hwy 17A interchange. Areas outside of the LAA are located along River Road East (adjacent to Fraser River), Tilbury Island, Annacis Island, and Roberts Bank. |
| Institutional | Includes schools (primary and secondary) and other civic uses (e.g. churches and other religious institutions). Within the LAA, these include Delta View Life Enrichment Centre retirement home, located northeast of the Ladner Truck Road and Highway 99 interchange. |
| Major Park and Recreation Area | Includes regional, municipal and public open spaces as well as recreation and conservation areas. Specialized commercial uses may be permitted to serve the users of these areas. Several parks are partially within the LAA including the Watershed Park along Highway 91, between Ladner Truck Road and Highway 99. |

| Land Use Designation | Description |
|------------------------------|---|
| Marina Garden Estates | Intended for a mix of uses including retail and office commercial, multiple-family residential, recreation, cultural, public, and open space. Within the LAA, future Marina Garden Estate development will be located on the southwest side of the Deas Slough (part of the Marina Garden Estates Development), immediately west of the Project alignment. The Millennium Trail connects to the development to the Deas Slough crossing. |
| Public Utility | Intended for electrical stations, wastewater treatment plants, public landfills, public works yards, or other public utility uses and includes the Vancouver Landfill (located north of Highway 99 and east of Highway 17). A portion of the Vancouver Landfill is located within the LAA, immediately adjacent to the Project alignment. This designation also includes Delta's Public Works facility and yard, located southwest of Highway 99 and 64 th Street, within the LAA. |
| Residential | Includes low, medium, and high-density residential areas. Within the RAA, these are mainly concentrated in the town centres of Ladner, Tsawwassen, and North Delta. Ladner is partially within the LAA. There is also an area of medium density residential east of the alignment (Riverwoods) |
| Riverside Mixed Use | Includes mix uses such as retail and office commercial, multiple-family residential, recreation, cultural, public, and open space. Portions of the future Riverside Development, paralleling the Deas Slough to the east of Highway 99, overlap the LAA. |
| Water | Water designations include the Fraser River and Deas Slough. |

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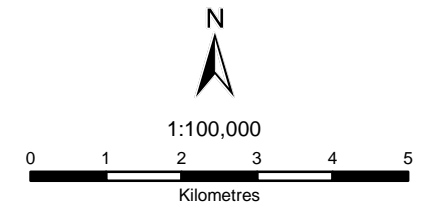
Legend

- Land Use Subcomponent Local Assessment Area
- Land Use Subcomponent Regional Assessment Area
- Project Alignment
- Agriculture
- Civic
- Commercial
- Community Study Area
- Environmentally Sensitive Area
- Industrial
- Heritage
- Residential
- Institutional
- Park
- Marine Garden Estates
- Mixed Use
- Public Utility
- Special Development Area
- Transportation Terminal
- First Nation Reserve
- Municipal Boundaries
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

CORPORATION OF DELTA OFFICIAL COMMUNITY
PLAN LAND USE DESIGNATIONS

| | |
|--------------|------------|
| Figure 5.3-7 | 26/05/2016 |
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Surrey Official Community Plan

The eastern end of the land use subcomponent LAA overlaps a small portion of lands designated as Agricultural Land within the Surrey Official Community Plan (2013) as shown in **Figure 5.3-8**. According to this OCP, the agricultural designation is intended to support agriculture, complementary land uses, and public facilities.

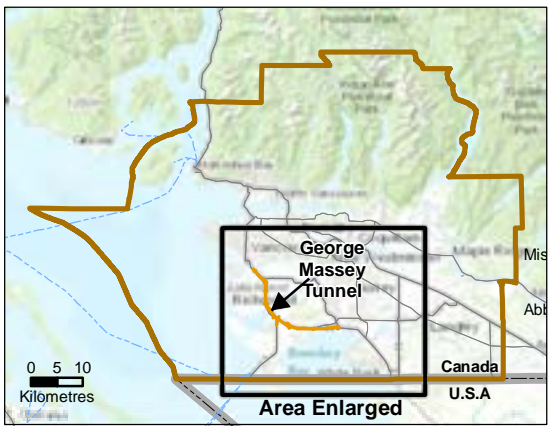
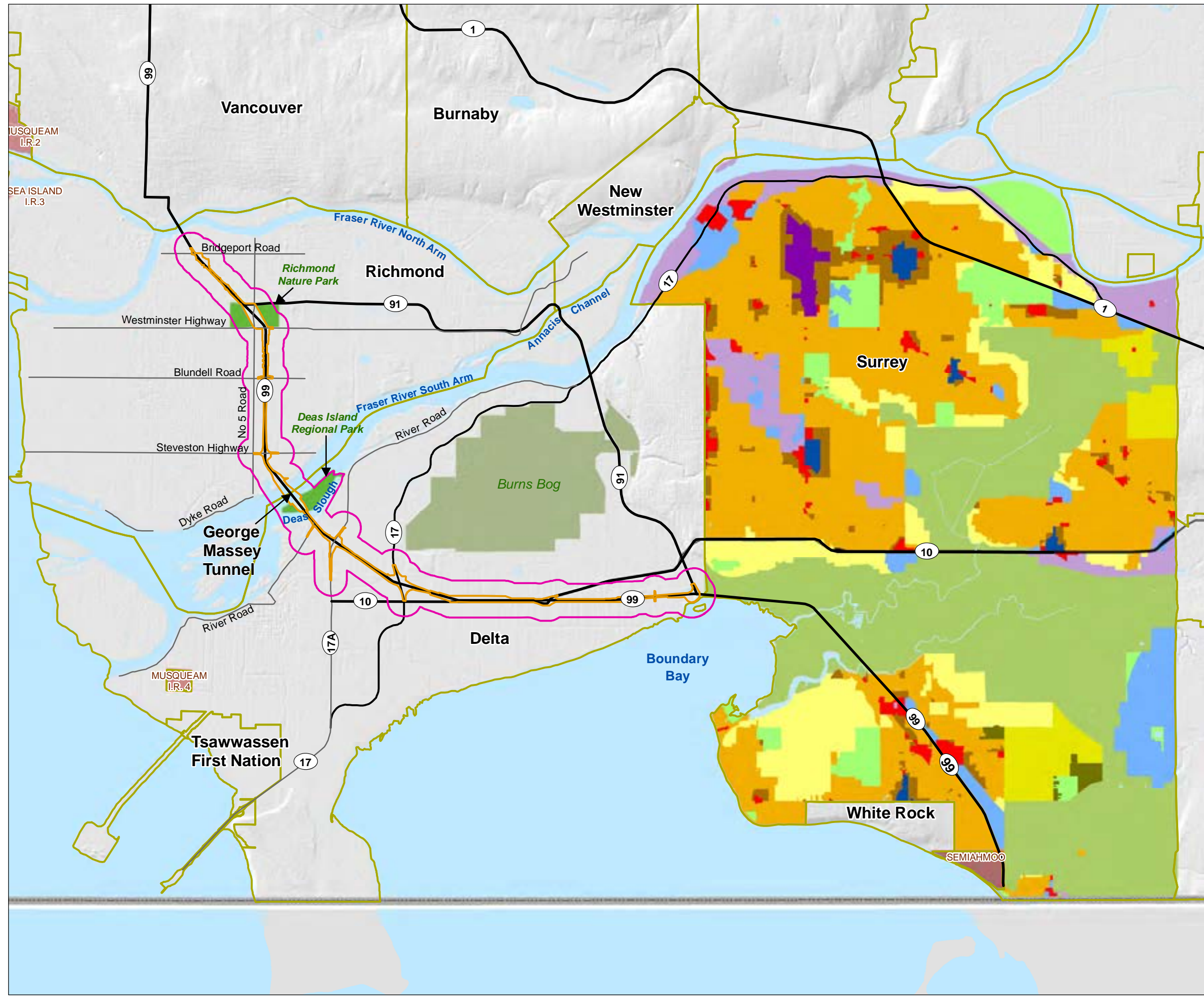
Other Planning Considerations

Local governments also prepare plans for specific land use, such as recreation or industrial development, to provide policy and guidance in addition to those outlined in OCPs or Metro Vancouver's RGS (2015).

Other relevant planning documents include:

- Richmond *Parks, Recreation and Cultural Services Master Plan* (City of Richmond 2006).
- Industrial development plans (Avison Young Commercial Real Estate 2012, 2013).
- Metro Vancouver (2016) *Regional Parks Plan*.
- Mayors' Council on Regional Transportation (2015) *Regional Transportation Investments, a Vision for Metro Vancouver*.
- Various agricultural documents (discussed in **Section 5.4 Agricultural Use**).

Although zoning bylaws specify the conditions for land use, the OCP designations are the primary determination of future uses. As such, zoning is not considered in this assessment.



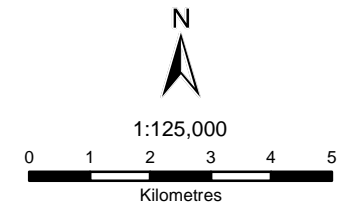
Legend

- Land Use Subcomponent Local Assessment Area
- Land Use Subcomponent Regional Assessment Area
- Agricultural
- Central Business District
- Commercial
- Conservation and Recreation
- First Nations Reserve
- Industrial
- Mixed Employment
- Multiple Residential
- Rural
- Suburban
- Suburban - Urban Reserve
- Town Centre
- Urban
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Official Community Plan Designation provided by the City of Surrey. <http://surrey.ca/city-services/1318.aspx>



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

CITY OF SURREY OFFICIAL COMMUNITY PLAN LAND USE DESIGNATIONS

Figure 5.3-8

13/05/2016



5.3.2.5 Land Uses

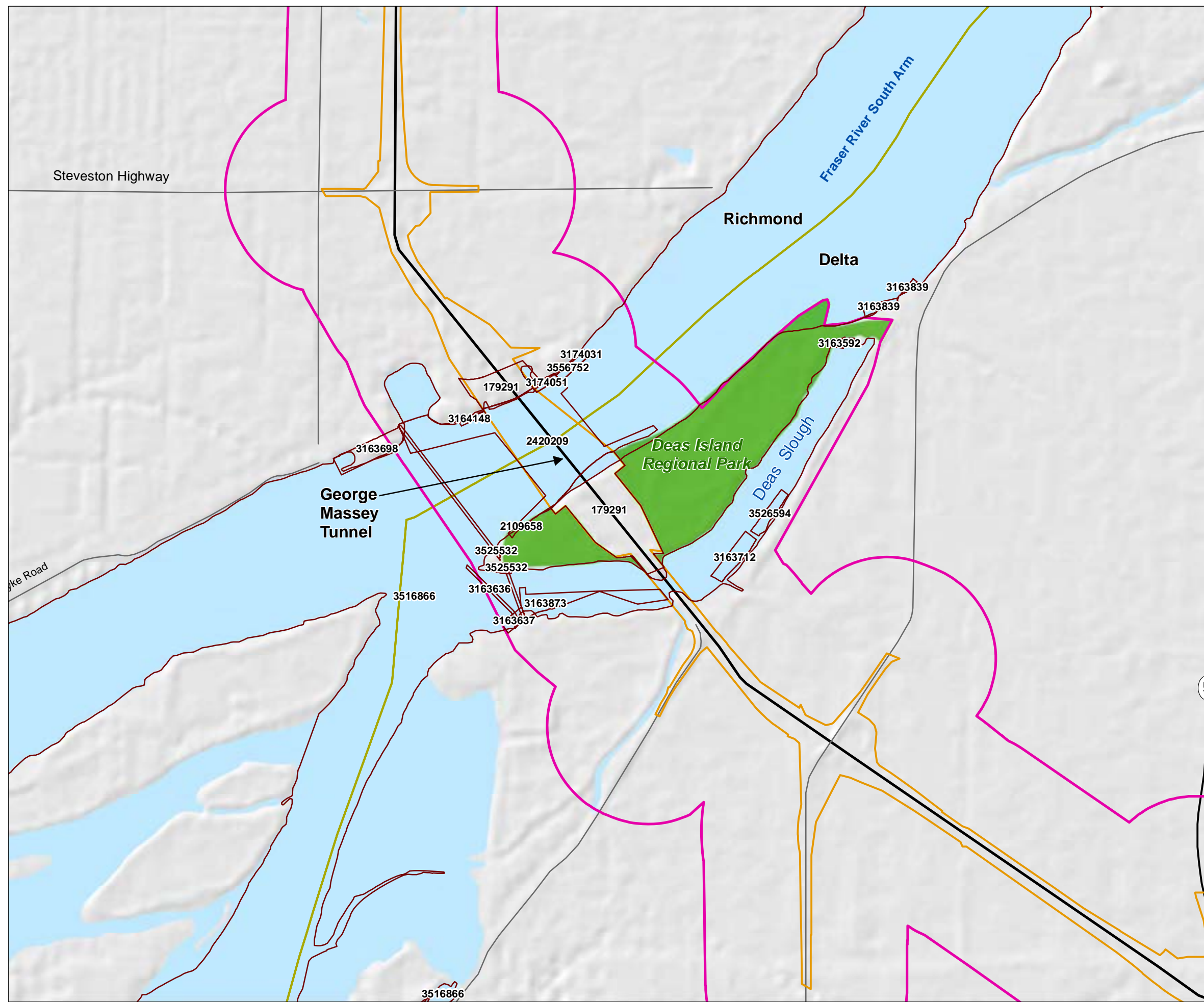
This section considers residential, commercial, industrial, park, and conservation land uses within the land use subcomponent LAA, and provides further detail on the types of use within each of these land use designations described in **Section 5.3.2.4**. Land uses within the submerged provincial Crown land in the Fraser River are also discussed.

Based on review of available aerial photographs and satellite imagery, the land uses in the land use subcomponent RAA and LAA generally conform to the land use planning designations. Navigation and other uses in the Fraser River South Arm are described in **Section 5.2 Marine Use**.

Land Uses on Provincial Crown Land

The riverbed of the Fraser River South Arm west of the eastern tip of Tilbury Island is provincial Crown land. Existing land uses are determined by the type of tenure held. The Ministry holds a transportation reserve for the area surrounding the Tunnel. Active (i.e., accepted) provincial Crown land tenures that overlap the Fraser River in the LAA are summarized as follows (**Table 5.3-1, Figure 5.3-9**):

- Fish exporter Ocean Fisheries GP has industrial licences adjacent to the north bank of the south arm of the Fraser River, northeast of the Tunnel.
- BC Hydro and Power Authority (B.C. Hydro) has a utility licence for the realignment of the electric power line in Deas Slough, west of the Highway 99 ROW.
- BC Ferries holds a reserve adjacent to the north bank of the Fraser River, adjacent south of the Tunnel transportation reserve area.
- Mainland Sand and Gravel Ltd. has an industrial licence on the north bank of the Fraser River, southwest of the Tunnel.
- The Greater Vancouver Water District has utility licences for crossings at the southwest end of Deas Island.
- Corporation of Delta has a utility licence south of Deas Island and a community licence at the north end of Ferry Road.
- Two marinas in Deas Slough, one by Captain's Cove Marina Ltd. and the other by Shato Holdings Ltd., hold commercial licences.
- Metro Vancouver holds an institutional licence at the northeast end of Deas Slough.



Legend

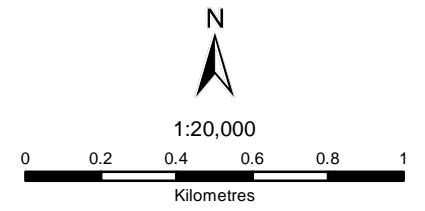
- █ Land Use Subcomponent Local Assessment Area
- █ Project Alignment
- █ Municipal Boundaries
- █ Crown Tenures
- █ Waterbody
- █ Canada - U.S. Border
- █ Highway
- █ Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Imagery provided by Bing. Tenure identification numbers provided by the Integrated Land and Resource Registry - <http://geobc.gov.bc.ca/irrr/>. Tenures provided by Data BC - <https://data.gov.bc.ca/>

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| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| PROVINCIAL CROWN LAND TENURES | |
| Figure 5.3-9 | 13/05/2016 |
| | |

Table 5.3-7 Provincial Crown Land Tenures beneath Fraser River Waters in the Land Use Local Assessment Area

| ILRR Interest Identifier | Interest Type | Interest Holder | Description | Total Area (ha) |
|---------------------------------|---|--|---|------------------------|
| 179291 | Transportation Reserve/Notation | B.C. Ministry of Transportation and Infrastructure | Roadway reserve for the north and south approaches of the George Massey Tunnel. | 22.10 |
| 2420209 | Transportation Reserve/Notation | B.C. Ministry of Transportation and Infrastructure | Reserve in the south arm of the Fraser River for the Tunnel. | 29.35 |
| 190876 | Utility ROW | B.C. Hydro and Power Authority | Electric power line, adjacent to Highway 99 ROW, Deas Slough. Transmission line is located within the Ministry ROW in the vicinity of the new bridge, and passes through the Tunnel, with a substation at north and south Tunnel entrances. | 0.05 |
| 3174031 | Industrial Licence | Jim Pattison Enterprises Ltd. | Industrial licence adjacent to the north bank of the south arm of the Fraser River. | 0.77 |
| 3174051 | Industrial Licence - | Jim Pattison Industries Ltd. | Industrial licence adjacent to the north bank of the south arm of the Fraser River. | 0.43 |
| 3556752 | Industrial Licence | Jim Pattison Enterprises Ltd. | Industrial licence adjacent to the north bank of the south arm of the Fraser River. | 0.77 |
| 3164148 | Environment, Conservation and Recreation Reserve/Notation | BC Ferries | Adjacent to the north bank of the Fraser River | 0.32 |
| 3163698 | Industrial Licence | Mainland Sand and Gravel Ltd. | Adjacent to the north bank of the Fraser River | 3.44 |

| ILRR Interest Identifier | Interest Type | Interest Holder | Description | Total Area (ha) |
|--------------------------|---|---|--|-----------------|
| 3163618 3525532 | Utility Licence and Utility Reserve/Notation | Greater Vancouver Water District | Water line crossing the Fraser River at the southwest end of Deas Island | 1.75 |
| 3163620 | Utility Licence | Greater Vancouver Water District | Waterline at the mouth of Green Slough, in Deas Slough | 0.03 |
| 3163873 | Commercial Licence | Captain's Cove Marina (1978) Ltd. | Marina in Deas Slough (west of Tunnel) | 4.36 |
| 3163712 | Commercial Licence | Shato Holdings Ltd. | Marina in Deas Slough (east of Tunnel) | 2.07 |
| 2109658 | Transportation Reserve/Notation | Fisheries and Oceans Canada | Navigation aid at the northwest end of Deas Island | 0.004 |
| 3516866 | Industrial Reserve/Notation | Ministry of Forests, Lands, and Natural Resource Operations | Light industrial, south arm of Fraser River within and outside the LAA | 4,404 |
| 3163592 | Institutional Licence | Metro Vancouver | Deas Island Regional Park, at the northeast end of Deas Slough (rowing club) | 0.25 |
| 3163636 | Utility Licence | Corporation of Delta | Sewer/effluent line from northeast end of Kirkland Island to South Arm Marshes | 0.63 |
| 3163637 | Community Licence | Corporation of Delta | South west entrance to Deas Slough | 0.77 |
| 3526594 | Residential Licence | Kyan Management Corporation | Residential licence in marine area east of Deas Island | 1.34 |

Notes: ILRR = Integrated Land and Resource Registry (2016)

Land Uses within Local Government Jurisdiction

Residential and Mixed Use

In Richmond, residential uses adjacent to No. 5 Road and in the northern portion of the Project include single and multi-family housing. Associated infrastructure, such as service centres and community centres (schools and religious buildings), are also present in these neighbourhoods. The northwest corner of the Steveston Highway and Highway 99 interchange is currently under residential development as The Gardens, which will be 4.86 ha including green space, garden plots, botanical gardens and trails when completed (The Gardens 2014).

In Delta, the Marina Garden Estates, situated immediately west of the Highway 99 ROW, is a division of the Captain's Cove Marina development. The existing development is of mixed housing and recreational uses (e.g., golf course, trails, boating). Future development will be a mix of multi-family housing with a commercial development along the shoreline. To the east of the Highway 99 ROW, adjacent to Deas Slough, are the Riverwoods residential development and a multi-family residential development with a pub and restaurant. Residential uses are also present on agricultural land in Richmond and Delta, as discussed in **Section 5.4**

Agriculture Use.

Commercial Uses

In Richmond, commercial uses within the LAA include several automobile dealerships located to the southeast of the Steveston Highway interchange, and various shops, hotels and other commercial uses near Bridgeport Road.

In Delta, commercial uses include a hotel, an office building situated northwest of the Highway 17A interchange, and gas stations located north of the Ladner Trunk Road interchange.

Industrial Uses

Within Richmond, industrial uses in the LAA are centred along the north shore of the Fraser River South Arm (include fish processing, manufacturing, distribution, and warehousing), and an area on the north arm of the Fraser River.

In Delta, a fish processing plant is located just outside the Land Use Subcomponent LAA northwest of the Highway 17A interchange.

Parks and Protected Areas

Multiple regional and municipal parks and protected areas occur within the Land Use Subcomponent LAA, as described below.

The Richmond Nature Park, in Richmond, is a raised peat bog habitat that covers approximately 80 ha and is designated as Conservation Area (City of Richmond 2012). A portion of Richmond Nature Park, north of Westminster Highway and adjacent to the Project alignment, is within the land use subcomponent LAA. Uses within the park include recreational walking trails, an interpretive nature centre, a picnic shelter, and a pavilion.

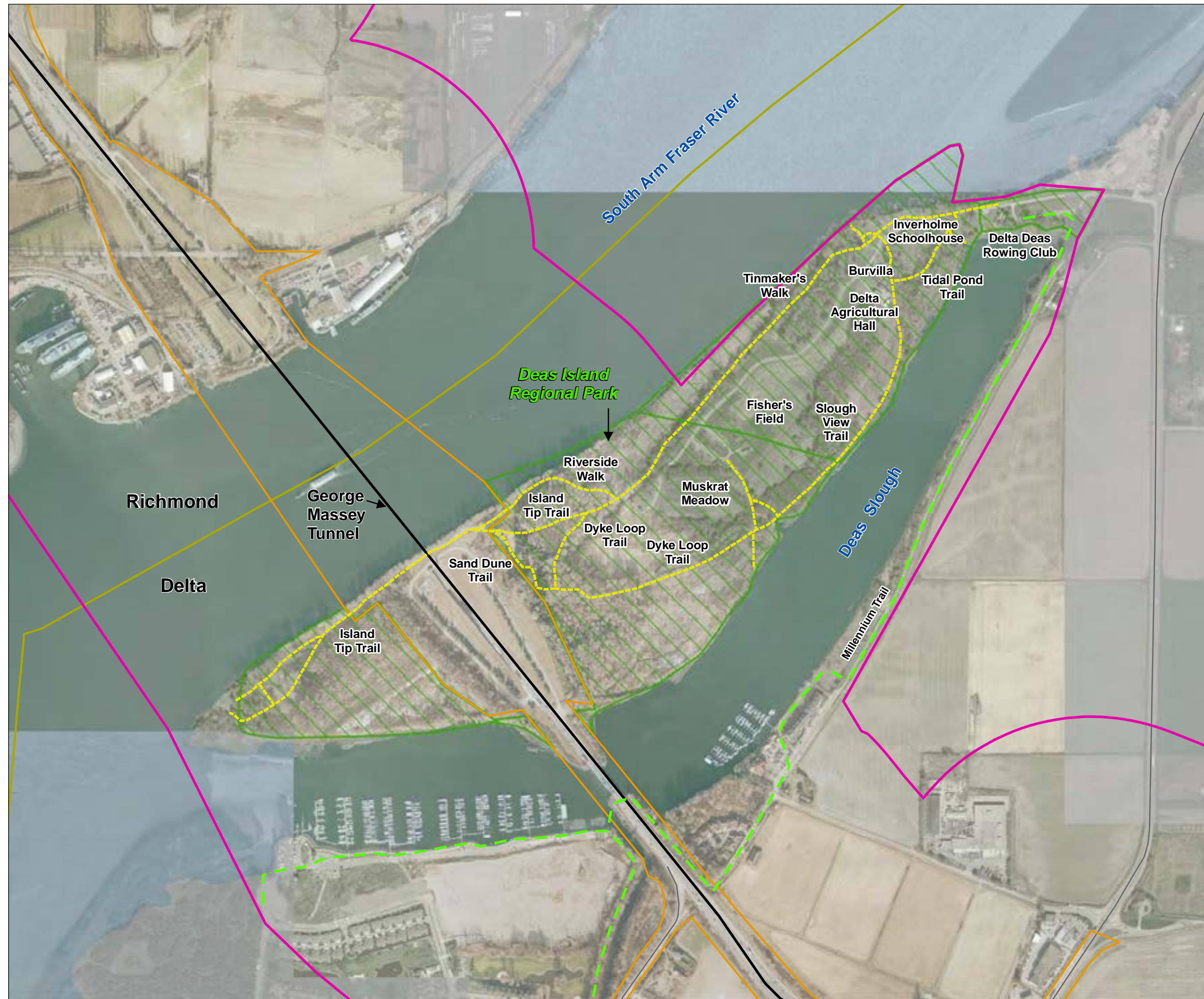
In Richmond, Talmei Neighbourhood, Tomsett Neighbourhood School, Odlin Neighbourhood, Odlinwood Neighbourhood, Kilby, Albert Airey Neighbourhood, and Model Airplane Parks occur at least partially within the land use subcomponent LAA. These parks are relatively small (< 10 ha) and contain a variety of amenities such as playgrounds, trails, benches, picnic tables, basketball courts, tennis courts, baseball diamonds, and grass fields for active play. The LAA also overlaps the Bridgeport Trail and Shell Road Trail.

Deas Island Regional Park is situated on both sides of the south end of the Tunnel on Deas Island, in Delta (**Table 5.3-11**). The park entrance is at the northeast end of the island, with access from River Road. Facilities within the park include a picnic shelter, 40-person group camp area, and an old schoolhouse building for holding functions. Activities within the park include fishing, cycling, horseback riding, watersports, and hiking trails. There are also organized nature walks in the park. The Island Tip Trail crosses the Tunnel on the north side of Deas Island (**Table 5.3-11**).

The Millennium Trail connects Crescent Drive and Ferry Slip Road to Deas Island. The trail follows the shoreline east from Marina Garden Estates, with an underpass for the Highway 99 ROW to link with the east section of River Road. Another western arm of the trail connects from Neilson Grove Elementary School to the underpass. An unpaved trail follows Boundary Bay from Tsawwassen to Surrey (Corporation of Delta 2015). In Richmond, the Richmond Loop trail to the west of the Steveston interchange and west of the LAA connects from the dyke along the Fraser River to Shell Road (The Trails Society of British Columbia 2014).

John Oliver Park, a municipal park in Delta, is situated at the Highway 99 interchange and contains sports fields and a clubhouse.

The Delta Golf Club is at the eastern border of Delta with Surrey, at the corner of Highways 10 and 99. The course is open to the public and features a clubhouse and banquet hall (Delta Golf Club 2009).



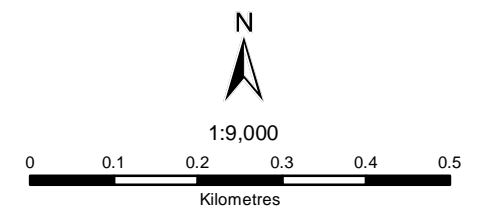
Legend

- Land Use Subcomponent Local Assessment
- Project Alignment
- Municipal Boundaries
- Deas Island Regional Park
- Deas Island Regional Park Trails
- Millennium Trail
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Imagery provided by Bing. Deas Island Regional Park trail digitized from trail map found Metro Vancouver trail maps - <http://www.metrovancouver.org/services/parks/parks-greenways-reserves/deas-island-regional-park>



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**DEAS ISLAND REGIONAL PARK
AND MILLENNIUM TRAIL**

Figure 5.3-10

13/05/2016

Public Utilities and Other Uses

In Delta, the Vancouver Landfill is an operational landfill situated north of the Project alignment. It accepts municipal solid waste and construction waste from the Metro Vancouver area. The landfill operations are conducted in accordance with the 2014 “Design, Operations & Progressive Closure Plan for the Vancouver Landfill” and agreements with Metro Vancouver and the Corporation of Delta which expire in 2037 (City of Vancouver Engineering Services 2015).

The Lulu Island- Delta Water Main crosses the South Arm of the Fraser River within the LAA to the west of the Project. It has an upland section on the southern tip of Deas Island, outside of the Deas Island Park boundary. In addition, the River Road West Water Main falls within the LAA on the south side of the Fraser River adjacent to works that will be undertaken in and around River Road and Green Slough. During construction, access for Metro Vancouver to the Lulu Island-Delta Main and River Road West Main will be provided, as it is for other utilities where access is potentially affected by the Project, to ensure site safety and coordination between Metro Vancouver’s requirements and construction of the Project.

In Richmond, an overpass for the CN rail line crosses Highway 99, south of Rice Mill Road and north of the Fraser River South Arm. The Burlington North Santa Fe rail crosses Highway 99 on the east side of Delta.

A BC Hydro electrical substation is situated south of the Project alignment, close to the intersection of Ladner Trunk Road and 64th Street. Rights of way for a BC Hydro transmission line parallel the highway alignment between the Delta works yard and Deas Island in Delta, and between Rice Mill Road and Richmond Nature Park in Richmond. BC Hydro has a permit with the Ministry for the sections of line within the Ministry’s ROW on Deas Island, in the Tunnel and other areas.

With decommissioning of the Tunnel, the existing BC Hydro transmission line will be reconfigured to a crossing of the Fraser River outside of the Tunnel, but within the existing highway right-of-way. Currently, three crossing options are being considered. Regardless of the option selected by BC Hydro, as with other utilities relocations within the highway right-of-way, physical works to be undertaken in support of utilities relocations are not considered to be within the scope of the Project and are not directly considered in the effects assessment. Where residual effects resulting from utilities relocations may occur, on VCs also potentially affected by the Project, such effects are considered in the context of the cumulative effects assessment.

Summary of Existing Conditions by Project Segment

Key information on OCP land use designation and land use within or adjacent to the Project alignment is summarized by Project segment in **Table 5.3-8**.

Table 5.3-8 Summary of Existing Conditions in the Land Use Local Assessment Area

| Project Segment | Land Use Designations in Land Use Subcomponent LAA | Land Uses in the Land Use Subcomponent LAA |
|--|---|--|
| City of Richmond^{1, 2} | | |
| Bridgeport Road Interchange | <ul style="list-style-type: none"> • Apartment Residential • Commercial • Industrial • Mixed Employment • Neighbourhood Residential • Park • School | <ul style="list-style-type: none"> • Apartment complex • Commercial buildings (e.g., retail, restaurants, car dealerships) • Industrial (e.g., TransLink Yard) • Hotels and Conference Centres • Residential • Talmey and Tomlett Neighbourhood Schools and parks • Service station (gas) • Transportation (Canada Line) • Religious institution • Municipal parks |
| Westminster Highway Interchange | <ul style="list-style-type: none"> • North of interchange: Neighbourhood Residential, Mixed Employment, and Neighbourhood Service Centre • Conservation Area • Environmentally Sensitive Area • South of interchange: Agriculture | <ul style="list-style-type: none"> • Agriculture • Richmond Nature Park • Recreation (trails in Richmond Nature Park) • Residential • Service station (gas) |

| Project Segment | Land Use Designations in Land Use Subcomponent LAA | Land Uses in the Land Use Subcomponent LAA |
|---|--|---|
| Highway 99 | <ul style="list-style-type: none"> • Agriculture • Apartment Residential • Neighbourhood Residential • Commercial • Community Institutional • Environmentally Sensitive Area | <ul style="list-style-type: none"> • Agriculture • Residential (multiple types) • Commercial buildings • Commercial recreation (Go-Kart track, golf course, gun range) • Community/Institutional (school, religious building) • Riparian areas |
| Steveston Highway Interchange and new Bridge north approach/ramp | <ul style="list-style-type: none"> • Agriculture • Commercial • Environmentally Sensitive Area • Mixed Employment (west of alignment) • Mixed Use • Neighbourhood Residential • Neighbourhood Service Centre • Industrial (adjacent to Fraser River) | <ul style="list-style-type: none"> • Agriculture (east and north of alignment) • Commercial agriculture (farm market) • Commercial buildings (auto dealership and service centre, commercial buildings) • Riparian areas • Residential (west of No. 5 Road) • Service station (gas) • Dock yards • Processing plant and storage yards |
| Corporation of Delta³ | | |
| Tunnel and new bridge | <ul style="list-style-type: none"> • Conservation and Recreation • Environmentally Sensitive Area • Water | <ul style="list-style-type: none"> • Deas Island Regional Park • Recreation (trails in Deas Island Regional Park, boat storage and launch) • Navigation • Public wharf |
| New bridge south approach and River Road ramp connection (Delta/Deas Slough crossing) | <ul style="list-style-type: none"> • Agriculture • Environmentally Sensitive Area • Marina Garden Estates and associated Park and Commercial area, • Multi-Unit Residential • One- and Two-Unit Residential • Riverside Mixed Use | <ul style="list-style-type: none"> • Agriculture • Green Slough • Commercial recreation (golf course) • Restaurants (pubs) • Recreation (Millennium Trails along shoreline) • Marinas • Residential (various types, Marina Garden Estates, Riverwoods, small portion of Ladner) • Ferry Road Boat Launch |

| Project Segment | Land Use Designations in Land Use Subcomponent LAA | Land Uses in the Land Use Subcomponent LAA |
|--|---|---|
| Highway 17A Interchange | <ul style="list-style-type: none"> • Agriculture • Industrial • Other Commercial | <ul style="list-style-type: none"> • Agriculture • Commercial buildings • Hotel, restaurants • Delta Pacific Seafoods |
| Highway 99 | <ul style="list-style-type: none"> • Agriculture • Public Utility | <ul style="list-style-type: none"> • Agriculture • Delta Public Works Yard • Electrical substation (Arnott) |
| Highway 17 Interchange (SFPR) | <ul style="list-style-type: none"> • Agriculture • Environmentally Sensitive Area • Public Utility | <ul style="list-style-type: none"> • Agriculture • Burns Bog Ecological Conservancy Area (north of LAA) • Environmentally Sensitive Area • Vancouver Landfill |
| Highway 99 | <ul style="list-style-type: none"> • Agriculture • Environmentally Sensitive Area • Public Utility • Transportation Terminal (regional airport) and Industrial (south of LAA) | <ul style="list-style-type: none"> • Agriculture including greenhouses • Burns Bog Ecological Conservancy Area • Vancouver Landfill • Boundary Bay Airport (south of LAA) |
| Ladner Trunk Road (Highway 10) Interchange | <ul style="list-style-type: none"> • Agriculture • Institutional • Other Commercial | <ul style="list-style-type: none"> • Agriculture including greenhouses • Care home • Gas station and other commercial |
| Delta east | <ul style="list-style-type: none"> • Agriculture • Major Parks and Recreation Areas • Private Recreation Area | <ul style="list-style-type: none"> • Agriculture • Delta Golf Club • John Oliver Park, • Marine intertidal and marine areas (Mud Bay) • Boundary Bay Dyke Trail • Burlington Northern Santa Fe Rail (Roberts Bank) crossing |
| City of Surrey⁴ | | |
| Surrey west | <ul style="list-style-type: none"> • Agriculture | <ul style="list-style-type: none"> • Agriculture |

Notes:

- 1 City of Richmond 2041 OCP Land Use Map (2015).
- 2 City of Richmond 2041 OCP Environmentally Sensitive Areas (ESA) Map (2014). It is noted that this designation is not presented on **Figure 5.3-6**. Refer to **Section 5.3.8** for access information.
- 3 Corporation of Delta Future Land Use Plan (2013).
- 4 City of Surrey OCP (2013).

5.3.2.6 Regional Growth

Regional growth strategies are managed in accordance with policies and land uses outlined in Metro Vancouver's RGS (2015), local government RGSs and OCPs, and the provincial Agricultural Land Commission for agricultural land. The location and density of existing and future land uses are governed by the land use designations in these plans (**Sections 5.3.2.4 and 5.3.2.5**), and are based on projected population and employment levels as well as land use supply and demand. While planning documents are regularly reviewed and updated, there is no indication that the regional land use designations will change to alter the supply of land for particular uses; however, changes to land use density within the broader categories may change as a component of normal development processes. For example, the ALR and the urban containment boundaries are not expected to change in any substantial manner and vacant available land for new development is constrained by the existing planning regime (Site Economics Ltd 2016; Coriolis 2014). The following discussion presents summaries of population and residential development trends, employment distributions, and industrial land use availability.

Metro Vancouver has been experiencing the same trends for population growth as the rest of Canada: households are smaller; more people live alone; and couples have fewer children. In 2006, Metro Vancouver's average number of persons per household was 2.55; single detached houses at 3.13; townhouse at 2.68; low-rise apartments at 1.94; and high-rise apartments at 1.70. This is compared to an average of 2.6 persons per household for the region, in 2011 (Site Economics Ltd 2016).

Metro Vancouver has experienced significant population growth since 1971. During the most recent Census period (2006- 2011), Metro Vancouver population grew by 6.5% or nearly 200,000 (i.e., nearly 40,000 per year on average). The population of Surrey grew by 120,000 (from 347,000 to 468,000) during the 2001-2011 period. With an approximately 35% growth, Surrey's growth over this period was higher than the regional average. Richmond also grew significantly, while growth was much lower in Delta (Site Economics Ltd 2016).

Future population predictions for the Metro Vancouver region indicate growth of approximately 1.1 million people total from 2011 to 2041 for a total population of 3.4 million (Metro Vancouver 2015). In general terms, Surrey and Vancouver are projected to accommodate a significant amount of the future population growth for the region. Strong population growth is forecasted to continue, with Surrey growing to 770,000 in 2041. Meanwhile, Delta is projected to grow from 102,000 in 2011 to 121,000 in 2041, and Richmond from 194,000 to 280,000 in the same period.

As future population growth is predicted to remain strong, demand for housing can also be expected to remain strong. The more urban municipalities in Metro Vancouver, such as Vancouver, Richmond, and Burnaby will have larger concentrations of employment, while Delta's employment will be more dispersed, consistent with prevailing land use designations and local population and employment volumes.

Metro Vancouver's RGS seeks to protect the region's industrial land base and promote the intensification of industrial use on those lands (Metro Vancouver 2013). As of mid-2010s, the inventory of vacant industrial land was approximately 6,600 acres. However, this includes land that has various constraints, such as poor location or a servicing limitation. The existing industrial land base may be depleted in the early to late 2020s, depending on the growth scenario (Metro Vancouver 2013).

Table 5.3-9 Population, Dwelling Units and Employment Predictions

| Sub-region | Total Population | | | | Total Dwelling Units | | | | Total Employment | | | |
|-----------------------------|------------------|-----------|-----------|-----------|----------------------|-----------|-----------|-----------|------------------|-----------|-----------|-----------|
| | 2011 | 2021 | 2031 | 2041 | 2011 | 2021 | 2031 | 2041 | 2011 | 2021 | 2031 | 2041 |
| MUNICIPALITY | 2011 | 2021 | 2031 | 2041 | 2011 | 2021 | 2031 | 2041 | 2011 | 2021 | 2031 | 2041 |
| Metro Vancouver Total | 2,356,000 | 2,788,000 | 3,152,000 | 3,443,000 | 890,000 | 1,112,000 | 1,287,000 | 1,423,000 | 1,209,000 | 1,424,000 | 1,626,000 | 1,773,000 |
| Burnaby, New Westminster | 295,000 | 350,000 | 406,000 | 447,000 | 117,400 | 154,900 | 178,600 | 196,300 | 169,600 | 189,000 | 233,000 | 251,000 |
| Burnaby | 227,700 | 270,000 | 314,000 | 345,000 | 86,800 | 117,800 | 136,000 | 149,300 | 140,900 | 152,000 | 189,000 | 203,000 |
| New Westminister | 67,300 | 80,000 | 92,000 | 102,000 | 30,600 | 37,100 | 42,600 | 47,000 | 28,700 | 37,000 | 44,000 | 48,000 |
| Langley City and Township | 131,900 | 174,140 | 220,150 | 249,000 | 48,600 | 65,800 | 85,300 | 96,800 | 70,500 | 92,000 | 110,000 | 125,000 |
| Langley City | 25,600 | 30,140 | 34,150 | 38,000 | 11,300 | 13,800 | 16,300 | 18,800 | 18,000 | 21,000 | 23,000 | 25,000 |
| Langley Township | 106,300 | 144,000 | 186,000 | 211,000 | 37,300 | 52,000 | 69,000 | 78,000 | 52,500 | 71,000 | 87,000 | 100,000 |
| Maple Ridge, Pitt Meadows | 95,900 | 107,600 | 122,800 | 141,500 | 34,800 | 44,200 | 52,900 | 55,200 | 29,100 | 43,000 | 51,200 | 53,700 |
| Maple Ridge | 77,600 | 87,600 | 100,800 | 118,000 | 28,000 | 36,100 | 43,700 | 45,000 | 23,300 | 34,000 | 41,000 | 42,500 |
| Pitt Meadows | 18,300 | 20,000 | 22,000 | 23,500 | 6,800 | 8,100 | 9,200 | 10,200 | 5,800 | 9,000 | 10,200 | 11,200 |
| Northeast Sector | 222,900 | 289,400 | 341,100 | 363,900 | 79,595 | 110,150 | 136,130 | 149,340 | 79,825 | 108,550 | 129,490 | 141,520 |
| Anmore | 2,100 | 2,900 | 3,400 | 3,900 | 620 | 930 | 1,180 | 1,350 | 300 | 500 | 600 | 700 |
| Belcarra | 700 | 800 | 900 | 1,000 | 275 | 320 | 350 | 390 | 225 | 250 | 290 | 320 |
| Coquitlam | 129,000 | 176,000 | 213,000 | 224,000 | 45,500 | 67,700 | 86,700 | 94,100 | 46,800 | 70,000 | 86,000 | 94,000 |
| Port Coquitlam | 57,500 | 70,000 | 79,000 | 85,000 | 20,600 | 26,300 | 30,900 | 34,300 | 23,600 | 28,000 | 32,000 | 35,000 |
| Port Moody | 33,600 | 39,700 | 44,800 | 50,000 | 12,600 | 14,900 | 17,000 | 19,200 | 8,900 | 9,800 | 10,600 | 11,500 |
| North Shore | 185,100 | 206,425 | 224,650 | 243,700 | 73,200 | 84,300 | 92,775 | 100,450 | 78,400 | 91,350 | 100,460 | 109,570 |
| North Vancouver City | 49,800 | 56,000 | 62,000 | 68,000 | 23,000 | 25,600 | 28,000 | 30,200 | 31,100 | 34,000 | 37,000 | 40,000 |
| North Vancouver District | 87,700 | 98,000 | 105,000 | 114,000 | 31,300 | 37,500 | 41,000 | 45,000 | 28,300 | 33,000 | 36,000 | 40,000 |
| West Vancouver | 46,300 | 51,000 | 56,000 | 60,000 | 18,400 | 20,600 | 23,100 | 24,500 | 18,700 | 24,000 | 27,000 | 29,000 |
| Lions Bay | 1,300 | 1,425 | 1,650 | 1,700 | 500 | 600 | 675 | 750 | 300 | 350 | 460 | 570 |
| Delta, Richmond, Tsawwassen | 296,900 | 344,000 | 380,000 | 409,500 | 103,100 | 125,300 | 142,900 | 161,100 | 178,750 | 210,200 | 233,400 | 252,500 |
| Delta | 101,900 | 110,000 | 116,000 | 121,000 | 34,800 | 39,000 | 41,000 | 44,000 | 49,900 | 62,000 | 67,000 | 71,000 |
| Richmond | 194,300 | 230,000 | 258,000 | 280,000 | 68,000 | 85,000 | 100,000 | 115,000 | 128,600 | 147,000 | 165,000 | 180,000 |
| Tsawwassen First Nation | 700 | 4,000 | 6,000 | 8,500 | 300 | 1,300 | 1,900 | 2,100 | 250 | 1,200 | 1,400 | 1,500 |
| Surrey, White Rock | 497,500 | 614,500 | 707,000 | 793,500 | 162,800 | 211,000 | 251,000 | 288,000 | 175,200 | 221,800 | 266,400 | 306,300 |
| Surrey | 477,800 | 594,000 | 685,000 | 770,000 | 152,900 | 200,000 | 239,000 | 275,000 | 168,200 | 214,000 | 258,000 | 297,000 |
| White Rock | 19,700 | 20,500 | 22,000 | 23,500 | 9,900 | 11,000 | 12,000 | 13,000 | 7,000 | 7,800 | 8,400 | 9,300 |
| Vancouver, Electoral Area A | 630,500 | 702,000 | 750,000 | 795,000 | 270,250 | 316,200 | 347,000 | 376,000 | 427,700 | 468,000 | 502,000 | 533,000 |
| Vancouver | 617,200 | 685,000 | 725,000 | 765,000 | 265,100 | 309,000 | 336,000 | 362,000 | 406,700 | 446,000 | 477,000 | 505,000 |
| Electoral Area A | 13,300 | 17,000 | 25,000 | 30,000 | 5,150 | 7,200 | 11,000 | 14,000 | 21,000 | 22,000 | 25,000 | 28,000 |

Notes: Retrieved from Metro Vancouver's Regional Growth Strategy (2015).

5.3.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with land use. Information on mitigation of potential effects, including design measures to avoid adverse effects, is provided in **Section 5.3.5** (i.e., effects remaining following the implementation of mitigation measures) and described in **Section 5.3.4**. A discussion of potential cumulative effects on land use is presented in **Section 5.3.6**. Potential Project-related effects on marine uses, including recreational marine use, are addressed in **Section 5.2 Marine Use**.

Further analysis of potential Project-related effects on Aboriginal Interests related to land use, and measures to address such potential effects is included in **Section 10.1.3**.

5.3.3.1 Project Interactions

An overview of potential interactions between Project components and activities and land use during Project construction and operation is provided in **Appendix B**. A preliminary evaluation of the potential effects of Project interactions on land use, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Land Use Subcomponent

Construction: Small portions of adjacent land parcels may need to be acquired to accommodate the Project alignment, which could influence land use within or adjacent to those parcels. Project-related activities such as construction of the bridge, bridge approaches, and ramp connections, as well as interchange upgrades may lead to disturbances due to changes in traffic patterns and access to commercial, recreational, and emergency services. These interactions are expected to be temporary and site-specific.

Operation: Once operational, interaction of the Project with land use is expected to be limited to maintenance activities involving change in traffic patterns and access, shadows cast by the new bridge and approaches, and potentially through changes in noise, visual quality and air quality. Maintenance will be carried out in accordance with the Ministry's standard operating practices (B.C. MOTI 2003).

Regional Growth Subcomponent

Construction: The assessment recognizes that potential changes to regional growth patterns could evolve during planning and construction of the Project in anticipation of improved access; however, it can be assumed that changes, if any, are more likely to substantially occur during the operational phase.

Operation: Improved transportation infrastructure has the potential to influence population and employment distribution within the region, as well as the development and distribution of non-residential land.

5.3.3.2 Project Effects

This section summarizes the methods used to assess potential Project-related effects on land use that may result from interactions with the Project during construction and operation. The assessment of Project effects considers discussions with stakeholders, reviews of the Ministry's previous provincial highway assessments (B.C. MOTI 2006a, 2007), a review of the Application Information Requirements for the Project, experience from past projects and activities, and professional judgement of the Project team.

5.3.3.3 Land Use Subcomponent

Potential Effect #1: Consistency with Land Use Plans and Designations

The desktop review of relevant federal, provincial, regional, and municipal land use planning documents presented in **Section 5.3.2.4** indicates that the Project, while not specifically identified in all such documents, is generally consistent with long-range plans, including land use designations, to accommodate regional population growth and economic development. Through the desktop review, the goals and objectives of key planning documents were compared against the key Project attributes that support them as described below and summarized in **Table 5.3-11**.

Metro Vancouver and TransLink Plans: The Project supports the Mayors' Council vision (2015) by reducing congestion, funding transit infrastructure, and creating new pedestrian and cycling opportunities to help make these modes of transportation more viable for commuting and other personal trips. The Project also supports TransLink's RTS (2013) by integrating the overall Project design with the regional transportation network. The RTS guided the development of TransLink's *2014 Base Plan and Outlook* (2013). While this plan does not specifically refer to the Tunnel or its replacement, the plan identifies a goal to strategically maintain and grow the existing transportation system with partners.

VFPA Land Use Plan (2014): The VFPA Land Use Plan includes goals to ensure the safe and efficient movement of port-related cargo, traffic and passengers throughout the region. The Plan has objectives to preserve, maintain and improve transportation corridors and infrastructure, including support for maintaining and improving corridors outside of VFPA's jurisdiction, and to collaborate with industry, transportation agencies and local governments. The Project's Highway 99 improvements and objectives to improve safety and achieve travel time savings are consistent with objectives of the Land Use Plan.

Metro Vancouver RGS (2015): Key Project attributes align with and support the goals and strategies of the RGS including those related to the goal of Support Sustainable Transportation Choices. In this context, the RGS acknowledges TransLink’s mandate for the regional transportation system and communicates to TransLink its objectives to implement strategic transportation plans that support focused growth in Urban Centres, Frequent Transit Development areas, and other appropriate areas in the Frequent Transit Network (Metro Vancouver 2015). In addition, the RGS identifies general transportation goals, including support of transportation systems required to nurture a strong regional economy.

The Project includes improved opportunities for high-occupancy vehicles, transit, cycling and walking, which are consistent with and support the RGS, and will result in congestion reductions, travel time savings and improvements in air quality that also align with RGS goals and strategies.

Richmond OCP (2016): Highway 99 improvements, including the new Steveston Highway interchange, contribute to Richmond’s objective to better manage high traffic volumes moving to and from Highway 99. The OCP’s mobility and access objectives to optimize the existing road network, improve circulation and goods movement, and reduce the need for added road capacity, includes reference to supporting “the implementation of improvements along Highway 99, including an upgraded interchange at Steveston Highway and a new interchange at Blundell Road, to enhance local circulation and connectivity, increase safety and improve goods movement”.

Delta OCP: Delta’s OCP (2014) includes an objective to reduce traffic congestion and mitigate its effects, working with provincial and federal governments and agencies to secure improvements to transportation systems and maximize the capacity of existing corridors, wherever possible, before building new corridors to accommodate increasing traffic demand. The Project’s congestion reduction objectives within an existing corridor are consistent with key goals and objectives of this OCP.

Surrey OCP (2014): Surrey’s OCP has objectives to develop efficient and adaptable infrastructure systems and provide a comprehensive transportation network that offers reliable, convenient, and sustainable transportation choices. The OCP defines several relevant policies under this objective which include efficiently managing, maintaining, and improving a transportation system for all modes of transportation, reducing congestion, and coordinating with strategic operational plans of the Ministry. The Project aligns with these policies.

Specifically, it provides for all modes of transportation (including new bike and pedestrian options across the new bridge), reducing congestion, and improving transportation reliability.

The intended use of the Project alignment to support the proposed improvements, as presented in the **Section 16.1 Reference Concept**, is consistent with policies in existing local and regional plans to provide safe, reliable, transportation options that reduce congestion while also encouraging other modes of transportation. While the proposed Project is not specifically identified in all plans, the objectives of the Project are considered to support the land use policies in local and regional land use plans. Therefore, this effect is not considered further in this assessment.

Table 5.3-10 Project Consistency with Land Use Plans

| GMT Goals and Attributes ¹ | Land Use Plan | | |
|---|---|---|---|
| | Metro Vancouver RGS ² | Mayors' Council Vision ³ and TransLink RTS ⁴ | Richmond, Delta, and Surrey OCPs ^{5, 6, 7} |
| <p>Relieve congestion and improve reliability:</p> <ul style="list-style-type: none"> • Dedicated transit/HOV lanes and integrated transit stops. • Improve travel time reliability and save round-trip commuters up to 30 minutes a day. • Support 2045 population and employment growth projections. • By 2045, transit service between King George Boulevard and Bridgeport Road will be 20 minutes shorter than without improvements. | <ul style="list-style-type: none"> • Support efficient movement of vehicles. • Support regional population/employment growth projections. | <p>Mayors' Vision</p> <ul style="list-style-type: none"> • Reduce traffic congestion by 10 per cent, allowing drivers and transit users to save 20-30 minutes per day on some of the region's most congested corridors. <p>RTS</p> <ul style="list-style-type: none"> • Increase local and regional connectivity and improve goods movement • Provide additional capacity where needed to improve travel-time reliability on key goods movement corridors in a way that does not increase general purpose traffic. • Optimize roads and transit for efficiency, safety and reliability • Make travel more reliable. • Make it easier and less stressful to get to work and school | <p>Richmond</p> <ul style="list-style-type: none"> • Enhance transit service to better allow all trips to be made using a refined hierarchy of services tailored to meet the community's mobility needs. <p>Delta</p> <ul style="list-style-type: none"> • Provide a local road network that safely, efficiently and effectively enables movement of people and goods. <p>Surrey</p> <ul style="list-style-type: none"> • Provide a comprehensive transportation network that offers reliable, convenient, and sustainable transportation choices. • Reduce congestion, and coordinate with strategic operational plans of the Ministry. |
| <p>Provide more transportation options:</p> <ul style="list-style-type: none"> • Support additional transit with continuous dedicated transit/HOV lanes and integrated transit stops. • The bridge will accommodate future rapid transit. • New pedestrian and cyclist paths and connections, to make these viable travel options between Delta and Richmond. • Tolls will encourage transit and car-pooling and limit traffic growth over time. • Improve community connectivity and access to Deas Island Regional Park. | <ul style="list-style-type: none"> • Support sustainable transportation choices. | <p>Mayors' Vision</p> <ul style="list-style-type: none"> • Increase bus service for more reliable, more frequent and extended service. • Better connections to transit through pedestrian improvements. • Improve/extend bus service and expand rapid transit, to provide a real alternative to driving for those who can use it. • Make cycling a safer and viable travel choice. • Encourage alternatives to vehicle traffic, with direct emphasis on pedestrian, cycling and transit. <p>RTS</p> <ul style="list-style-type: none"> • Increase transportation options. • Invest in walkway, bikeway and transit networks | <p>Richmond</p> <ul style="list-style-type: none"> • Increase the priority of sustainable transportation modes (cycling, rolling, walking) while maintaining an adequate balance in road capacity for all users. <p>Delta</p> <ul style="list-style-type: none"> • Promote use of public transit and work to make it more attractive to users. • Promote alternate modes of transportation with safe and attractive facilities. • Reduce travel demand within Delta, and between Delta and other municipalities. <p>Surrey</p> <ul style="list-style-type: none"> • Manage, maintain and improve transportation system for all modes of transportation • Support transit oriented development along major corridors linking urban centres and employment areas |

| GMT Goals and Attributes ¹ | Land Use Plan | | |
|---|--|---|---|
| | Metro Vancouver RGS ² | Mayors' Council Vision ³ and TransLink RTS ⁴ | Richmond, Delta, and Surrey OCPs ^{5, 6, 7} |
| <p>Support the economy:</p> <ul style="list-style-type: none"> Benefit goods movers and trade by reducing travel times, increasing travel time reliability, and improving agricultural access. Relieve congestion and improve accessibility for work-related commuter and commercial traffic. Dedicated transit/HOV lanes will ensure buses have uncongested and reliable direct access. The urban containment boundary and the ALR, combined with limited access to Highway 99, will help focus growth in designated areas and reduce urban sprawl. Multi-use pathways will provide cyclists and pedestrians with a continuous connection between Richmond and Delta, with recreation, health and commuting benefits. | <ul style="list-style-type: none"> Support a sustainable economy. Create a compact urban area (with the urban containment boundary). | <p>Mayors' Council Vision</p> <ul style="list-style-type: none"> Transit investments should support higher population densities designed to utilize land at the lowest cost for taxpayers and the environment. <p>RTS</p> <ul style="list-style-type: none"> Support RGS goals, and regional economic development regional and provincial environmental objectives. Support a region that is vibrant and sustainable Invest in the road network to improve safety, local access and goods movement Ensure businesses continue to prosper with better access to more workers and markets. Make living, working and doing business in this region more affordable. Give people better access to jobs and more opportunities. | <p>Richmond</p> <ul style="list-style-type: none"> Implement timely roadway improvements for goods movement to support economic activities. <p>Delta</p> <ul style="list-style-type: none"> Provide a wide range of economic opportunities and sustain a healthy and diverse economy. Support safe and efficient movement of commercial and agricultural vehicles. <p>Surrey</p> <ul style="list-style-type: none"> Provide a comprehensive transportation network that offers reliable, convenient, and sustainable transportation choices. Encourage the development of more compact and efficient land uses. |
| <p>Improve safety:</p> <ul style="list-style-type: none"> The new bridge is expected to provide a more than 35 per cent drop in collisions. The new bridge's wider lanes and shoulders will facilitate faster first responder access. The Project will improve safe and efficient merging at interchanges. The bridge will include multi-use pathways and provide 24/7 safe passage for pedestrians and cyclists. Infrastructure will be built to current earthquake resistance standards. | <ul style="list-style-type: none"> Support the safe movement of vehicles. | <p>Mayors' Council Vision</p> <ul style="list-style-type: none"> The new Pattullo Bridge will include modern lane widths that meet safety standards, a centre barrier separating northbound and southbound traffic, and effective cycling and pedestrian facilities. <p>RTS</p> <ul style="list-style-type: none"> Make travel safe and secure for all users. Make infrastructure changes that improve road safety. | <p>Richmond</p> <ul style="list-style-type: none"> Improve safety measures for road users, particularly pedestrians, cyclists and those living with disabilities <p>Delta</p> <ul style="list-style-type: none"> Provide safe, efficient connections between communities and to the regional transportation network <p>Surrey</p> <ul style="list-style-type: none"> Provide a comprehensive transportation network that offers reliable, convenient, and sustainable transportation choices. |

| GMT Goals and Attributes ¹ | Land Use Plan | | |
|--|--|--|---|
| | Metro Vancouver RGS ² | Mayors' Council Vision ³ and TransLink RTS ⁴ | Richmond, Delta, and Surrey OCPs ^{5, 6, 7} |
| <p>Benefit the environment:</p> <ul style="list-style-type: none"> • Reduced congestion and more fuel-efficient travel speeds will help lower per-trip fuel consumption and Greenhouse Gas (GHG) emissions. • Tolling of the new bridge will result in a reduction in overall daily traffic levels, further reducing GHG emissions. • Area under the new bridge will be restored with native vegetation and reconstruct marshlands, providing habitat improvement and connections for wildlife. • The Project will provide additional environmental mitigation and restoration opportunities along the shorelines on either side of the Fraser River, and at Deas Slough and Green Slough. | <ul style="list-style-type: none"> • Protect the environment and respond to climate change impacts. | <p>Mayors' Council Vision</p> <ul style="list-style-type: none"> • Congestion is bad for the air we breathe, it's damaging to our economy, it erodes family time and it impacts our health. <p>RTS</p> <ul style="list-style-type: none"> • Support regional and provincial environmental objectives. • Support a region where air is clean and the land and people are healthy by creating and supporting a cleaner more efficient transportation system • Support Metro Vancouver's Integrated Air Quality and Greenhouse Gas Management Plan goals to protect public health and the environment; improve visual air quality; and minimize the contribution to global climate change | <p>Richmond</p> <ul style="list-style-type: none"> • Support broad-base community greenhouse gas emission reduction to achieve a 33 per cent reduction from 2007 levels by 2020 and 80 per cent reduction by 2050. <p>Delta</p> <ul style="list-style-type: none"> • Protect the natural environment, agricultural lands, and heritage features. • Protect and enhance watercourses, ravines, forested uplands, wetlands, foreshore and marine areas as habitat for wildlife. • Improve air quality and reduce greenhouse gas emissions. <p>Surrey</p> <ul style="list-style-type: none"> • Design a community that is energy efficient, reduces carbon emissions and adapts to a changing climate • Transit oriented development to reduce greenhouse gas emissions • Support transportation infrastructure that increases energy efficiency and conservation in a sustainable manner • Reduce the impacts of transportation on the natural environment |

| GMT Goals and Attributes ¹ | Land Use Plan | | |
|--|--|---|---|
| | Metro Vancouver RGS ² | Mayors' Council Vision ³ and TransLink RTS ⁴ | Richmond, Delta, and Surrey OCPs ^{5, 6, 7} |
| <p>Improve quality of life:</p> <ul style="list-style-type: none"> • Provide significant travel time savings and reliability benefits, reducing the amount of time spent travelling. • Improved access, safety and security for traffic, pedestrians and cyclists, supporting healthier transportation choices and improved recreational access. • Improve cross-highway connectivity to make travel within communities easier. • Provide opportunities for better community connectivity and improvements at Deas Island Regional Park. | <ul style="list-style-type: none"> • Develop complete communities where people can work close to where they live. | <p>Mayors' Council Vision</p> <ul style="list-style-type: none"> • Offer residents a high quality of life and the opportunity to live in thriving urban centres linked by efficient and clean transportation options <p>RTS</p> <ul style="list-style-type: none"> • More time for doing the things we love • Make travel easy and attractive for all users. • Make travel safe and secure for all users • Make it easier and less stressful to get to work and school • Support a region where air is clean and the land and people are healthy by creating and supporting a cleaner more efficient transportation system • Provide access to a full range of transportation services • Helping us live healthier and more active lives, reducing the burden on the healthcare system • Helping us get out on the sidewalk to meet our neighbours and deter crime | <p>Richmond</p> <ul style="list-style-type: none"> • The City is inclusive and designed to support the needs of a diverse and changing population. <p>Delta</p> <ul style="list-style-type: none"> • Be a sustainable, healthy and safe, and a place in which today's quality of life will also be enjoyed in the future. • Be a community in which people of all ages, family structures, backgrounds and interests can live, work and play. <p>Surrey</p> <ul style="list-style-type: none"> • Goal to meet the needs of the present generation in terms of socio-cultural systems, the economy and the environment, while promoting a high quality of life but without compromising the ability of future generations to meet their own needs |

Notes: 1. George Massey Tunnel Replacement Project Evaluation of Crossing Scenarios (MMK Consulting 2014)
2. Metro Vancouver Regional Growth Strategy (2015)
3. Mayor's Council on Regional Transportation (2015)
4. TransLink Regional Transit Strategy (2013)
5. City of Richmond Official Community Plan (2012)
6. Corporation of Delta Land Use Plan (2014)
7. City of Surrey Official Community Plan (2014)

Potential Effect #2: Compatibility with Adjacent Land Uses

The Project is considered compatible with adjacent land uses where indirect effects of the Project do not adversely interact with existing and planned land uses during the operational phase of the Project. Potential effects associated with Project construction activities (i.e., noise, traffic, air) are temporary in nature and not considered in assessing compatibility with adjacent land use but are considered in the context of **Potential Effect # 4 (Disturbance to Residential, Commercial and Industrial Land Uses)**.

Potential Project-related indirect effects during operations that could interact with existing and planned land uses include: changes in traffic congestion on access routes in adjacent neighbourhoods, noise levels on sensitive use lands along the length of the Project alignment, air quality, and visual quality, and shadowing in the vicinity of the new bridge.

With respect to parks and recreational land uses adjacent to Highway 99, including Deas Island Regional Park, the Project will not change the existing land use within the right-of-way. As such, it is considered to remain compatible with the adjacent land use associated with the Park. Recognizing that the Project includes changes to existing infrastructure, and has the potential to result in changes to conditions within the Park, disturbance to recreational land uses in the vicinity of the new bridge is considered under **Potential Effect # 5 (Disturbance to Recreational Uses near the New Bridge)**.

A desktop review of planning documents for all levels of government indicates that adjacent and proximal land uses are compatible with the Project. Over the past several decades, since the establishment of the Highway 99 corridor, urban development and agricultural uses have evolved along the Highway 99 corridor. During this time, development has taken place in way that takes into account proximity to Highway 99 by providing building setbacks and vegetated buffers for separation and minimizing the placement of sensitive receptors like schools, institutions, and residences immediately adjacent to the Highway. Because these land uses have evolved over time with the Highway, they are considered compatible with the proposed Project improvements, however additional support for this conclusion is presented below.

Traffic: Traffic safety, traffic volumes, congestion, and mode share, and the anticipated changes resulting from Project components and activities are addressed in **Section 5.1 Traffic**. The Project has been designed to address issues related to current and future traffic safety, congestion, and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. As proposed, Project-related improvements, including tolling, will help moderate traffic growth while effectively serving forecast demand at the crossing. Measures in the Ministry's Intelligent Transportation Systems

(ITS) to integrate communication and information technology to better manage and operate B.C.'s transportation system, will support improved operational performance on the Highway and, in doing so, will reduce traffic congestion within adjacent local road networks and provide improved access to the Highway. In this context, the Project is anticipated to have a positive effect on traffic conditions along the Highway 99 corridor and anticipated changes in traffic are not anticipated to change the compatibility between land use on the existing right-of-way and that in adjacent areas.

Noise: Land uses sensitive to changes in noise conditions are considered to be residences, hospitals, educational facilities, places of worship, libraries, museums, and passive recreational facilities (parks). As discussed in **Section 4.10 Atmospheric Noise**, mitigation measures will be implemented at select locations to address Project-related changes in noise levels during operation. With the application of mitigation, ambient noise levels during operation are expected to be lower than current levels—on average by 4 dBA at residences and 1.5 dBA at schools and places of worship. Noise levels at parks adjacent to the Project, including Deas Island Regional Park (discussed further below), are expected to increase by varying degrees dependent on the distance from the highway, but generally will remain below levels that warrant mitigation for residences, schools, and places of worship. With the implementation of mitigation identified in **Section 4.10 Atmospheric Noise**, land use within the existing right-of-way is anticipated to remain compatible with adjacent land uses.

Air Quality: Because the Project will result in improvements in air quality, this potential indirect effect is anticipated to improve compatibility and is therefore not considered further (**Section 4.9 Air Quality**).

Visual: Potential changes to viewscales were considered in **Section 5.5 Visual Quality**, at viewpoints considered sensitive to visual quality, by considering site-specific changes in visual quality class (VQC). Key conclusions of the assessment include:

- The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment.
- Replacement of interchanges also has the potential to change visual conditions at these locations.
- At distances greater than one kilometre, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers.
- Vegetated buffers will minimize visual effects to residential developments within close proximity to the bridge in Delta.

- Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.
- Changes are identified from several viewpoints in the vicinity of the new bridge (within 1 km); however for the majority of the viewpoints, the VQC rating does not change.

As such, Project-related changes in visual quality are not anticipated to result in changes in compatibility between land use on the existing right-of-way and that in adjacent areas. The influence of changes in viewsapes on recreational land uses in the vicinity of the new bridge is considered separately in **Potential Effect # 5 (Disturbance to Recreational Uses near the New Bridge)**.

Shadow: During operations, shadows will be cast by the new bridge deck, piers, and support towers over areas where the existing highway infrastructure does not create shadows. A study was conducted using a computer-based visual simulation program (AutoCAD) to illustrate the extent and location of shadows from the new bridge at different times of day during the winter and summer solstices (**Appendix A**). As shown on **Figures 1 and 2 of Appendix A**, the longer shadows during the winter solstice transit a slightly larger area compared to the areas shaded during summer solstice.

Land uses that are commonly considered sensitive to shadowing include useable outdoor spaces associated with residential, institutional, and commercial uses; recreational areas (discussed in **Potential Effect # 5 Disturbance to Recreational Uses near the New Bridge**); and, agricultural lands (discussed in **Section 5.4 Agricultural Use**). Within the Project alignment, the potentially sensitive land uses are primarily located in Delta. These uses include the existing residential area of Riverwoods, east of the Highway 99, and Captain's Cove Marina. The shadow effects on these areas during winter and summer solstice are further described below. The future residential development in Marina Garden Estates west of the Highway 99 ROW and River House Marina are not expected to experience shadow effects from the new bridge.

Computer simulations indicate that during the winter solstice (December 21), when the sun is lowest in the sky, residents of Riverwoods will experience some shading after 12 p.m. until dusk as the shadow of the new bridge deck transits their housing development. Up to nine units at a time will experience shading for a period of about two hours in the afternoon. This change in shading could result in temporary reduction in the amount of natural light and solar gain. During the summer solstice (June 21) shadows will be cast at 7 a.m. on two berths at the tip of the easternmost finger of the Captain's Cove Marina. This shading would last for less than two hours. The residents of units located on the western side of Riverwoods would experience some

shading after 7 p.m. until sunset as the bridge deck shadow moves across the complex. In the western marina, two berths would be shaded for a short time during the early morning in summer. Given the variability in individual responses to shading, the short periods of shading, and the relatively few number of residences and marina berths affected by shadows, this effect is considered negligible and is not carried forward in this assessment.

Reduced traffic congestion and improvements in local air quality associated with the Project will improve existing conditions and enhance compatibility between land use within the existing right-of-way and adjacent land uses. With the implementation of mitigation measures applicable to the operations phase, as referred to in the preceding section (i.e., traffic, noise, visual quality), the Project is considered compatible with existing and planned land uses and potential effects to land use compatibility are not carried forward.

Potential Effect #3: Change in the Area of Existing Land Uses

The Project will require the use of minor areas of additional land outside the existing Highway 99 ROW in Richmond and Delta. Based on the reference concept, a total of 716 m² of private land (non-agricultural) are required for the Project (**Table 5.3-11**). For the affected parcels, only small narrow lengths of land adjacent to the existing ROW would be needed. The area removed from agricultural use will be offset by surplus ROW being needed for productive farming and is considered in detail in **Section 5.4 Agricultural Use**. The potential effects of construction on biophysical values associated with existing ESAs are assessed in **Section 4.4 Fish and Fish Habitat** and **Section 4.8 Terrestrial Wildlife**.

Table 5.3-11 Portions of the Project Alignment not within the Highway 99 Right-of-Way

| Land Use | Area (m ²) | Description |
|--------------------------------|------------------------|---|
| Limited Mixed Use | 12 | North west corner Steveston interchange |
| Commercial | 32 | North east side of east Hwy 17A onramp |
| Environmentally Sensitive Area | 340 | North west side of River Road alignment |
| Commercial | 78 | Hwy 17A interchange, north of north east ramp |
| Industrial | 254 | Hwy 17A interchange, north of north east ramp |

The Ministry will acquire properties in accordance with Ministry policies and best practices that typically guide property acquisition. Once the properties have been acquired, no further changes in the area of existing land uses are anticipated. Therefore, this effect is not considered further in this assessment.

Potential Effect #4: Disturbance to Residential, Commercial and Industrial Land Uses

During the Project's construction phase, residential, commercial and industrial land uses in proximity to the Project alignment may experience adverse effects (e.g. delays in access, temporary access restrictions, construction noise). Potential disturbance effects to marine and agriculture uses are presented **Sections 5.2 Marine Use** and **5.4 Agricultural Use** respectively, and not addressed herein.

The construction phase includes preparing the sites, upgrading interchanges, widening the highway, constructing a new bridge, and decommissioning the Tunnel and Deas Slough Bridge. Portions of the Project alignment will be used temporarily as laydown areas for equipment and construction materials. To protect the safety of workers and the public and facilitate an efficient construction schedule, periodic changes or restrictions in access in and adjacent to the Project components will be required as construction proceeds.

Potential disturbance effects on land use during construction include those related to the Traffic, and Marine Use VC assessments and the Noise IC assessment. These temporary disturbances are summarized below:

- Traffic
 - Travel patterns may be temporarily affected, or travel speeds reduced for safety. Residential and mixed use areas adjacent to the Project alignment in Richmond and Delta, especially near the interchange upgrades and along the south shore of Deas Slough, may experience periodic delays due to traffic controls, including possible rerouting of traffic.
- Marine Use
 - Restricted access to shore-based facilities: New bridge construction over the Fraser River South Arm and Deas Slough, as well as decommissioning of the Tunnel and Deas Slough Bridge, could result in periodic temporary restrictions in access to marinas, wharves, and boat launches.

- Noise:
 - The Project is located in an area where existing noise levels are high and dominated by noise from traffic on Highway 99 and connecting roadways. Temporary construction related sound may affect noise-sensitive receptors. The change in noise levels will vary relative to the distance from the noise source and type and duration of construction activity. While ambient sound levels include traffic noise, it is likely the increase in noise due to construction will be perceptible at some receptors.

Potential Effect #5: Disturbance to Recreational Uses near the New Bridge

The recreational use experience in the Deas Island Regional Park and the Millennium Trail may be affected by Project-related construction and operation activities as summarized below.

Construction

- Traffic/Access
 - Restricted use of Millennium Trail: Pedestrian and cycling access to the Millennium Trail section that currently loops under the Deas Slough Bridge in Delta would be temporarily restricted during construction of the new bridge. Users would still be able to use sections of the trail on either side of the restricted area.
 - Restricted areas in Deas Island Regional Park: Recreational use of the Island Tip Trail, which passes through the Project alignment within Deas Island Regional Park, would be temporarily restricted during new bridge construction and Tunnel decommissioning. The main access to the park, parking areas, boat launch, beach area, and major trails would not be directly affected by construction.
- Marine Use: For recreational watercraft located in Deas Slough, temporary periods of restricted access may affect the operations of marinas and water-based recreation programs with shore-based facilities (e.g., rowing club based in Deas Island Regional Park).
- Noise: Noise levels have been assessed in **Section 4.10 Atmospheric Noise**. Daytime noise levels at locations within Deas Island Regional Park may increase due to bridge construction activity including intermittent pile driving activity. While park users may be acclimatized to existing noise conditions associated with vehicle traffic on Highway 99, the increases in baseline noise levels during construction are expected to be perceptible.
- Air Quality: potential incremental changes to air quality associated with highway construction are well understood, and implementation of mitigation measures described in **Section 5.3.4** are expected to minimize potential Project-related effects in air quality during Project construction, with no anticipated residual adverse effects.

In summary, during construction, access restrictions and noise are anticipated to temporarily adversely affect recreational activities in the vicinity of the replacement bridge.

Operation

During the operation phase, both potential beneficial and adverse effects of the new bridge and highway improvements are anticipated.

Potential benefits to the Deas Island Regional Park during operation include the following:

- **Land Use:** Access to the western end of the Deas Island Regional Park will be improved following decommissioning of the Tunnel. In addition, the useable area of the Ministry's ROW adjacent to the Park will be increased through the replacement of the Tunnel with the new bridge.
- **Vegetation:** On completion of construction, areas now required for the Tunnel will be revegetated in accordance with the Terrestrial Vegetation and Wildlife Management Plan (**Section 4.7 Vegetation**). Revegetation of such areas will use native species and the selection of species will take into account ecological conditions in adjacent areas with Deas Island Regional Park. In addition, the Ministry will engage with Metro Vancouver Parks and Delta Department of Parks, Recreation and Culture during design activities regarding the alignment of the reconnected Island Tip Trail and Millennium Trail. Shoreline areas will be restored, and contiguous.
- **Air Quality:** During the operational phase, no Project-related adverse residual air quality effects are anticipated as concluded in **Section 4.9 (Air Quality)**. The new bridge is anticipated to result in an improvement in air quality conditions due to eliminating congestion at the crossing and better dispersion from traffic moving over an elevated bridge rather than through the Tunnel. Such access improvements will also support ongoing use of the Park.

Potential adverse effects may result from shadows, noise, and visual disturbances as follows:

- **Shadow:** Computer simulations indicate that during the winter solstice (December 21), when the sun is lowest in the sky, a greater area of Deas Island Regional Park, to the east of the new bridge, will experience shading at some time throughout the day compared to summer solstice. The affected areas are mainly used for trails. Further, users of the Millennium Trail will experience some shading as they travel the trail corridor. During the summer solstice (June 21) when the sun is highest in the sky shadows will be cast on Deas Island Regional Park over an area where trails are located. From dawn to dusk, the shading will move from the west to the east over a distance slightly wider than the Project alignment. The Park's picnic areas and fields to the east of the new bridge will not experience shading. The Millennium Trail would experience the greatest amount of shading but because trail users are transient, they would experience the shading for a short period of time.

- **Noise:** **Section 4.10 Atmospheric Noise** considers potential changes in noise as a result of highway improvements, and forecast growth in traffic. Predicted changes in noise within Deas Island Regional Park range from a 4 dBA increase at its eastern end (approximately 1,200 m from Highway 99), to an approximate 10 dBA increase 350 m to the east and west of the Highway 99 centreline. This results in a predicted level of 50-57 dBA. While the Ministry's *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways* (Wakefield Acoustics Ltd. 2014) does not include quantitative noise parameters for passive parks, this noise level is below the thresholds for mitigation for other identified land uses. Current recreational users in the park and on trails may be acclimatized to the existing condition, but will likely initially notice the change in noise levels.
- **Visual:** **Section 5.5 Visual Quality** assessed potential visual effects of the bridge at viewpoints including those within the vicinity of the new bridge. The presence of the new bridge will add noticeable visual features to the landscape and result in changes in visual conditions at certain viewpoints. In Deas Island Regional Park, the visual quality classes change from "modification" to "maximum modification" for the viewpoint closest to the new bridge, and "retention" to "partial retention" at the east end of Deas Island Regional Park. Viewpoints adjacent to the southern end of the new bridge, including a Millennium Trail site, will change to "maximum modification". The Ministry will engage with the Corporation of Delta regarding potential vegetation buffers to be installed within 150 m on either side of the bridge alignment. In designing vegetation buffers at these locations, screening views of the new bridge will need to be balanced with the maintaining views of Deas Slough or the Fraser River and nearby mature vegetation. Potential residual visual effects are assessed as non-significant for the Project, noting that the findings are subjective because viewer perceptions and opinions vary.

In summary, during operation, changes in visual quality and noise are anticipated to have moderately adverse effects on recreational activities in the vicinity of the new bridge, some of which can be mitigated. Potential effects of shadow are not considered further, as it is anticipated that pedestrians and cyclists will be transiting the shaded trails in seconds or minutes and effects on the recreational experience are considered negligible. Countering disturbance affects noted above, the Project will also result in benefits to recreational land uses including those associated with increases in usable area for parkland, restoration of land and shoreline areas, and improvements in air quality.

5.3.3.4 Regional Growth Subcomponent

The regional growth subcomponent focuses on potential land use effects related to reducing existing congestion and improving access and mobility in the Project corridor. Given the temporary nature of construction activities, no effects on regional land use considerations are expected as a result of construction phase activities, and not carried forward further in the assessment. As such, the assessment of potential effects related to changes in the regional growth subcomponent focus on the operations phase of the Project.

The primary focus, with respect to potential Project related changes in regional land use, is potential effects on regional growth considerations associated with reductions in current congestion and improvements in access, mobility, mode choice and travel time reliability. The following section provides the assessment of potential effects on regional growth through a consideration of the two regional growth indicators.

Potential Effect # 6: Change in Regional Population Growth and Distribution

Reviews of recent transportation infrastructure projects in Metro Vancouver, including studies conducted by the Ministry (Site Economics, 2016) and TransLink (Coriolis, 2014), indicate that the Project is not likely to have a substantial effect on land use at the local or regional level because it does not provide new access to marketable and useable lands that were otherwise inaccessible. Rather, unlike new transportation infrastructure (i.e., new access), which can result in substantial changes in the distribution of population, improved highway access and highway connections encourage denser, land intensive, high quality forms of development within existing land uses.

Given the strong policy presence of Metro Vancouver's Urban Containment Boundary and the Provincial ALR, the opportunities for the Project to result in substantially different development from that considered in the RGS and OCPs of adjacent municipalities is extremely limited.

In anticipation of an improved crossing to address congestion at the George Massey Tunnel, TransLink retained Coriolis Consulting Corp. in 2014 to study the potential effects of the Project on changes in housing and population, and population serving employment forecasts to 2045. The study used regional RTM modelling to consider potential effects at a neighbourhood, or traffic zone, level. The modelling assumes a new bridge with four lanes in each direction (three general purpose lanes and one HOV/transit lane), a \$3 toll, and upgrades to major interchanges on Highway 99.

While the Project includes one additional lane in each direction (as well as additional provisions for improved transit, cycling and walking which were not modelled in the Coriolis study), it represents a similar improvement to access rather than new access. As such, the findings of the Coriolis study are considered relevant in the context of understanding the influence of the Project on the how predicted growth in population and employment would be accommodated in adjacent municipalities.

Modelling results from the Coriolis study indicate a small localized shift in population and employment growth as a result of the Project. An excerpt of the conclusions of this report follows:

- "The new bridge is not anticipated "to lead to a direct increase in the total regional rate of population or employment growth after completion, but it is an important component in sustaining the region's overall ability to access external markets and will help sustain the region's competitiveness."(Coriolis 2014, p.9)
- "South Delta and south Surrey will likely capture slightly higher shares of the total ground-oriented multi-family market (and therefore population growth) within the Project alignment, than in the absence of the new bridge. This will translate into slightly higher shares of population and population-serving employment (e.g., retail and service employment). There may also be a small shift in population growth from high-density nodes to south Delta and south Surrey. In the Coriolis 2014 scenario, about half of the projected shift in population growth from Richmond will locate in south Delta and about half will locate in south Surrey." (Coriolis 2014, p. 12)

TransLink independently verified the Coriolis study findings¹, noting only minor differences in modelled traffic volumes across the new bridge.

While some of the scope assumptions that Coriolis modelled are different relative to proposed Project, the Ministry's land use experts contend that the magnitude of these differences, such as 10 lanes instead of eight lanes, would be small and limited to a modest increase in the pace of development rather than a change in final population distribution (Site Economics 2016).

Local governments may choose to review/update their respective plans as required, to continue to accommodate higher density development within their Urban Containment Boundaries, as a part of the regular process of updating their OCPs; however, the overriding foundation of the Agricultural Land Reserve and the land use plan set out in Metro Vancouver's RGS (2015) would limit the effects that any such change might have. Because the Project is not anticipated to affect overall regional growth trends under the RGS or to substantially change the long-term population distribution, potential effects to regional population growth and distribution are not carried forward in the assessment.

¹ http://www.metrovancouver.org/boards/Transportation/Transportation_Committee-March_12_2014-Agenda-Revised.pdf

Potential Effect # 7: Change in Non-residential Land (Industrial and Commercial) Development and Distribution

The shortage of developable land in Metro Vancouver, to support non-residential (i.e., commercial and industrial) land use is well documented and a key focus of dialogue between all levels of government. Given awareness of the ongoing pressure for developable land to support regional economic development goals, regional and local governments indicated concerns that improved access, such as provided for the Project, could further increase demand for new sources of developable land resulting in encroachment into lands currently protected from development.

The Coriolis report (Coriolis 2014) concludes that the Project has the potential for a short term shift in the pace of light industrial development that occurs in Richmond, Delta and parts of south Surrey, but no overall effect on the total amount of light industrial employment, as noted in the following excerpt:

- “The George Massey Bridge and associated road network improvements could cause a shift in the pace of light industrial development that occurs in Richmond, Delta (e.g. Tilbury, Tsawwassen First Nation), and parts of South Surrey in the short term. We expect that these areas may develop at a slightly faster pace in the short term, with a corresponding decrease in the pace of development in South Burnaby and North Surrey. However, these areas (and the entire region) are likely to be constrained in terms of industrial land supply over the forecast period in any case, so by 2045 there is not likely to be a discernable difference in the total amount of light industrial employment in these locations” (Coriolis 2014, p. 10)”

Recognizing local and regional government’s concerns about potential land use changes as a result of the Project, the Ministry commissioned Site Economics Ltd. to review the influence of transportation infrastructure improvements on land use trends, including changes in availability of developable land, by considering recent local and international experience.

The study (Site Economics 2016) noted that most lands in Metro Vancouver are already developed, or in the process of being developed and that demand for real estate exceeds the limited supply of residential, commercial, industrial and agricultural land. Given the context that Metro Vancouver is considered a mature urban area, where demand exceeds supply, infrastructure development is recognized to follow growth, rather than to lead or shape it. As such, transportation projects that improve accessibility have a modest influence on the timing and nature of development forms and timing. Key findings from recent local projects are as follows:

- Alex Fraser Bridge (1986) – Many logistics and goods handling firms in Vancouver moved to Delta and Surrey and developed large tracts of land zoned for industrial use, while Vancouver re-developed to higher and better uses the sites vacated by these firms. Lands on the south side of the Alex Fraser Bridge experienced moderate and controlled change, which was almost always anticipated within the existing land use designations. The value of employment related land in Delta increased in response to development while the value of employment-related land in Vancouver also continued to grow. For both Delta and Vancouver, changes to employment-related land values focused on development areas that were already designated for development and did not entail changes to the existing land use designations or expansion of the developable land base. Almost 30 years later, today there remain intact areas of ALR near the Alex Fraser Bridge and along its corridor and land use designations have not notably changed.
- Golden Ears Bridge (2009) – Prior to the Golden Ears Bridge, Maple Ridge/Pitt Meadows land values had generally lagged behind the region due to lack of access. Following construction of the Golden Ears Bridge, the area has become an integral part of the region’s economy and vacant designated land values have increased by more than 10 per cent, moving closer to the regional average.
- South Fraser Perimeter Road (2013) – Denser, land intensive, high quality forms of industrial development are being seen throughout the Tilbury and Sunbury Industrial area of Delta in particular as well as along other industrial areas near or adjacent this new highway. While the pace and quality of industrial land use development has changed, this project has not led to substantial changes to land use designations.
- Port Mann/Highway 1 (2013) – This project has not substantially changed or expanded land areas designated for development.

Extrapolating the experience noted for other regional transportation improvement projects, to what would be anticipated as a result of the Project, Site Economics (Site Economics 2016, p2) concludes the following:

- “The influence of the Project on land use will be very moderate, primarily due to the lack of vacant developable land on both sides of the crossing, and the presence of strong and restrictive land use controls across the region.
- “Because the Project does not change Metro Vancouver’s Urban Containment Boundary, it can be reasonably anticipated that long-term development will focus on intensification of existing urban areas rather than expansion onto new land areas or ‘sprawl’.
- The only measurable influence of the Project is to add value and density to lands already designated for current and future development. There is no potential for the improved river crossing to change this or lead to the conversion of non-development land into development land.

- The potential for municipal governments to expand land areas for urban development is a separate local major policy decision beyond the scope of the proposed Project.
- Given the strength of existing land use policies such as the Agricultural Land Reserve, Metro Vancouver’s regional growth strategy and the Official Community Plans of Vancouver, Richmond, Delta, Surrey and White Rock, any significant changes in this regard are considered unlikely”

Given the severe lack of industrial land on both sides of the Fraser River, changes in development pressure on non-residential lands due to the improved access across the river is anticipated to be far less influential than already exists. As a result, the Project is not anticipated to substantially change current trends in industrial land use and development other than to encourage denser, land-intensive, high quality forms of industrial development and a faster absorption rate in both Delta and Richmond. This in term will support long-term economic growth that otherwise would have occurred outside of the region.

Because the potential effect of the Project to the use and development of commercial and industrial land is anticipated to be negligible, the potential effect is not carried forward in the assessment.

5.3.4 Mitigation Measures

This section describes the mitigation measures developed to avoid or reduce the potential adverse effects of the Project on land use, specifically, disturbance to adjacent land uses.

A hierarchical approach based on avoidance of potential effects first, followed by minimization or reduction of unavoidable effects was used in identifying strategies to mitigate potential Project-related effects on land use.

Measures to avoid potential adverse effects have been/will be incorporated into the Project considerations such as project design, and construction and operation procedures and practices. Where potential effects cannot be avoided through project considerations, standard mitigation measures, Best Management Practices (BMPs), and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels. These measures, described in general terms in the mitigation measures presented below, will be detailed in the Construction Traffic Management Plan (CTMP) and Marine Access Management Plan (MAMP) (**Section 12.0 Management Plans**), and are standard approaches used to address land use effects resulting from the construction and operation of transportation projects. The CTMP will follow the Ministry’s Traffic Management Guidelines for Work on Roads (B.C. MOTI 2001), Traffic Control

Manual (B.C. MOTI 1999), and Standard Traffic Signs and Pavement Markings Manual (Ministry 2000) for temporary lane markings. These mitigation measures are based on Ministry policies and practices and are known to be effective as they have been used in other transportation projects in the region, including the South Fraser Perimeter Road, the Port Mann/Highway 1 and Sea to Sky Highway Improvement projects. The assessment of the potential effects to the land use VC and subcomponents assumes that the mitigation measures proposed for components in the pathway of effects and complementary environmental and social effects assessment sections (**Sections 4.9 Air Quality, 4.10 Atmospheric Noise, 5.1 Traffic, 5.2 Marine Use, and 5.5 Visual Quality**) are implemented. The mitigation measures, described in these sections and summarized below, are considered effective measures to mitigate the indirect effects to land uses during construction and operation, and their implementation is assumed in the assessment of the residual effects in Section 5.3.5.

5.3.4.1 Avoidance

The Project has been designed to be largely within the existing Highway 99 ROW, thus avoiding displacement of nearby land uses where possible (potential effect # 2).

5.3.4.2 Minimization

Air Quality: Potential effects to land users from air quality will be minimized through the implementation of an Air Quality and Dust Control Management Plan, and the design and management of the Project to ensure optimum traffic flow conditions, in turn reducing congestion and emissions. Road dust during operation will be managed by cleaning the road where dirt, debris, sand, and gravel have accumulated at an appropriate frequency, in accordance with Ministry requirements for highway maintenance (B.C. MOTI 2010) (**Section 4.9.4**).

Noise: The potential effects from changes in atmospheric noise to sensitive receptors (and therefore sensitive land uses) will be minimized through the implementation of a Noise Management Plan in the Construction Environmental Management Plan (CEMP). The plan will describe equipment and activity restrictions to minimize noise, site specific schedules, best management practices to control construction noise, a noise monitoring program, and processes for community communication and consultation. Operational mitigation for sensitive receptors is proposed in accordance with the Ministry's *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways* (Wakefield Acoustics Ltd. 2014) (**Section 4.10.4**).

Vegetation: Potential effects to vegetation resources, relevant to park and protected area land uses, will be managed through environmental protection measures within the CEMP and the OEMP. The CEMP will include a Terrestrial Vegetation and Wildlife Management Plan, which will include invasive species management measures. Mitigation measures also include habitat enhancement for portions of a cattail marsh adjacent to River Road, and habitat offsetting in consultation with Aboriginal Groups through the creation of cattail marsh for those portions of lost marsh within the bridge footprint (**Section 4.7.4**).

Visual Quality: Potential effects to visual quality have been avoided or minimized through design considerations incorporated into the Project, and, where possible, the addition of vegetation buffers to screen views. In designing vegetation buffers at affected viewpoints in the vicinity of new bridge, the desire to screen views of the bridge will need to be balanced with the desire to maintain views of Deas Slough or the Fraser River and nearby mature vegetation. The Ministry will develop and share potential options for minimizing Project-related effects with stakeholders prior to finalizing the appropriate type and extent of vegetated buffers to be installed within 150 metres on either side of the bridge alignment (**Section 5.5.4**).

Traffic: A CTMP, as discussed in **Section 12.0 Management Plans**, will be developed and include a communications component. Richmond, Delta, and owners of property adjacent to the Project alignment, including Metro Vancouver, will be afforded opportunities to provide input regarding the timing and location of accesses, and options for pedestrians and cyclists along recreation trails. The CTMP will identify how information about construction activities, construction periods, and route options will be communicated to adjacent land users. Communication methods may include signage, a website, and a direct telephone line for information. Additional information on the CTMP is presented in **Section 5.1 Traffic**.

Development and implementation of a traffic management plan is a standard approach to minimize potential disturbance to other land uses, resulting from the construction of transportation projects. Specific mitigation measures to be implemented under the CTMP are based on Ministry policies and practices that are known to be effective in addressing potential traffic-related effects from other regional transportation projects.

Marine Use: A MAMP will be developed that includes a communications component, to manage access to marine uses along the Fraser River and Deas Slough. This plan will be part of the CEMP (**Section 12.0 Management Plans**). For a description of MAMP provisions, refer to **Section 5.2.4 Marine Use Mitigation Measures**.

Development and implementation of a marine access plan is a standard approach to minimize potential disturbance to other land uses, resulting from the construction of transportation projects in marine areas. Specific mitigation measures to be implemented under the MAMP are based on Ministry policies and practices that are known to be effective as they have been used to support other regional transportation projects.

Reconnect Recreational Trails

At the end of the construction phase, the Ministry will reconnect the Island Tip Trail, which passes through the Project alignment within Deas Island Regional Park, and would be disconnected during new bridge construction and Tunnel decommissioning. Also at the end of the construction phase, the Ministry will reconnect the Millennium Trail on the south shore of Deas Island slough within the Highway 99 ROW. The Ministry will engage with Metro Vancouver Parks and Delta Department of Parks, Recreation and Culture during final design and construction to confirm the alignment of the reconnected trails.

Reconnection of the existing recreation trails on completion of construction is considered an effective mitigation, in combination with mitigation measures for indirect effects presented in other sections, to minimize operational effects to recreational uses on Deas Island and the Millennium Trail.

5.3.5 Residual Effects and their Significance

After the successful implementation of mitigation measures, residual effects remain to disturbance to residential, commercial and industrial land uses during Project construction, and disturbance to recreational uses near the new bridge during Project construction and operations. These residual effects are characterized and assessed here following the methodology presented in **Section 3.0 Assessment Methodology**.

5.3.5.1 Characterization of Residual Effects

Residual effects are those that remain following implementation of the mitigation measures described in **Section 5.3.4**. Potential residual effects to land use considered further in this assessment include disturbance to other land uses.

The identified potential residual effects to land use are characterized with respect to direction, magnitude, extent, duration, frequency, reversibility, and likelihood. Definitions for ratings applied to residual effects criteria are presented in **Table 5.3-12**. A summary of criteria ratings for the potential residual effects on land use are provided for each residual effect.

Table 5.3-12 Criteria Used to Characterize Residual Effects on Land Use

| Criteria | Description | Definition of Rating | |
|-----------------------------------|--|----------------------|---|
| Direction | Overall nature of the residual effect | Adverse | Negative effect as a result of the Project |
| | | Positive | Beneficial effect as a result of the Project |
| | | Neutral | Neutral effect as a result of the Project |
| Magnitude (land use subcomponent) | Intensity of the effect relative to natural or baseline conditions | Negligible | No measurable change in land use |
| | | Low | A measurable change in land use, however, not readily distinguished from existing conditions |
| | | Moderate | A measurable change in land use, or within a land use designation, but which will not affect use in the remainder of the area |
| | | High | A measurable change in land use, or within a land use designation, which will affect use in the remainder of the area or cannot be accommodated elsewhere in the regional assessment area (RAA) |
| Extent | Geographic extent / distribution of the residual effect | Site | Effect is restricted to the immediate Project components |
| | | Local | Effect is restricted to the local assessment area |
| | | Regional | Effect is restricted to the RAA |
| Duration | Length of time over which the residual effect is expected to persist | Short term | Effect occurs during Project construction |
| | | Long term | Effect occurs for the operational life of the Project |
| | | Permanent | Effect occurs beyond the operational life of the Project |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|---|
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor affects the VC) | Rare | Effect occurs once |
| | | Uncommon | Effect occurs intermittently during Project construction or operation |
| | | Frequent | Effect occurs frequently during Project construction or operation |
| | | Continuous | Effect occurs continuously during Project construction or operation |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or after a period of time after the disturbance has ceased) | Reversible | Conditions will return to pre-Project state |
| | | Irreversible | Conditions will not return to pre-Project state |
| | | Change | Effect may fluctuate between positive and adverse for the duration of the disturbance |

Residual Effect #1: Disturbance to Residential, Commercial and Industrial Land Uses during construction

Changes in access during construction will be required to enable construction and assure safety. Even with implementation of the CTMP, construction activities in the Project alignment will likely result in some disturbance to adjacent land uses, primarily due to temporary changes in access. Implementation of a MAMP is expected to minimize potential effects on marine use as a result of temporary hindering of passage through, or use of, and access to a section of the Fraser River South Arm during Project construction (see **Section 5.3.6**). With the majority of the LAA used for agriculture or having low-density development, only a limited number of land uses will be directly affected by construction activities. Shore-based marina facilities in Deas Slough may require temporary changes in their activity schedules.

During construction, mitigation measures and best practices as discussed in **Section 4.10.4.1**, including equipment and activity restrictions, appropriate scheduling of construction activities, noise monitoring, and community communication, will be implemented to minimize potential Project-related effects on ambient noise conditions for sensitive receptors. However, frequent construction noise will be experienced in areas near active construction sites. The Magnitude of residual construction noise effects will vary from low to high, depending on receptor location relative to a construction site, and the nature of construction activity. The duration of residual noise effects will be short-term during construction of interchanges etc. and of moderate term during pile installation for the new bridge. During other construction activities, effects of lower magnitude will be experienced occasionally to frequently at receptor sites along the corridor for short durations. All construction-related effects on atmospheric noise will be temporary and fully reversible.

The magnitude of this residual effect is considered low because changes in land use are not readily distinguished from existing conditions or may be accommodated with minor changes in the timing of activities. Because the effects on other land uses would be experienced close to the areas of construction activities and during times of construction, the effects are considered local in extent, frequent in terms of timing, and short term in duration. The effects are reversible, being closely linked to the timing, extent, and location of construction activities.

The context for this Project is one of high resilience to change for the following reasons:

- Past improvements to highway infrastructure, including Highway 99 widening to accommodate a shoulder bus lane, construction of Highway 17, as well as ongoing municipal infrastructure servicing along roads, indicate proven capabilities to manage changes in transportation access during construction

- Development densities in the immediate vicinity of the Highway 99 corridor are generally low, except for the area around the Steveston Highway interchange and Bridgeport Road, reducing the number of affected land users

Existing land uses are expected to accommodate the proposed Project components and activities with only minor disturbances to the existing land uses at select locations. **Table 5.3-13** presents a summary of the criteria ratings for residual effect #1.

Table 5.3-13 Criteria Ratings for Residual Effect #1: Disturbance to Land Uses during Construction

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Construction activities in the Project alignment will result in some disturbance to adjacent land uses, primarily due to changes in access and construction noise. |
| Magnitude | Low | Changes in access can be accommodated with minor changes in timing of activities. The magnitude of construction noise is anticipated to vary with the location of the sensitive receptor. |
| Extent | Local | The effect would be experienced close to the areas of construction activities. |
| Duration | Short term | The effect would be experienced during Project construction. |
| Frequency | Frequent | The effect would be experienced during specific times of Project construction. |
| Reversibility | Reversible | Land use patterns will return to pre-Project state on completion of Project construction. |

Residual Effect #2: Disturbance to Recreational Uses near the new bridge during construction

The Proponent will engage with Metro Vancouver Regional Parks and Delta in developing access plans during the construction phase to minimize potential effects to access for recreational uses in Deas Island Regional Park and the Millennium Trail. Access to recreational uses will need to be temporarily restricted for periods of time to protect the safety of recreational users and workers and facilitate an efficient construction schedule. Access to the western portion of Deas Island Regional Park will be affected, but the main Park access, parking areas, boat launch, beach area, and major trails will remain available. Access to the Millennium Trail section that currently loops under the Deas Slough Bridge will be restricted while construction activities are in the area. Users will still be able to use sections of the trail on either side of the restricted area. These restrictions will likely affect a relatively small number of users for a short

period of time. Potential adverse residual effects are anticipated to be moderate in magnitude, local, short term, frequent and reversible. Deas Island Regional Park will continue to be available as an option for regional recreational users.

On completion of construction, areas now required for the Tunnel will be revegetated in accordance with the Terrestrial Vegetation and Wildlife Management Plan. Revegetation of such areas will use native species and the selection of species will take into account ecological conditions in adjacent areas with Deas Island Regional Park. In addition, the Ministry will engage with Metro Vancouver Parks and Delta Department of Parks, Recreation and Culture during design activities regarding the alignment of the reconnected Island Tip Trail and Millennium Trail. Shoreline areas will be restored.

During operation of the Project, potential adverse noise and visual residual effects to recreational uses in Deas Island Regional Park and portions of the Millennium Trail are anticipated to be moderate in magnitude, local, long term, and continuous. The extent to which the overall change to the recreational experience at Deas Island Regional Park is beneficial or adverse is subjective and will be perceived differently by different viewers.

The characterization of residual effects of disturbance to park and recreation areas in relation to land use is summarized in **Table 5.3-14** (during construction) and **Table 5.3-15** (during operation).

The context for this Project during operation is one of high resilience to change because the quality of the recreational experience currently encompasses the existing highway and tunnel, and the existing facilities will remain available in the long term.

Table 5.3-14 Criteria Ratings for Residual Effect #2: Disturbance to Recreational Land Uses near the new bridge during Construction

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Construction activities in the Project alignment will result in some disturbance to adjacent land uses, primarily due to changes in access and noise. |
| Magnitude | Moderate | Access to the majority of the affected recreational land uses will not be restricted. Access to the Millennium trail crossing at the Deas Slough bridge and the western end of Deas Island Regional Park will be temporarily restricted. Construction noise will be distinguishable from existing conditions. |
| Extent | Local | The effect will be experienced close to the areas of construction activities. |
| Duration | Short term | The effect will be experienced during Project construction. |
| Frequency | Frequent | The effect will be experienced during times of Project construction. |
| Reversibility | Reversible | Access routes will be reconnected on completion of construction. |

Table 5.3-15 Criteria Ratings for Residual Effect #2: Disturbance to Recreational Land Uses during Operation

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|--|
| Direction | Adverse | Noise, and visual effects. |
| Magnitude | Moderate | Visual and noise residual effects will be distinguishable from existing conditions. |
| Extent | Local | The effect will be experienced close to the areas of recreation activities. |
| Duration | Long term | The effect will be experienced during Project operation. |
| Frequency | Continuous | The effect will be continuous |
| Reversibility | Irreversible | Land use patterns will return to pre-Project state or be improved on completion of Project construction. Sound and visual residual effects will persist for the life of the Project. |

5.3.5.2 Likelihood of Residual Effects

The likelihood of residual effects occurring on land use is influenced by existing conditions, Project activities, potential effects, and the implementation of mitigation measures. Information on these factors is used to determine the likelihood of there being an adverse residual effect. The likelihood of a residual effect on land use occurring is characterized as:

- Low – Chance of the residual effect to occur is less than 25%.
- Moderate – Chance of the residual effect to occur is between 25% and 75%.
- High – Chance of the residual effect to occur is greater than 75%.

Table 5.3-16 summarizes the likelihood ratings of a residual effect on land use occurring and provides the rationale for the rating.

Table 5.3-16 Likelihood Rating of a Residual Effect on Land Use

| Residual Effect | Likelihood Rating | Rationale for Rating |
|---|-------------------|---|
| Disturbance to residential, commercial and industrial land uses | High | Construction activities in the Project alignment will result in some disturbance to adjacent land uses, primarily due to changes in access. |
| Disturbance to recreational land uses near the new bridge | High | Construction and operation activities will result in disturbance to recreational land uses. |

5.3.5.3 Proponent’s Determination of Significance

Significance Definition

Land uses within the Project alignment are primarily determined through local government plans and regulations, in recognition of federal and provincial policies and regulations. Land use regulations are assumed to be indicative of current societal goals, because plans and regulations are updated on a regular basis in consultation with governments, businesses, and residents. Therefore, the significance of residual effects is defined in relation to the existing regulatory context. For land use, a significant adverse residual effect is considered to occur where the proposed use of land for the Project and Project-related activities:

- Is not compatible with adjacent land use activities designated through a regulatory land use process
- Will create a change or disruption that widely restricts or degrades present land uses to a point where the activities cannot continue at current levels, and for which the environmental effects are not mitigated or compensated

A residual adverse effect is considered not significant if the change does not meet either or both of the above thresholds.

Significance Determination

The residual effects associated with Project construction in terms of disturbance to other land uses are determined to be not significant because the effects do not meet either of the thresholds defined above. The rationale for this determination is presented below.

Disturbance to residential, commercial and industrial land uses

Disruption to other land uses is limited in extent to uses adjacent to or within the Project alignment and does not result in restrictions throughout the Project alignment. The duration of effects will be linked to the construction schedule, resulting in short term disruptions during construction of various Project components. The effects will be reversible once construction is completed.

The magnitude of disturbance to other land uses will likely be low for a number of reasons. A small number of land-based users may have to use alternative access routes or plan their travel around road closures for short periods of time when construction is occurring nearby. Similarly, marine users in Deas Slough and Fraser River South Arm may experience changes in schedule for shore based and water access through these areas during the construction phase.

Disturbance to recreational uses near the new bridge

The majority of the recreation use areas in the vicinity of the decommissioned Tunnel and new bridge will continue to be available during construction, and full use will be returned during operation. Other recreation areas are available nearby, so trail users have the option of using available facilities or recreating elsewhere during the times that access is limited due to construction activities. Shore-based recreational facilities at Deas Island Regional Park with access to Deas Slough will be affected by the Project due to potential delays to egress/ingress when construction activities are occurring nearby. During operation, shadow, noise and visual residual effects will be perceptible, however are not anticipated to change the level of recreational activities.

The significance and likelihood of significant adverse residual effects to land use are presented in **Table 5.3-17**. The determination of the residual effects being not significant is considered likely because the mitigation measures have been used during construction of similar projects in the Metro Vancouver region over the past 15 years.

Table 5.3-17 Summary of Determination of Significance of Residual Effects for Land Use

| Residual Effect | Significance (significant/not significant) | Likelihood (low/moderate/high) |
|--|--|--------------------------------|
| Residual Effect #1: Disturbance to other land uses during construction | Not significant | High |
| Residual Effect #2: Disturbance to recreational uses during construction and operation | Not significant | High |

5.3.5.4 Confidence and Risk

Prediction of confidence was based on expert judgment and characterizes the level of uncertainty associated with both the significance and likelihood determinations. The level of confidence is based on scientific information, statistical analysis, professional judgment of the discipline expert, effectiveness of mitigation, and assumptions made.

Low, moderate, or high confidence reflects the level of uncertainty associated with determinations of likelihood and significance.

The level of confidence in the effects predictions, associated with both the significance determination and the likelihood, is high, based on the level of certainty associated with the significance and likelihood determinations.

Given the high confidence level in the effects prediction and the anticipated not significant residual effects, risk is determined to be low and risk analysis is not required (see **Section 3.9 Confidence and Risk**).

5.3.6 Cumulative Effects and their Significance

This section describes the assessment of potential total cumulative effects of the Project on land use. The combination of the residual Project effects with the effects of all other certain and reasonably foreseeable projects and activities that will be carried out comprise the total future cumulative effects. Because the existing conditions (**Section 5.3.2**) take into account the effects of other past and present projects, this cumulative effects assessment considers only certain and reasonably foreseeable future projects.

The assessed Project-related residual effects that have been excluded from the cumulative effects assessment, along with a rationale for their exclusion are listed in **Table 5.3-18**.

Table 5.3-18 Residual Effects Excluded from the Cumulative Effects Assessment

| Residual Effect | Rationale for Exclusion |
|---|--|
| Disturbance to other land uses during construction | Residual effects will be of low magnitude, short term, and reversible once construction is completed (Table 5.3-13), and are therefore considered not likely to interact cumulatively with other projects and activities. |
| Disturbance to recreational land uses during construction | Residual effects will be of low magnitude, short term, and reversible once construction is completed (Table 5.3-14) and are therefore considered not likely to interact cumulatively with other projects and activities. |

Disturbance to recreational land uses in the vicinity of the new bridge during operation is carried forward, as the residual effects are long term and continuous.

The effects of other projects and activities that have been carried out, as well as the effects of other projects and activities that will have been carried out prior to the Project’s construction, were considered in **Section 5.3.2**, and are therefore integrated into the Project residual effects described in the preceding section. Consequently, this section examines only the potential for interactions between the adverse residual effects of the Project and the incremental effects of other future projects and activities that are certain and reasonably foreseeable.

The transmission line that currently traverses Deas Island within the Ministry’s ROW will be relocated. The Ministry is liaising with BC Hydro regarding the location of the new line. However, it is anticipated that the transmission line will continue to be within the ROW on Deas Island, and therefore, is not considered to result in adverse residual effects on land that would interact cumulatively with the Project. The Marina Gardens residential development project, to the east of the highway alignment, will continue to support the Millennium Trail and provide other park facilities, and therefore is also not anticipated to interact adversely and cumulatively with the Project. No other projects or activities were identified that would interact cumulatively with the residual effects to recreational uses in Deas Park and vicinity during operation. A cumulative effects assessment is therefore not required.

5.3.7 Follow-up Strategy

For land use, follow up strategies that have been identified to support the assessment of other VCs and ICs will indirectly support follow up with respect to potential effects on land use. Strategies identified for other VCs and ICs that will support follow-up actions related to land use include:

Section 4.9 Air Quality: Air Quality and Dust Control Management Plan and BMPs as identified in **Section 4.9.4.2** will be developed and implemented to ensure potential construction-related effects on air quality are managed. Regular monitoring and analysis will be conducted during construction to confirm applicable air quality objectives are achieved.

Section 4.10 Noise: Once the Project is completed and traffic patterns have stabilized (no more than a year after completion), post-project, 24-hour noise monitoring will be carried out at selected, representative noise receiver locations. Such monitoring will serve to both confirm noise predictions and to assess the effectiveness of mitigation measures.

Section 5.1 Traffic: During construction, the TCMP will include traffic monitoring to ensure prescribed levels of service for travellers are maintained. Quality Control and auditing processes will be implemented to measure performance, ensure compliance, and identify any areas for improvement. The development and implementation of the CTMP will be supported by ongoing engagement with key stakeholders including Ministry Operations, the contractor, municipalities, schools, emergency responders, and special traffic generators and act as a follow up strategy for traffic related considerations during construction.

During operation, traffic monitoring for the Project will follow the same processes as other major highways in the Lower Mainland. In addition, specific monitoring of travel times, traffic incidents, transit, cycling and pedestrian usage, and goods movement surveys will be carried out to verify the Project performance objectives related to traffic.

Section 5.2 Marine Use: Project-related effects are anticipated to be limited to construction activities. During construction, monitoring will include assessment of the implementation and effectiveness of the mitigation applied, including compliance with the Notice of Works and the MAMP. The development and implementation of the MAMP will be supported by ongoing engagement with key stakeholders including the contractor, municipalities, marine users and Aboriginal Groups, and act as a follow up strategy for marine use related considerations during construction.

Section 5.5 Visual Quality: The mitigation proposed to address effects on visual quality focuses on the establishment of vegetation adjacent to the bridge abutments that are within the viewscape of nearby residential developments. As the establishment of vegetated buffers is a best management practice that has been applied effectively in similar projects, a follow up strategy is not proposed.

In addition to VC- and IC-specific follow-up strategies that relate to land use, and recognizing the interrelated potential effects related to recreational land use at Deas Island Regional Park, future stages of Project development will be supported by follow up with Metro Vancouver in order to address considerations such as: access across the highway right of way during construction, reconnecting shoreline trails on Deas Island, and habitat restoration associated with the existing right-of-way on Deas Island Regional Park following Tunnel decommissioning.

5.3.8 References

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APPENDIX A

Shadow Simulation Methods

Study Overview

Project-related changes will result in shadows where there are currently none. Shading can be important for some adjacent land uses because the users or occupants of land have expectations for direct sunlight and warmth from the sun. Such land uses are termed shadow-sensitive, because sunlight is important to function, physical comfort, and commerce. Land uses that are considered shadow-sensitive include residential, primarily outdoor or routinely used outdoor spaces associated with recreational (e.g., open parks), institutional (e.g., schools), or outdoor commercial (agriculture and outdoor dining). The study examined whether the shadow of the new bridge would cast on shadow sensitive land uses, where currently there are no infrastructure shadows. The study objective was to identify change in shadow cast on shadow-sensitive receptors relative to baseline conditions.

Shadow Study Area

The shadow study area is the maximum extent of the area that could be in shadow at some point due to operation of the new bridge. This area was defined from the shadow modeling outputs and is discussed in the section below on characterization of shadow.

Methods

Shadow analysis was completed for two periods of the year to understand the extent of shadow effects at times when users would be most affected. Shadows are cast in a clockwise direction from west/northwest to east/northeast from approximately 7:00 a.m. to 4:00 p.m. or later, depending on the time of the year. The shortest shadows are cast during the summer solstice (June 21), with shadows growing increasingly longer until the peak at winter solstice (December 21). For this assessment, the shadow cast by the new bridge was modelled at winter and summer solstice since these dates represent the full range of shadow lengths on sensitive land uses (e.g., residents, outdoor diners, and farmers).

AutoCAD was used to model the shadow cast at 9:00 a.m., 12:00 p.m., and 3:00 p.m. for winter solstice and at 7:00 a.m., 12:00 p.m., and 7:00 p.m. for summer solstice. The inputs to the model were a three-dimensional (3D) rendering of the new bridge deck, the date and time, and the spatial location of the bridge (longitude and latitude). The times for the model were selected based on the time of sunrise and sunset, and the times when people would be most affected by shadowing. The model also takes into account daylight savings. The spatial extent of shadow at those times was determined. This study is conservative, assuming no shading from other infrastructure or trees, and assuming no cloud cover – all of which would reduce the shadow effect of the new bridge.

Results

Characterization of Shadow

Areas of Delta and Richmond will experience changes in shadow from the new bridge. The shadow renderings are provided in **Figures 1** and **2**. A description of the areas influenced by shadow is presented in **Table 1**.

Table 1 Area Influenced by the Shadow of the New Bridge

| Time | General Description of Shadow | Area Influenced by Shadow | |
|----------------------------------|---|---|---|
| | | Delta | Richmond |
| June 21 (Summer Solstice) | | | |
| 7 a.m. | ≠ Shadow is cast west of the bridge | <ul style="list-style-type: none"> ≠ Cast over approximately 100 m of the Millennium Trail ≠ Cast over the two marina dock fingers furthest east at Captain's Cover Marina ≠ Cast over a small portion of the western end of Deas Island Regional Park | <ul style="list-style-type: none"> ≠ Cast over the mostly industrial area west of the bridge. This area appears to consist of light industrial and commercial activities, including a car dealership. ≠ Adjacent to the Fraser River, shadow is cast in an industrial area that appears to be used for BC Ferries maintenance activities. |
| 12 p.m. | ≠ Shadow is cast directly under the bridge deck | ≠ Cast directly under the bridge deck | ≠ Cast directly under the bridge deck |
| 7 p.m. | ≠ Shadow is cast east of the bridge | <ul style="list-style-type: none"> ≠ A small portion of the shadow is cast on the western edge of the Riverwoods at River Road housing development. ≠ Cast over the middle of Deas Island Regional Park | <ul style="list-style-type: none"> ≠ Cast over the agricultural area east of the bridge ≠ Adjacent to the Fraser River, shadow is cast over an industrial area. |

| Time | General Description of Shadow | Area Influenced by Shadow | |
|--------------------------------------|---|---|--|
| | | Delta | Richmond |
| December 21 (Winter Solstice) | | | |
| 9 a.m. | ≠ Majority of the shadow is cast directly under the bridge deck while the remainder is cast slightly west of the bridge | <ul style="list-style-type: none"> ≠ Cast over less than approximately 50 m of the Millennium Trail ≠ A small shadow is cast over the western end of Deas Island Regional Park. | ≠ A small shadow is cast over the mostly industrial area west of the bridge. This area appears to consist of light industrial and commercial activities, including a car dealership. |
| 12 p.m. | ≠ Shadow is cast east of the bridge | <ul style="list-style-type: none"> ≠ A small portion of the shadow is cast on the western edge of the Riverwoods at River Road housing development. ≠ Cast over the middle of Deas Island Regional Park | <ul style="list-style-type: none"> ≠ Cast over the agricultural area east of the bridge ≠ Adjacent to the Fraser River, shadow is cast on an industrial area east of the bridge. |
| 3 p.m. | ≠ Shadow is large and is cast east of the bridge | <ul style="list-style-type: none"> ≠ Cast over majority of the Riverwoods at River Road housing development ≠ Cast over the middle of Deas Island Regional Park | <ul style="list-style-type: none"> ≠ Shadow from the bridge deck and the piers is cast over the agricultural area east of the bridge. ≠ Adjacent to the Fraser River, shadow is cast on an industrial area east of the bridge. |



7:00am -7h UST



12:00pm -7h UST



7:00pm -7h UST

Legend

- ▲ Point of Interest
- Millennium Trail

SOURCES

Renderings captured by Hemmera 2014, created and designed by Binnie 2014.



GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT

SHADING ANALYSIS
JUNE 21 - UST -7h

Figure 2

02/01/2016



Path: C:\1217-299\289\077\03\mxd\Lighting_Visual\EA\Shadow_Analysis\Fig1-2_285_077_03_EA_Shading-June-Dec21_Base_160102.mxd



Legend

- ▲ Point of Interest
- Millennium Trail

SOURCES

Renderings captured by Hemmera 2014, created and designed by Binnie 2014.



GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT

SHADING ANALYSIS
DECEMBER 21 - UST -8h

Figure 1

02/01/2016

APPENDIX B

Overview of Potential Project Interactions with Land Use

Table 1 Overview of Potential Project Interactions with Land Use

| Project Phase / Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|---|--|
| Pre-Construction / Site Preparation | | | |
| Pre-construction / site preparation | No interaction | <ul style="list-style-type: none"> • Surveying | <p>Nature of interaction: No interaction anticipated.</p> <p>Rationale: Because the Project Area is within an existing highway corridor, it is considered consistent with plan designations</p> |
| | No effect | <ul style="list-style-type: none"> • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction | <p>Nature of interaction: Activities with the potential to cause temporary, short-term disturbance to adjacent land uses.</p> <p>Rationale: All potential disturbances to adjacent land uses can be effectively addressed through proven best practices informed by the Ministry’s experience with previous projects of comparable nature and magnitude.</p> |
| | Potential effect | <ul style="list-style-type: none"> • Acquiring property for the Project | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Changes to the compatibility of the Project alignment with adjacent land uses • Changes to the area of existing land uses |

| Project Phase / Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|---|---|
| Construction | | | |
| | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| New Bridge including approaches and ramp connections | Potential effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Installing retaining walls • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Installing piers adjacent to Deas Slough and Green Slough, including pile installation | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Disturbance to other land uses (e.g., recreation) due to changes in access and noise during Project construction. Effects will largely be experienced near the construction sites, which are phased over time. |

| Project Phase / Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|---------------------|---|---|
| Highway 99 improvements, including interchange upgrades | No interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Disturbance to other land uses due to changes in access during Project construction. Effects will largely be experienced near the construction sites, which are phased over time. |
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | N/A |
| | No effect | N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Disturbance to other land uses (e.g., recreation) due to changes in access and noise during Project construction. Effects will largely be experienced near the construction sites, which are phased over time. |

| Project Phase / Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---------------------------------------|---------------------|---|---|
| Decommissioning of Deas Slough Bridge | No Interaction | N/A | N/A |
| | No effect | N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> Removal of Deas Slough Bridge including substructures | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> Disturbance to other land uses (e.g., recreation) due to changes in access and noise during Project construction. Effects will largely be experienced near the construction sites, which are phased over time. |
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | <p>Nature of interaction: Activities with the potential to cause disturbance to other land uses</p> <p>Rationale: Disturbance to adjacent land uses is anticipated to be negligible because the Project is a modification of an existing highway corridor</p> |
| | Potential effect | N/A | N/A |

| Project Phase / Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---------------------------|---------------------|---|---|
| New Bridge | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: Activities with the potential to cause disturbance to other land uses</p> <p>Rationale: Disturbance to adjacent land uses is anticipated to be negligible because the Project is a modification of an existing highway corridor</p> |
| | Potential effect | <ul style="list-style-type: none"> • Operating the new bridge | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Shadowing of adjacent areas, visual and noise effects to recreational uses. • Improving trails within the Highway 99 corridor on Deas Island and along the Millennium Trail could result in moderate positive interactions. |

5.4 Agricultural Use Assessment Highlights:

- The Project has been designed to accommodate all proposed works predominantly within the Highway 99 ROW, minimizing the need for land acquisitions to the extent possible.
- The Ministry has identified suitable land parcels that will be made available for agricultural use to offset the acquisition of small portions of farmland for the Project. These parcels are located adjacent to existing farm fields and can be restored to comparable land capability, enhancing their agricultural potential.
- Project-related offsetting is expected to result in a net gain of up to 1.4 ha of land for agricultural use.
- The Project is expected to result in potential changes to the boundaries of a small number of farms. Potential effects associated with these changes will be mitigated through measures such as parcel consolidation and using elevated guideways to minimize land requirements.
- Agricultural operations along the Project alignment are expected to benefit from Project-related improvements to irrigation and drainage systems as well as increased reliability in getting agricultural goods to market.
- No significant Project-related residual or cumulative effects on agricultural use are expected.

5.4 Agricultural Use

5.4.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on agricultural use in terms of Project setting, and defines the spatial, temporal, administrative and technical assessment boundaries. The rationale for selecting the assessment boundaries is also provided.

5.4.1.1 Assessment Context

Agricultural use in this assessment encompasses both on-farm activities and activities carried out by the agricultural sector to support on-farm activities. On-farm activities include but are not limited to; soil cultivation and management, nutrient management, irrigation, drainage, crop production, livestock production, and farm-gate sales of products. Off-farm activities considered in the assessment include but are not limited to; travel between farm parcels (many farm owners farm on multiple properties), transportation of inputs (e.g., fertilizer, fuel) and supplies to farms, and transportation of products to market.

Agricultural use is important to the Lower Mainland and Metro Vancouver for economic, historical, cultural, and ecological reasons. Farming has occurred in the vicinity of the Project since the 1860s, and continues to be an important economic activity that is also part of the cultural identity of the region. Agricultural land provides the base for food security, which will grow in importance as world populations increase and climates change. Agricultural land also provides a number of ecological and socio-community services including wildlife habitat (especially in winter), nutrient and organic matter recycling, carbon sequestration, aesthetics (green space), and flood management.

5.4.1.2 Methodology

The assessment of agricultural use follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Building on this approach; the assessment of agricultural use was designed to focus on specific aspects or features considered most appropriate in the context of existing conditions in the Project area. In this context, the assessment of agricultural use focuses on three sub-components as presented in **Table 5.4-1**.

Table 5.4-1 Sub-components of Agricultural Use

| Sub-component | Representative of: | Rationale for Selection |
|---|--|--|
| Land in Agricultural Land Reserve (ALR) | Agricultural capability in local communities and the region | Land in the ALR provides the base for food production and future food security. It also provides wildlife habitat in winter and has aesthetic value (e.g., as green space). |
| Irrigation and drainage | Public (municipal) and private (farm) infrastructure that makes farming viable | Agricultural operations throughout the local assessment area depend on drainage systems in autumn, winter, and spring to manage soil wetness, but may require irrigation during the growing season to compensate for soil moisture deficits. Most farms are not economically viable without these systems. |
| Farm infrastructure and operations | Farm-specific infrastructure, crop, and animal production | Individual farms must be viable for the overall agricultural land base to meet local, regional, and provincial needs. |

The change in ALR land by capability class, change in irrigation and drainage systems, and change in farm infrastructure and operations were used as indicators to assess trends of agricultural use within the assessment area and to evaluate potential Project-related effects. **Table 5.4-2** presents the indicators chosen for the assessment of Project-related effects on the three agricultural use sub-components, and the rationale for their selection.

Table 5.4-2 Indicators for Assessment of Agricultural Use Sub-components

| Sub-Component | Indicator | Rationale for Selection |
|------------------------------------|---|--|
| Land in ALR | Change in ALR land by capability class | Loss of local and regional agricultural capability may reduce the land base available for agricultural production. |
| Irrigation and drainage | Change in irrigation and drainage systems | Impairment of municipal agricultural drainage infrastructure and changes to irrigation water quality or quantity may impact agricultural production in the local communities. |
| Farm infrastructure and operations | Change in farm operations | Changes to individual farm operations (such as loss of land, parcel fragmentation, boundary adjustments, on-farm drainage systems, or utilities), access, and travel times may influence the economic viability of a few specific farms. |

During pre-Application consultation on the Project, information on plant harvesting in and around the Project area by Aboriginal Groups, including the types of plants harvested and key harvesting locations, was communicated to the Ministry. However, there were no comments that related specifically to commercial agriculture. Most agricultural activity in the LAA occurs on privately-owned lands, including farm land owned by the Tsawwassen First Nation who has developed an agricultural plan to manage farming activity on their lands (Zbeetnoff 2013). This agricultural use assessment includes consideration of the potential for effects (direct and indirect) on those lands. Potential influence of the Project on traditional harvesting or gathering of plants and associated effects on Aboriginal Groups are discussed in **Chapter 10 Aboriginal Consultation** of this Application.

5.4.1.3 Assessment Boundaries

Spatial, temporal, administrative, and technical boundaries identified for the assessment of Project-related effects on agricultural use, and the rationale for selecting them are discussed below.

5.4.1.3.1 Spatial Boundaries

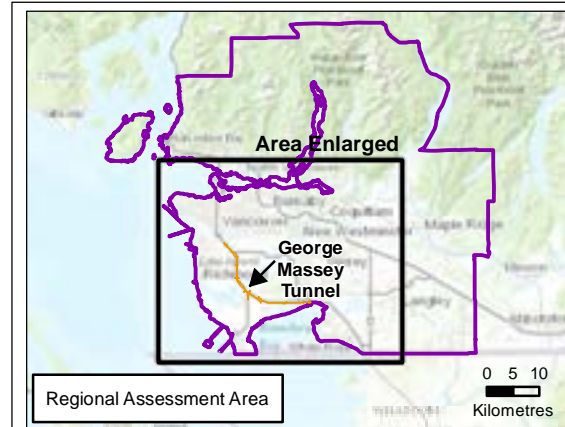
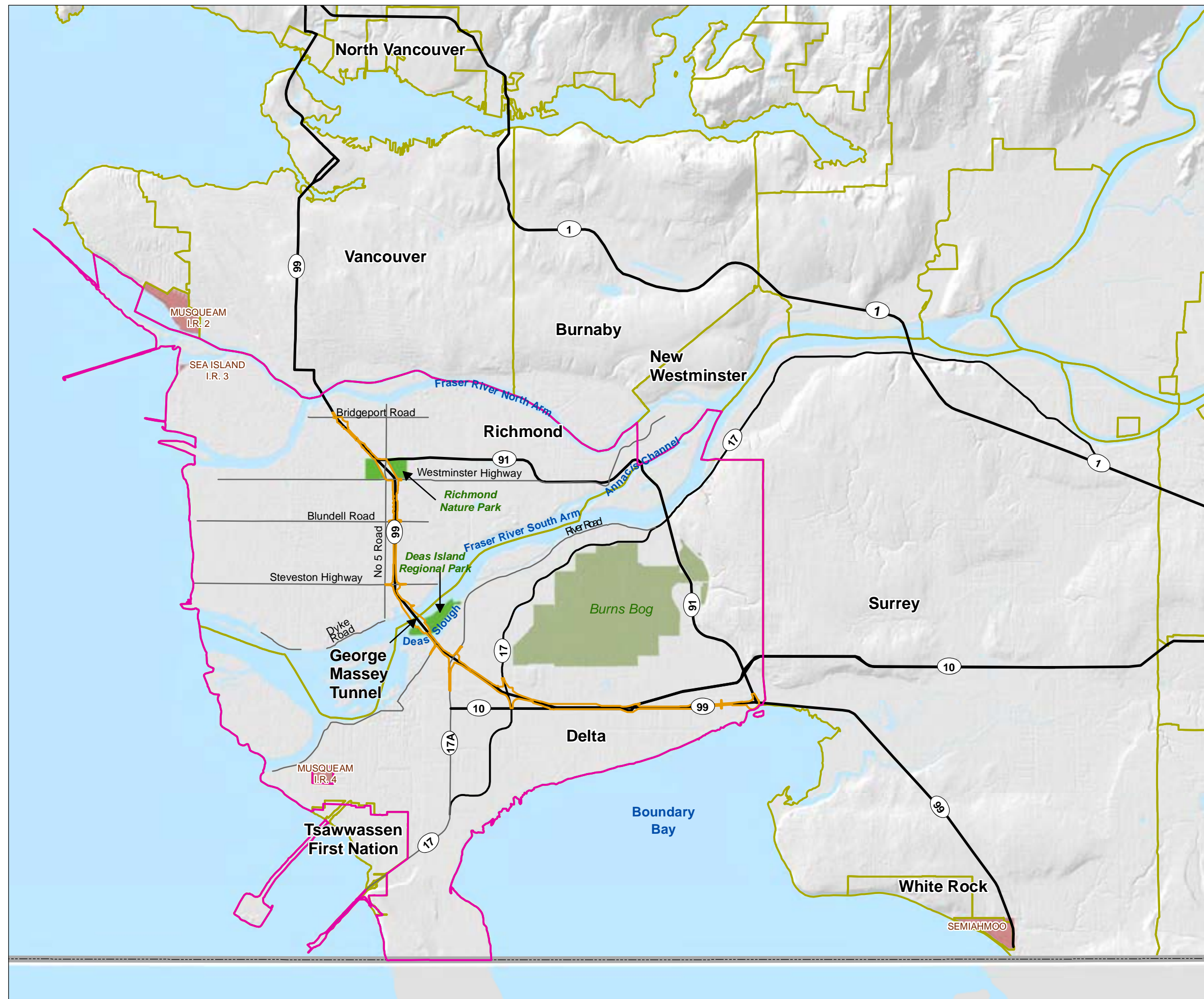
The local assessment area (LAA) and regional assessment area (RAA) are defined in **Table 5.4-3** and shown on **Figure 5.4-1**. Boundaries of the assessment area take into account the scale and spatial extent of potential environmental effects that are appropriate for the three sub-components.

Table 5.4-3 Spatial Boundary Definitions for Agricultural Use

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local Assessment Area (LAA) | The boundaries of the City of Richmond (Richmond), Corporation of Delta (Delta), and the City of Surrey (Surrey) |
| Regional Assessment Area (RAA) | The boundary of Metro Vancouver |

The LAA was established to encompass the area within which the Project is expected to interact with, and potentially have an effect on, agricultural use. To consider the maximum extent of potential indirect interactions, the LAA includes the municipalities described in **Table 5.4-3** above. In determining LAA boundaries, consideration was given to the nature and characteristics of agricultural use, its potential exposure to various influences, and the maximum extent of potential Project-related influence on agricultural use. The LAA was defined as those municipalities that could be influenced directly (i.e., through overlap with Project components) or indirectly (i.e., through potential effects on drainage/irrigation and transportation) by the Project. The Project is located within the municipal boundaries of Richmond and Delta, and has the potential to affect agricultural use in these municipalities both directly and indirectly. Given that all Project components are located outside of its municipal boundaries, no direct Project-related effects on agricultural use are expected in Surrey. The potential for the Project to influence agricultural use in Surrey indirectly through changes in transportation or irrigation/drainage was considered, and it was determined that, given the extent of the Project alignment relative to municipal boundaries, such influences would be negligible. Surrey is therefore discussed in the regional context in this assessment.

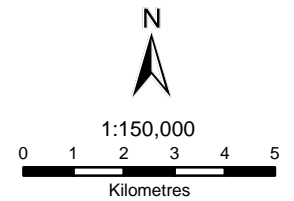
The RAA was established to provide a regional context for the assessment of Project effects, and is consistent with the planning boundaries for the Regional Food System Strategy (Metro Vancouver 2011) which establishes the framework for agricultural land use planning in the region. An agricultural “footprint” was identified that consists of ALR land within the portion of the Project alignment that extends beyond the boundaries of the existing Highway 99 right-of-way (ROW). This area with direct effects on agricultural land consists of narrow segments of land along Highway 99 between Blundell Road and Steveston Highway, and Deas Slough and Highway 17 (see **Figure 5.4-1** and **Appendix A, Figures 1a – 1aa**).



- Legend**
- Agricultural Use Local Assessment Area
 - Agricultural Use Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AGRICULTURAL USE LOCAL AND REGIONAL ASSESSMENT AREAS | |
| Figure 5.4-1 | 18/05/2016 |
| | |

5.4.1.3.2 Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on agricultural use were established based on the potential for each phase of the Project to interact with and have an effect on agricultural use. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect agricultural use present within the Project alignment; therefore, the following temporal boundaries were defined for the agricultural use assessment:

- Existing conditions
- Project construction (including Tunnel decommissioning)
- Project operation (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of Proposed Project**. Specific temporal considerations for the assessment of agricultural use and its sub-components (e.g., planting and harvest seasons; land, water and nutrient management in winter) are discussed in the context of Project interactions and potential effects in **Section 5.4.3 Potential Effects**.

5.4.1.3.3 Administrative Boundaries

The boundaries of both the LAA and the RAA are defined by municipal/regional administrative boundaries because those boundaries provide the planning and socio-economic contexts for the effects assessment. The LAA is defined by the boundaries of municipalities that could potentially be affected by the Project. The RAA is defined by the boundaries of Metro Vancouver.

5.4.1.3.4 Technical Boundaries

Technical boundaries refer to the constraints imposed on an environmental assessment by limitations in the ability to predict the effects of a project. There are no technical boundaries directly applicable to the assessment of agricultural use as a VC. However, some aspects of the agricultural use assessment rely on technical work completed for other VCs; specifically the modelling used to predict changes in the Fraser River salt wedge, ambient noise conditions, and air quality.

5.4.1.3.5 Trends in Agricultural Land Use

Recent and projected future population growth and economic development in the Lower Mainland suggest a potential trend of continuing pressure on the ALR within the RAA. In recent years, projects such as the South Fraser Perimeter Road (SFPR) and the exclusion of former ALR lands related to the Tsawwassen First Nation Lands, as defined by the *Tsawwassen First Nation Final Agreement* (2007), lands have contributed to the loss of agricultural land, particularly in Delta. In the case of the SFPR, the effects were offset in part through substantive improvements to the drainage and irrigation systems in Delta (i.e., the Delta Irrigation Enhancement Project). Local governments in the LAA and RAA remain committed to agricultural land preservation and support for farming.

There is also a trend among consumers towards improved understanding of the value of agricultural land for food production and for a range of other benefits such as green space, aesthetics, wildlife habitat, local employment, stormwater retention, and greenhouse gas (CO₂) uptake. The 2013-2016 drought in California, combined with the recent change in value of the Canadian dollar compared to the U.S. dollar, has contributed to this increase in awareness of the importance of local agriculture and its role in food security.

5.4.2 Existing Conditions

This section provides an overview of the methodology used in collecting baseline data, and describes the existing conditions of agricultural use within the assessment area. An overview of the regulatory context that is relevant to agricultural use is also provided.

5.4.2.1 Baseline Data Collection

In 2014, the Ministry initiated studies on agricultural use to support Project planning and assessment. Building on available information, these studies were designed to address known data gaps, as summarized in **Table 5.4-4**.

Table 5.4-4 Agricultural Use Desktop and Field Studies

| Study Name | Purpose of Study |
|-------------------------------------|---|
| Desktop Review | <ul style="list-style-type: none"> • Provide the agricultural context and baseline conditions within the study areas through a review of existing background information including reports, maps, aerial photographs, and data files. |
| Preliminary Stakeholder Meetings | <ul style="list-style-type: none"> • Meet with stakeholders to discuss potential effects of the Project at a local and regional scale, and understand community concerns. |
| Mapping and Spatial Analysis | <ul style="list-style-type: none"> • Overlay Project components with ALR boundary maps to determine the potential direct effects on individual farm properties and operations. |
| Field Studies and Farmer Interviews | <ul style="list-style-type: none"> • Gain an understanding of land use and the transportation network in the LAA and RAA. • Assess potential direct and indirect effects of the Project on individual farm operations and fields. Site visits focused on farm fields with the potential for direct Project-related effects. |

These studies are described in further detail below.

5.4.2.1.1 Desktop Review

To initiate the agricultural use assessment, existing background information relevant to the Project was assembled and reviewed from sources including the following:

- Orthophoto and topographic maps
- Published soil maps and reports
- Agricultural land and climate capability maps
- ALR boundary maps
- Agricultural area plans and Official Community Plans (OCP) for Richmond and Delta
- Drainage and irrigation studies
- Agricultural commodity profiles
- Agricultural Census of Canada statistics

5.4.2.1.2 Preliminary Stakeholder Meetings

To augment the information review, stakeholder meetings were held to review the Project and discuss potential effects of the Project at a local and regional scale. These included meetings between the Ministry and representatives of the B.C. Ministry of Agriculture, the B.C. Agricultural Land Commission (ALC), the Richmond and Delta Farmers' Institutes, and municipalities of Richmond and Delta.

During preliminary meetings, members of the Farmers' Institutes outlined current challenges related to agricultural infrastructure in the region and posed general questions about the Project, based on the high-level design concepts available at the time. These preliminary meetings were followed by field visits and interviews with a number of farm owners or operators to verify existing soils and agricultural capability/use information and to gain a better understanding of potential Project-related effects on individual farm properties.

5.4.2.1.3 Mapping and Spatial Analysis

The ALR parcels along the Highway 99 corridor that could potentially be directly or permanently affected, or both, were identified by overlaying the ALR boundaries and the Project components on an orthophoto base with cadastral (legal property boundary) information. The Project components included the road prism out to the edge of fill slopes (as indicated by the orange-shaded areas in the maps included in **Appendix A**). The map was also overlain with existing soils and agricultural capability and use information. This mapping was used to help determine potential direct Project-related effects on individual farm properties and operations.

5.4.2.1.4 Field Studies and Farmer Interviews

A preliminary field survey was conducted along the Highway 99 corridor to verify land use in the context of the LAA and RAA. More detailed field assessments and owner/operator interviews were conducted in areas with potential for direct footprint effects.

5.4.2.1.5 Quality and Reliability of Information on Existing Conditions

Most of the published information used for the agricultural use assessment is of sufficient quality to enable the evaluation of potential adverse effects on the first two sub-components – land in the ALR, and drainage and irrigation. The LAA is located in one of the most important agricultural regions in B.C. and, as a result, there is a robust database of information on soils, crops, and water management within this area. For the assessment of effects on specific farm operations, the level of reliability is good for the majority of farm parcels where effects are limited to small adjustments in the Highway 99 ROW. For parcels where the potential effects are

more complex, the reliability is good in the cases where visits to the site with the farm owner or operator were possible and somewhat less reliable where the evaluation was based on site reconnaissance only.

5.4.2.2 Regulatory Context

Responsibility for agriculture in Canada is shared by the federal and provincial governments, and there is a high level of inter-governmental cooperation. The federal government regulates agricultural imports and exports, carries out research, and supports a number of federal-provincial programs, but does not regulate land use. The B.C. government regulates many of the individual producer sectors in the province, and is responsible for land use through the B.C. ALC, an independent provincial agency. Local governments have a role in agricultural use through zoning and other planning tools. Regulation and management of agricultural use in the region surrounding the Project Area occurs primarily through the following provincial legislation:

- *Agricultural Land Commission Act*, SBC 2002, c. 36
- Agricultural Land Reserve Use, Subdivision and Procedure Regulation, B.C. Reg. 171/2002
- *Agricultural Land Commission Amendment Act*, 2014, Bill 24 – 2014
- *Farm Practices Protection (Right to Farm) Act*, R.S.B.C. 1996, c. 131
- *Environmental Management Act*, S.B.C. 2003 c. 53 Agricultural Waste Control Regulation B.C. Reg. 131/92 (including January 2015 amendments)

The *Agricultural Land Commission Act* sets the legislative framework for the establishment and administration of the agricultural land preservation program. This legislation takes precedence over but does not replace other legislation and bylaws that may apply to the land. The ALR is provincially designated land on which agriculture is recognized as the priority use and is encouraged, and on which other land uses are controlled (ALC 2004). The ALR is administered in favour of agriculture by the ALC. The *Agricultural Land Commission Act*, its 2014 amendment, and Regulation 171/2002 specify the regulatory requirements that will need to be satisfied for the Project to move forward. Specifically, authorization from the ALC must be obtained for the following transportation, utility, or recreational works within the ALR:

- Widening of an existing road ROW
- Construction of a road within an existing ROW
- Dedication of a ROW or construction of any of the following:
 - A new or existing road or railway
 - A new or existing recreational trail

- A utility corridor use
- A sewer or water line other than for ancillary utility connections
- A forest service road under the *Forest Act*, RSBC 1996, c. 157
- The new use of an existing ROW for a recreational trail

Local and regional governments, as well as other provincial agencies, are expected to plan in accordance with the provincial policy of preserving agricultural land. In general, the policies and bylaws of the two municipalities in which the Project is located (Richmond and Delta), and Metro Vancouver support and promote agricultural use in the ALR. The ALC obtains the comments and recommendations of local governments for all applications for transportation use in the ALR.

The *Farm Practices Protection Act* (FPPA) provides protection of normal farm practices from nuisance suits (e.g., related to noise from air canons or bird detractor and odour from dairy farms). It only applies to land within the ALR. The FPPA is not expected to be relevant to the Project as nuisance suits are normally confined to the rural/residential interface.

The *Agricultural Waste Control Regulation* (AWCR) describes environmentally sound practices for using, storing and managing wastes, such as manure, and by-products (composted materials) or other materials used in agriculture (wood waste). The AWCR is not relevant to the Project as there are no dairy, swine or poultry producers, or compost facilities that will be directly impacted by the Project

5.4.2.3 Existing Conditions

This section describes the existing conditions of agricultural use, as well as the surrounding environment and factors influencing agricultural use, organized according to the three sub-components identified in **Table 5.4-1**. The biophysical conditions (i.e., soils and agricultural capability) are described only for the areas overlapping the Project components, since the Project will not affect the biophysical conditions of the LAA or RAA outside of these limits. The existing socio-economic conditions are described for the LAA and RAA. The Highway 99 corridor through the RAA is bordered on one, or both sides, by the ALR along 26.6 km, or 66% of its 40-km length.

5.4.2.3.1 Land in ALR

Land Areas currently in the ALR

Based on the BC Ministry of Agriculture’s (2014) land use inventory, there were 4,756 ha of land in the ALR within the City of Richmond as of 2011. Of this, 2,797 ha (59%) was being farmed, 1,032 ha (22%) was anthropogenic/not farmed, and 927 ha (19%) was in a natural or semi-natural state. Within Delta, 6,691 ha (76%) of the ALR was farmed out of a total of 8,843 ha, with 996 ha (11%) anthropogenic/not farmed and 1,155 ha (13%) natural or semi-natural. A further 164 ha of ALR was on Tsawwassen First Nation lands. Since 2011 there have been relatively few inclusions or exclusions of ALR land in the LAA. The 2011-2012 to 2014-2015 annual reports produced by the ALC indicate a net increase of 63 ha to the ALR in the South Coast Region¹ over that time period (ALC 2016).

Soils

Although a variety of soil types exist in the Project footprint, the surficial materials are primarily medium-textured deltaic deposits with poor drainage and saline phases (**Table 5.4-5**; Luttmending 1981). Deltaic sediments have been deposited by the Fraser River since the end of the Fraser Glaciation (about 10,500 years before present), after sea levels stabilized at near their current levels (Luttmending 1981). The most common soils along the Richmond section of the Project alignment are Richmond, Delta, Westham, and Crescent soil. In the Delta section of the Project alignment, the most common soils are the Westham and Crescent soil series. Spetifore, Blundell, and Tsawwassen soils also occupy small areas of the footprint (indicated by purple polygons in **Appendix A, Maps A1 to A13**). Soil types in the Project footprint are described in **Table 5.4-5**; the corresponding Soil Management Groups (outlining agricultural limitations, required inputs, and suitable crops of the soil types) are described in **Table 5.4-6**.

¹ The South Coast Region includes Metro Vancouver plus the Sunshine Coast, Fraser Valley, and part of the Squamish-Lillooet Regional Districts.

Table 5.4-5 Soil Types in the Project Footprint and Adjacent Areas

| Soil Name and Map Symbol | Soil Parent Material | Drainage | Classification Code * | Soil Management Group ** |
|--------------------------|---|---|-----------------------|--------------------------|
| Blundell Soils (BU) | medium-texture deltaic deposits | poorly drained; very high water table | R.Gs | Blundell |
| Crescent (CT) | medium-texture deltaic deposits | mod. poor or imperfect; high water table | O.G | Crescent |
| Delta (DT) | medium-texture deltaic deposits | very poor; high water table | O. HG | Delta |
| Richmond (RC) | >160 cm of partially decomposed org matter | very poor; very high water table | T. H | Lumbum |
| Spetifore Soil (SF) | saline deltaic deposits >1m on sand | poor to very poor; water table at or near surface | R. HGs | Spetifore |
| Tsawwassen (TS) | coarse textured (sandy) Fraser River deposits | well to mod. well; medium water table | O.G. | Grevell |
| Westham (WS) | medium-texture deltaic deposits | poor; high water table | R. HG | Delta |

Codes: R.Gs Rego Gleysol (saline phase) O.G. Orthic Gleysol; O.HGs Orthic Humic Gleysol (saline phase); T.H Typic Humisol; R.HGs Rego Humic Gleysol (saline phase); O.R Orthic Humisol; R.HG Rego Humic Gleysol.

**See Table 5.4-6 for information on management practices and suitable crops for these groups.

Sources: Luttmerding (1984) and Bertrand et al. (1991)

Table 5.4-6 Soil Limitations for Agriculture and Typical Management for Soil Management Groups in Project Footprint

| Soil Management Group | Dominant Limitations | Typical Land Inputs and Management Practices | Well-suited and Suited Crops | Unsuited Crops |
|-----------------------|---|--|---|---|
| Blundell | <ul style="list-style-type: none"> • Poor drainage • Low pH | <ul style="list-style-type: none"> • Drainage system • Ditches and underdrains • Sub-soiling • Liming and fertilization • Cover crops | <ul style="list-style-type: none"> • Annual legumes • Blueberries • Cereals • Cole crops • Corn • Perennial forage crops • Root crops (except carrots) • Shallow-rooted annual vegetables | <ul style="list-style-type: none"> • Nursery and Christmas trees • Raspberries • Strawberries • Tree fruits • Celery and carrots |
| Crescent | <ul style="list-style-type: none"> • Poor drainage • Low levels of natural organic matter | <ul style="list-style-type: none"> • Appropriate cultivation to prevent structural degradation • Ditches and underdrains • Periodic sub-soiling | <ul style="list-style-type: none"> • Annual legumes • Blueberries • Cole crops • Corn • Perennial forage crops • Root crops (except carrots) • Shallow-rooted annual vegetables (except celery) | <ul style="list-style-type: none"> • Nursery and Christmas trees • Tree fruits • Celery and carrots |

| Soil Management Group | Dominant Limitations | Typical Land Inputs and Management Practices | Well-suited and Suited Crops | Unsuited Crops |
|-----------------------|---|---|---|--|
| Delta | <ul style="list-style-type: none"> • Poor drainage • Salinity | <ul style="list-style-type: none"> • Drainage system • Sub-soiling and irrigation to flush salts • Organic matter additions • Cover crops | <ul style="list-style-type: none"> • Annual legumes • Blueberries • Cereals • Cole crops • Corn • Perennial forage crops • Root crops (except carrots) • Shallow-rooted annual vegetables (except celery) • Strawberries | <ul style="list-style-type: none"> • Carrots • Celery • Nursery and Christmas trees • Raspberries • Tree fruits |
| Lumbum | <ul style="list-style-type: none"> • Poor drainage • Natural low fertility and acidity • Low-bulk density • Loss of organic matter when drained • Restricted root zone | <ul style="list-style-type: none"> • Drainage systems • Cover crops to control wind erosion • Fertilization winter flooding to limit organic matter loss • High flotation tires on farm equipment | <ul style="list-style-type: none"> • Annual legumes • Blueberries • Cereals • Cole crops • Corn • Perennial forage crops • Root crops • Shallow-rooted annual vegetables | <ul style="list-style-type: none"> • Nursery and Christmas trees • Raspberries • Strawberries • Tree fruits |

| Soil Management Group | Dominant Limitations | Typical Land Inputs and Management Practices | Well-suited and Suited Crops | Unsuited Crops |
|-----------------------|--|--|---|---|
| Grevell | <ul style="list-style-type: none"> • Low water-holding capacity • Low nutrient supply • Prone to flooding by Fraser River | <ul style="list-style-type: none"> • Irrigation required in short intervals to prevent drought • Organic matter additions | <ul style="list-style-type: none"> • Annual legumes • Blueberries • Cereals • Cole crops • Corn • Christmas trees • Perennial forage crops • Raspberries • Rooted crops • Shallow-rooted annual vegetables • Strawberries • Tree fruits | <ul style="list-style-type: none"> • None |
| Spetifore | <ul style="list-style-type: none"> • High water tables • Salinity • Low pH | <ul style="list-style-type: none"> • Drainage system to lower water table and manage salinity • Ditches and underdrains • Sub-soiling and irrigation to flush salts • Liming • Cover crops • Land leveling | <ul style="list-style-type: none"> • Annual legumes • Blueberries • Leaf vegetables • Perennial forage crops • Potato • Shallow-rooted annual vegetables (except celery) | <ul style="list-style-type: none"> • Celery • Nursery and Christmas trees • Raspberries • Root crops • Strawberries • Tree fruits |

Note: Adapted from Luttmerding (1984) and Bertrand et al. (1991).

Land Capability for Agriculture

As noted above, agricultural capability in B.C. is rated through the Land Capability Classification for Agriculture in British Columbia (B.C. MOE and B.C. MOAF 1983). The system ranks soils into seven land capability classes (Class 1 to Class 7), the highest classification (Class 1) has no or only very slight limitations for agriculture; the lowest (Class 7) has no capability for soil-bound agriculture. **Table 5.4-7** summarizes the descriptions for each class. In most agricultural regions of B.C., two ratings are assigned to a soil unit: the first (unimproved rating) to reflect the natural soil, drainage, and terrain properties, and the second (improved rating) reflects the soil capability after implementation of management improvements to offset limitations (ALC 2013). Improvements typically implemented in B.C. include drainage systems, irrigation, stone picking, and soil amendments.

The system also ranks Class 2 to Class 7 soils into capability subclasses based on the types of limitations. **Table 5.4-8** lists the limitations that are commonly found in the RAA along with the improvement measures that are typically taken.

For the RAA, two capability ratings are shown on the published agricultural capability mapping: an unimproved or natural rating, and an improved rating to reflect changes to capability after management improvements are implemented (ALC 2004). Improvements include drainage system, irrigation systems, or both, stone picking, and soil amendments such as the addition of organic matter, lime, or fertilizer. The improved land capability rating is the appropriate indicator of land quality because drainage and other improvements have been widely implemented throughout the RAA, where soils are primarily limited by a high water table. The improved (drained/irrigated) agricultural capabilities within the areas overlapping Project components and adjacent areas are primarily Class 2, with some Class 1 and Class 3 soils.

Maps A1 to A13 (**Appendix A**) show the land capability ratings for the soil polygons that are present adjacent to the Highway 99 alignment.

Table 5.4-7 Land Capability Classes for Agriculture

| Class | Description |
|----------------|---|
| Class 1 | Land either has no or only very slight limitations that restrict its use for the production of common agricultural crops. |
| Class 2 | Land has minor limitations that require good ongoing management practices or slightly restrict the range of crops, or both. |
| Class 3 | Land has limitations that require moderately intensive management practices or moderately restrict the range of crops, or both. |
| Class 4 | Land has limitations that require special management practices or severely restrict the range of crops, or both. |
| Class 5 | Land has limitations that restrict its capability to producing perennial forage crops or other specially adapted crops. |
| Class 6 | Land is non-arable but is capable of producing native and/or uncultivated perennial forage crops. |
| Class 7 | Land in this class has no capability for arable or sustained natural grazing. |

Note: Adapted from ALC (2013).

Table 5.4-8 Limitations to Agriculture and Associated Improvements

| Symbol | Limitation | Common Improvements |
|----------|--|---|
| W | Excess water | Drainage systems |
| L | Permeability (organic soils) | Cannot be improved |
| D | Undesirable soil structure | Organic matter additions |
| N | Salinity | Difficult to improve. Improvement by drainage with regular flushing with non-saline irrigation water possible in some situations. |
| I | Inundation (by flooding) | Diking |
| A | Soil moisture deficiency | Irrigation |
| P | Stoniness | Stone picking |
| F | Fertility | Fertilizer additions |
| T | Topography | Cannot be improved (except in exceptional circumstances) |
| R | Shallow depth to bedrock or bedrock outcrops | Cannot be improved |

Note: Adapted from ALC (2013).

5.4.2.3.2 Irrigation and Drainage

Climate Capability and Climatic Moisture Deficits

Richmond and Delta receive relatively high rainfall in late autumn and winter, but experience a moisture deficit in the summer (**Figure 5.4-2**). Thus, many agricultural fields require drainage and irrigation improvements to maintain favourable soil moisture conditions during crop production. Climatic moisture deficits (CMD) are calculated using precipitation data and the estimated potential evapotranspiration².

Independent of Land Capability for Agriculture, as described above, the agricultural capability of an area is also classified based on the local climate using the Climate Capability Classification for Agriculture in B.C. (B.C. MOE 1981). This system ranks climate capability into seven classes based on the number of frost free days, growing degree days, and CMD or climate moisture surplus (CMS); the highest classification (Class 1) is associated with a wide range of crops; the lowest (Class 7) has no potential for agriculture.

The general climate capability for agriculture in the LAA is Class 1 for thermal characteristics, but mainly Class 3A for CMD (the “A” denotes aridity due to CMD). The CMD can generally be overcome by supplemental irrigation which improves the capability rating to Class 1 for soils with sandy loam or finer textures (B.C. MOE 1981, B.C. MOE and B.C. MOAF 1983). More information on agricultural capability in the LAA is provided in the Soils and Agricultural Land Capability section above.

² Evapotranspiration is the ability of the atmosphere to remove water from the surface through processes of evaporation and transpiration.

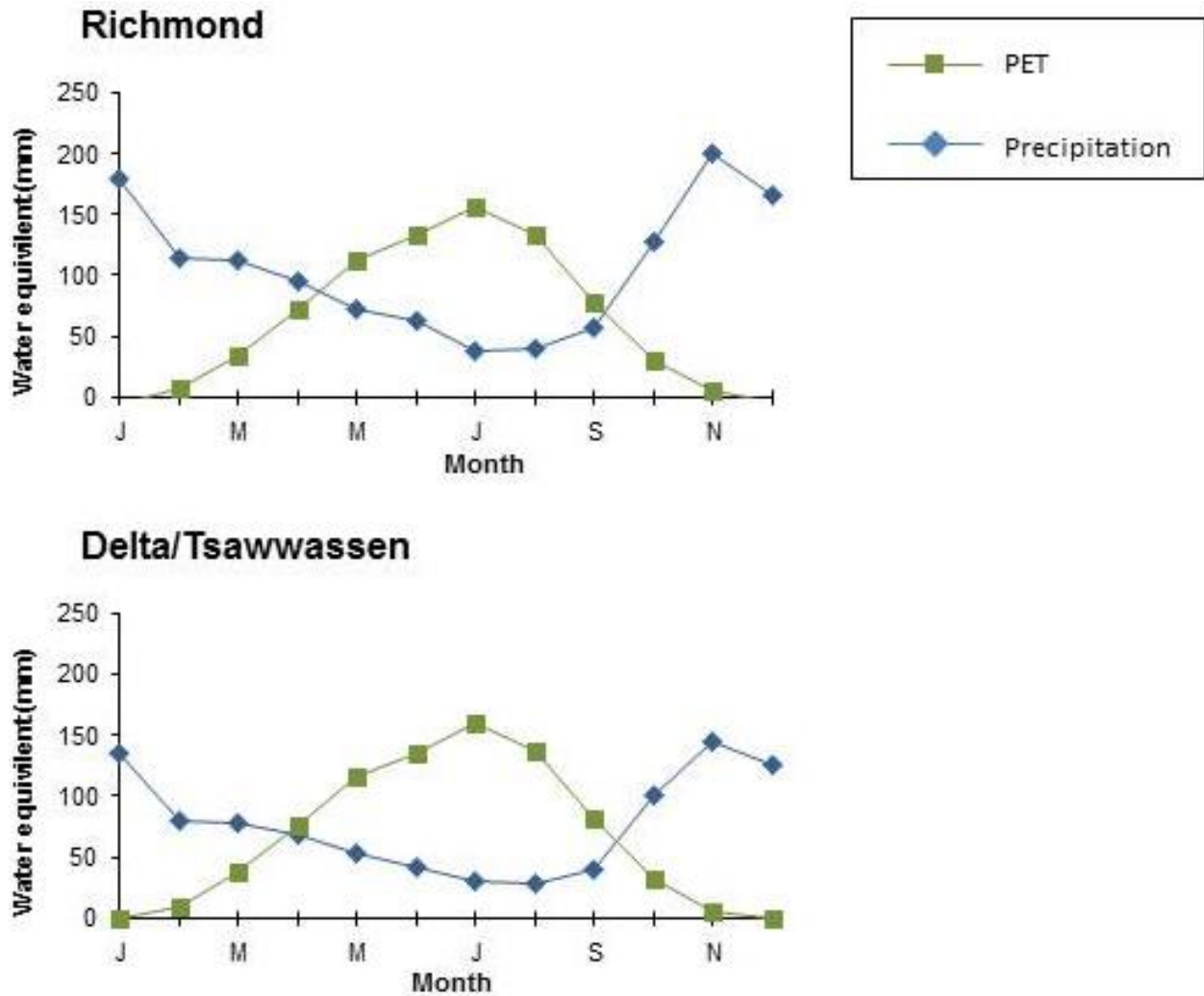


Figure 5.4-2 Monthly Normal Precipitation and Potential Evapotranspiration (PET) in Richmond and Delta

Drainage and Irrigation Infrastructure and Water Quality

Adequate drainage is a major problem for all lowland agricultural areas of the RAA. High or perched groundwater tables (saturated soils) are frequently encountered as a result of a combination of high precipitation levels, high tides, or spring freshet conditions. Saturated soils can result in reduced yields, delayed planting in the spring, flooding and harvesting problems. To counteract the detrimental effects of saturated soils on agriculture, there is extensive private on-farm and municipal drainage infrastructure in place.

Despite the annual need to manage excess soil moisture through adequate drainage, in the summer months many farms in the RAA require irrigation to sustain production. Approximately 48% of all cultivated field crops in the RAA are irrigated (B.C. MOA 2014). In many municipalities, the drainage systems are designed to serve irrigation needs as well. Irrigation sources include withdrawal from surface water, groundwater, and municipal water systems. The limiting factor for agricultural water supply in the RAA is infrastructure requirements and the associated costs of storing or delivering water to agricultural producers, rather than overall water availability (Golder Associates Ltd. 2008).

To address agricultural drainage, irrigation, and water supply issues, the province and municipalities within the LAA and RAA have invested significantly in upgrading drainage and irrigation networks to bring systems to be consistent with the B.C. *Agricultural Drainage Criteria* (B.C. MOAFF 2002), improve irrigation water quality, and increase water supply. Specifically Richmond and Delta have significantly improved their drainage and irrigation systems with new ditch construction or upgrades, new or improved pump stations, and remote salinity monitoring. For example, the Delta Irrigation Enhancement Project (DIEP), constructed as part of the mitigation strategy for the SFPR project, provides greater flow capacity and non-saline irrigation water during the summer months. Due to the complexity of these drainage and irrigation systems, additional improvements and on-going maintenance are needed to optimize their functions.

To address limitations in the existing systems, municipalities (particularly Richmond and Delta) are committed to continuing with drainage and irrigation system improvements in the near future.

5.4.2.3.3 Farm Infrastructure and Operations

Land Use and Cropping

The RAA includes less than two per cent of the total area of farms in B.C.; however, farms in the RAA generate over twenty-five percent of the total gross farm receipts based on the most recent census (Statistics Canada 2011). This is largely due to the moderate climate in the RAA compared with the rest of the agricultural areas in B.C., and the proximity to markets. Forage and pasture are the most common crop type in the RAA, accounting for 49% of all cultivated land (i.e., prepared and used for raising crops; tilled). Berries are the next most common followed by vegetables, nursery, and tree plantations. In addition to cultivated field crops, there are 491 ha of land in greenhouses and other buildings used to produce crops. The majority of all such buildings in B.C. occur in Delta, the Township of Langley, and Surrey.

Cranberries are the most dominant crop in Richmond, and account for approximately 33% of B.C.'s cranberry acreage (Statistics Canada 2011). Cranberry production primarily occurs in the area north of Highway 91 and east of No. 6 Road. Many of the cranberry farms are farmed as contiguous properties with an average parcel size of approximately 20 ha. Agricultural land use south of Highway 91 generally comprises smaller land parcels, around four hectares, in blueberries and vegetables. Due to the small parcel sizes, many farm operations work multiple land parcels throughout Richmond, often located far apart.

Delta's average farm size (35 ha) is the largest of any municipality in Metro Vancouver, and is over twice that of the Metro Vancouver average, which indicates the importance of full-time commercial farming in Delta. Potatoes are the largest agricultural commodity produced with approximately 1,532 ha of farmland in potato production (Statistics Canada 2011). Delta is also a large greenhouse vegetable and field vegetable area, with approximately 50% of B.C.'s greenhouse vegetable area, and about 25% of the field vegetable area.

Agricultural Economy

The RAA is one of the most important food producing areas in B.C. and is a vital component of Metro Vancouver's regional economy. In 2011, gross farm receipts from farms in the RAA were estimated to be \$789 million. This equates to 27% of the gross farm receipts for all of B.C., generated on only about 2% of the province's farmland. The revenue generated from agriculture in the RAA has increased 228% over the 20 years leading up to 2011 (Statistics Canada 2011).

Farming is also a substantial part of the economy in the LAA. According to the 2011 census of agriculture, Richmond's agricultural economy generated \$48.6 million in gross farm receipts, while Delta generated \$167.2 million (Statistics Canada 2011). This represents 1.6% and 5.7%, respectively, of the total gross farm receipt revenues of all of B.C. (Statistics Canada 2011). The revenues generated from agriculture have increased, by 11% for Richmond and 401% for Delta, since 1990. The increases in Delta are greater than the increase in the consumer price index for the same period. Thus, agriculture is a thriving and growing industry, especially in Delta.

Agriculture within OCPs and Agricultural Plans

Municipalities in the RAA are currently facing several challenges relating to agriculture. These include issues such as drainage and irrigation, urbanization pressures, high agricultural land values that limit the entry of young farmers, and farm business factors such as the high cost of farm labour, nutrient management, fuel, and fertilizer. To alleviate these issues, most of the municipalities in the RAA have developed agricultural policies and strategies as part of their Official Community Planning to enhance agricultural viability by supporting and protecting

agriculture within each region. Most municipalities have also developed detailed Agricultural Plans which are intended to augment the agricultural policies and strategies outlined in their OCPs. In addition, Metro Vancouver has developed the Regional Food System Strategy to address interest in food issues. Goals of this strategy include increasing capacity to produce more local food, and improving the financial viability of the food sector (Metro Vancouver 2011). In 2013, the Tsawwassen First Nation developed an agricultural plan to manage Tsawwassen First Nation agricultural lands.

Richmond Agricultural Viability Strategy and Backlands Policy

In 1999, Richmond embarked on a process to develop an Agricultural Viability Strategy to manage their agricultural areas for long-term viability (Richmond, 2003). The goal of the strategy is to enhance agricultural viability in Richmond by not removing land from the ALR unless there is a substantial net benefit to agriculture, and there is consultation with agricultural stakeholders. The strategy's guiding principles are as follows:

- The dominant use of the land in the ALR will be for a competitive, diverse, and flexible agricultural industry.
- The stability and integrity of the ALR boundary will be supported and maintained.
- Agricultural economic growth, innovation, diversification, and best practices are the best ways to protect agricultural land in Richmond and to ensure the ongoing viability of agricultural operations.
- Urban development in the ALR will be minimized.
- Subdivision in the ALR will be minimized, except where it supports agricultural viability (e.g. diversification, expansion, etc.).
- Richmond farmers will be provided with the necessary support, services and infrastructure that are required for agricultural viability.
- Residents of Richmond will be encouraged to learn more about agriculture in their city and to support locally grown agricultural products.
- Effective and positive communication with the general public and the agricultural sector will be a priority.
- Decision-making will be coordinated in a consultative manner and will consider all potential impacts on agricultural viability.
- A sustainable environment will be maintained to provide quality air, water, and land which supports and complements farming.

The City of Richmond also developed a policy for the area identified as the No. 5 Road Backlands Policy Area (the Backlands). The Backlands comprise 33 parcels to the immediate west of Highway 99, between Blundell Road and Steveston Highway, that are zoned for agricultural and assembly use. This area was re-zoned in the 1990s to support Assembly District uses within 110 meters along No. 5 Road while maintaining the remaining eastern portions of the property for agricultural purposes.

To ensure that active farming occurs on the Backlands, the City of Richmond established the Backlands Policy that outlined landowner requirements for farming this area in 1990. The current Backland Policy (Policy 5037) was adopted in 2000 and stipulates that all landowners subject to the policy are required to submit a detailed farm plan to the ALC and demonstrate that the agricultural areas are being actively farmed. To date, only three of the nine parcels required³ have submitted a detailed farm plan. However, limited and/or intermittent farming is occurring on most properties.

Delta Agricultural Plan

Delta has created an Agricultural Plan that contains strategies to assist in pursuing the long-term viability of farming in the community to address these issues (Delta 2011). The successful future of Delta's agriculture will depend on several factors, including the ability to attract complementary agri-industry, reduce costs, diversify, add economic value, attract new entrants, mitigate or offset impacts from projects, comply with regulatory processes, and meaningfully engaging the public in support of agriculture. Delta's 20-year vision includes the following goals:

- The agricultural sector is highly productive, creating efficient production systems and significant value-added activity, assisted by well-functioning infrastructure.
- Local agriculture effectively services local and non-local markets.
- Agriculture's ecological and social attributes are recognized by and cost-shared with society.
- Farming is attractive and accessible, providing a successful alternative career for younger people and new entrants.
- Agriculture will have successfully adapted into the future by adopting new technology, embracing innovation, adjusting to climate change, and reducing reliance on fossil fuels.

³ Parcel #36 (BC Muslim Association) is zoned as Assembly Use only, is fully developed and is therefore exempt from this requirement.

Metro Vancouver Regional Food System Strategy

In 2011, the Metro Vancouver Board adopted the Regional Food System Strategy (the Strategy, Metro Vancouver 2011) to address the regional interest in food issues. This Strategy is part of Metro Vancouver’s commitment to making a sustainable region. The Strategy provides a framework for creating a collaborative approach to a sustainable, resilient, and healthy food system that will contribute to the well-being of all residents and the economic prosperity of the region while conserving our ecological legacy (Metro Vancouver 2011). This will be achieved by meeting six goals:

1. Increasing capacity to produce more local food
2. Improving the financial viability of the food sector
3. Encouraging people to eat healthier diets
4. Ensuring a more equitable access to nutritious food
5. Reducing food waste in the food system
6. Protecting the ecological health of our region and surrounding water

The first two goals are vital to the agricultural sector of the RAA. Metro Vancouver proposes increasing capacity to produce more local food by protecting agricultural (ALR) land and enabling the expansion of agricultural production through access to water, labour, and protecting farmers’ rights to farm. To improve the financial viability of the food sector, Metro Vancouver plans to increase the capacity for distribution of local food (Metro Vancouver 2011).

Tsawwassen First Nation Agricultural Plan

Tsawwassen First Nation’s Agricultural Plan provides a framework and roadmap for executing its vision regarding management of agricultural land resources (Zbeetnoff 2013). Tsawwassen First Nation has 217 ha of agricultural land within Tsawwassen treaty lands. The plan aims to protect the productive agricultural land base by ensuring transportation and access routes do not interfere with farmland and that farmers have access to their fields with heavy equipment. Lands designated Agricultural are within the ALR.

5.4.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with agricultural use, and potential effects of such interactions on the land in the ALR, irrigation and drainage, and farm infrastructure and operations. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 5.4.4 Mitigation Measures**. Potential residual effects (i.e., effects remaining following

the implementation of mitigation measures) are described in **Section 5.4.5 Residual Effects and their Significance**. A discussion of potential cumulative effects on agricultural use is presented in **Section 5.4.6 Cumulative Effects**.

5.4.3.1 Project Interactions

An overview of potential interactions between Project activities and agricultural use during the construction and operation of Project components is provided in **Appendix B**. A preliminary evaluation of the potential effects of Project interactions on agricultural use, intended to focus the assessment on those interactions of greatest importance, is provided in this section. Interactions rated as having no potential for effects are not considered further in the assessment. The following are effects that could potentially occur. The assessment of potential effects begins in the following **Section 5.4.3.2**.

Construction: Potential interactions with and effects on agricultural use during Project-related site preparation and construction activities could include the following:

- Changes to irrigation and drainage systems
- Changes in transportation between farm parcels, markets, and suppliers
- Short-term disturbance to livestock
- Accidental spills of deleterious substances
- Sedimentation in agricultural drainage ditches
- Degradation of agricultural soils
- Changes to farm utilities and infrastructure
- Economic considerations

Operation: Potential interactions with and effects on agricultural use during Project-related operation and maintenance activities could include the following:

- Change in area of available agricultural land
- Severance or isolation of farm parcels and other changes in the viability of individual farms
- Increased runoff from new impervious surfaces that may affect soils and crops
- Temporary disruption of drainage during ditch maintenance

Potential positive effects as a result of the Project include:

- Alleviation of traffic volumes during peak hours, improving travel times and reliable access to farms
- Increasing efficiency of farming operations
- Improvement to drainage and irrigation ditches that run alongside the highway

5.4.3.2 Potential Effects

The methods used to assess potential Project-related effects on agricultural use are based on the ALC's *Planning for Agriculture - Resource Materials* (Smith 1998), which provides guidance for completing Agricultural Impact Assessments for large projects in the ALR, and includes an overview of potential impacts that should be assessed to determine if a project will have a significant impact on agricultural use. In general, the document recommends assessing the impacts on the agricultural resource, drainage and irrigation, land use compatibility, air quality and noise, transportation and traffic, and services such as stormwater and sewer.

5.4.3.2.1 Effects on Land in ALR

Loss of Agricultural Land

The Project will result in the removal of narrow segments of ALR land adjacent to the Highway 99 corridor between Blundell Road and Steveston Highway Interchange in Richmond, and River Road and Highway 17 in Delta. **Table 5.4-9** shows the estimated area of agricultural land that would be removed from agricultural production within the Project alignment, summarized by capability class. The total projected removal is a maximum of approximately 20 ha, of which approximately 17 ha is currently productive ALR land. The estimates in **Table 5.4-9** were generated by placing the property acquisition areas (obtained from the Ministry) along the design footprint (see **Appendix A, Maps A1 to A13**). These estimates represent the maximum extent of land required for the new alignment, including cut and fill slopes, setbacks and drainage related infrastructure.

The collective loss of ALR area may be considered equivalent to losing slightly more than one average-sized farm in the LAA. Approximately 20 ha of Class 1, 2 and 3 soils, based on the improved land capability ratings will be removed by the Project (**Table 5.4-9**). As noted earlier, the improved land capability rating is the appropriate indicator of land quality because drainage and other improvements have been widely implemented throughout the RAA.

Table 5.4-9 Estimated Agricultural Land Loss from the ALR

| Agricultural Capability Class (Improved) | Area (ha) | Area (% of total) |
|--|-------------|-------------------|
| 1 | 2.7 | 13 |
| 2 | 12.6 | 63 |
| 3 | 3.9 | 20 |
| 4 | 0 | 0 |
| 5 | 0 | 0 |
| 6 | 0 | 0 |
| 7 | 0 | 0 |
| Other | 0.9 | 4 |
| Total | 20.1 | 100 |

Note: This table summarizes the gross removal of agricultural land from the ALR, prior to consideration of surplus lands that can be returned to agriculture by the Ministry.

Based on the current Project design, agricultural land loss is expected to occur on 32 properties (**Appendix A, Figure 1a – 1aa**; highlighted orange). There may be slight changes to the Project design during final design stages; however, they are expected to be minor and the nature of the potential removals (i.e., narrow strips of land parallel to the roadway) will not change appreciably.

Individual losses to each of the 32 properties will be minor in extent, ranging from 0.01 ha to 2.8 ha on sites that are 0.2 ha to 51.4 ha. These sites are a mix of cultivated fields, non-cultivated fields, filled land, and non-productive sites (paved land).

Loss of agricultural land is considered an adverse effect because of the importance of preserving high capability agricultural lands within the ALR. The ALC, along with municipalities in the RAA, generally discourage removal of land from the ALR unless there is a demonstrated net benefit to agriculture through compensation or improvements as a result of non-agricultural development in the ALR.

Accordingly, to offset the losses listed in **Table 5.4-9**, the Ministry has identified several Crown or Ministry-owned parcels of land that will be made available for agricultural use. The potential for these additions to offset the losses from the new alignment and provide a net gain in available agricultural land is discussed in **Section 5.4.4.4**.

Degradation of Agricultural Soils

Degradation of agricultural soils is primarily related to temporary construction work that may affect soil quality. Soil quality degradation can occur in laydown areas, temporary construction areas, or heavy traffic areas where soils can become compacted. Soil compaction can impair water infiltration into soil, crop emergence, root penetration, and crop nutrient and water uptake. These can all result in lower crop yields.

Soils can also be degraded through soil contamination, soil erosion, and soil mixing. Soil contamination can occur as a result of chemical or fuel spills or contaminants from run-off water (e.g., oils). Project activities that disturb and expose soils can also result in soil erosion (either through water or wind erosion). Soil mixing, or admixing, can occur in temporary laydown areas where topsoils are salvaged for future reclamation.

5.4.3.2.2 Effects on Irrigation and Drainage

Drainage, Water Quality, and Irrigation

The Project has the potential to affect municipal drainage infrastructure and irrigation sources in the LAA, as well as on-farm drainage. Agricultural operations in the LAA rely on effective on-farm and municipal drainage and irrigation infrastructure (**Section 5.4.2**). The planned Project upgrades to Highway 99 will involve the replacement of some drainage structures within the new bridge and highway prisms, and some ditches and control structures may need to be moved or changed to accommodate the Project footprint.

Temporary alteration of drainage patterns, potential for sedimentation, and loss of access to irrigation water may negatively affect agricultural operations during the Project construction phase. Temporary alteration of drainage patterns also has the potential to disrupt existing drainage, resulting in saturated soils, reduced yields, delayed planting in the spring, and flooding and harvesting challenges. From a water quality and irrigation perspective, farmers who irrigate are most concerned about the negative impacts of high sediment concentrations (which can damage pumps), salinity and, to a lesser extent, agricultural chemicals or leachate from industrial areas (Klohn Leonoff Ltd. et al. 1992).

Locations where there is potential for effects on drainage or irrigation water quality include the highway drainage ditches on both sides of Highway 99 primarily between Blundell Road and the Steveston Highway interchange in Richmond, and between River Road and the Highway 17 interchange in Delta, where existing highway ditches will need to be relocated and reconstructed as part of the Project.

Fraser River Salt Wedge

Background

The salt water in the Strait of Georgia at the mouth of the Fraser River is denser than the outflowing river water. During the rising tide, this denser saline water advances up the river along the channel bottom while the river water flows over the top, creating the characteristic wedge shape. The Fraser River salt wedge has been studied since the 1960s, and monitoring in the early 1970s led to the development of a numerical two-layer model that was used to predict salt wedge behavior and thickness during low-flow conditions (Hodgins 1974, 1977). Due to the importance of salt wedge processes for fisheries, wastewater discharge, navigation, and agriculture (e.g. Ages 1979, 1988), monitoring continued in the 1970s and 1980s to assess wedge behavior under a range of tidal and river flow conditions. Later research was aimed at developing a better understanding of the factors that explain variations in the maximum upstream extent of the salt wedge, and the role that the salt wedge plays in causing sediment deposition at the mouth of the river (Kostachuck and Atwood 1990). On the latter point, sediment deposition occurs when the velocity of sediment-laden river flow slows and turbulence decreases as it is forced over the wedge. This process is referred to as shoaling. Shoaling is a complex process because the salt wedge influences sediment accumulation in the channel, which in turn affects salt wedge movement.

Recently, interest in the salt wedge has centred on potential effects if the Fraser River were to be dredged to enhance shipping access upstream of the Tunnel after the Tunnel is removed and replaced with a bridge (ter Borg 2015). There are currently no formal proposals to carry out such dredging. The results of on-going studies about the potential effects of dredging, which are being undertaken by the University of British Columbia and the Delta Farmers' Institute, are expected later in 2016.

Decommissioning of the Tunnel may have the potential to alter the hydraulic characteristics of the Fraser River, and questions have been raised as to whether or not those changes would influence the extent of the salt wedge in the river, and the salinity of the water within the wedge affecting irrigation water quality. Although the salt wedge regularly extends as far as Annacis Island under low flow conditions, such as January to March (Ages 1988), it reaches the irrigation pump station at 80th Street intake in Delta less frequently during the irrigation season (based on Neilson-Welch 1999). However, there are periods when the water in the vicinity of the 80th Street intake is too saline to be used for agricultural irrigation, and the key question is whether or not Tunnel removal could increase the length of time when the water is too saline for agricultural use.

The Province of B.C. has published guidelines for irrigation water quality that are based on a combination of water electrical conductivity and the sodium adsorption ratio (Tam and Peterson 2014). Crop selection begins to be restricted when electrical conductivity in the irrigation water is greater than 0.7 deci-Siemens per metre (dS/m), and is severely restricted if above 3.0 dS/m. With respect to berry crops, EC values <0.5 dS/m are considered safe for all berries, 0.5 to 3.0 dS/m are considered safe for most berries, and >3.0 dS/m is considered injurious to most berries (BC Ministry of Agriculture 2012). Typical salt wedge conductivity values are higher than 3.0 dS/m, although during flood tide the salt wedge is situated at the river bottom with the fresh water flowing over top. On ebb tides, however, turbulent mixing occurs and the surface water becomes saline. A sensor at the 80th Street intake stops inflow to the irrigation pump house when electrical conductivity reaches the threshold set by the City of Delta based on crop needs (Tetra Tech EBA 2015).

Modelling Potential Project Effects

To evaluate the potential for effects on irrigation water quality due to Project-related changes in the salt wedge, the effects of the removal of the Tunnel on the behaviour of the salt wedge in the Fraser River were evaluated by the Ministry (see **Appendix 16.7 Fraser River Salt Wedge Modelling**). This was accomplished using a three-dimensional hydrodynamic model (called H3D) that compared existing conditions with predicted conditions following Tunnel removal (Tetra Tech EBA 2016). The model was run for the hydraulic conditions measured in the Fraser River during the late fall of 2011 because that period coincides with the collection of bank-to-bank bathymetry data and salinity monitoring using a sensor installed in the river at the 80th Street intake in Delta. This enabled the modelling team to validate the model using actual salinity data from at the intake. The key results of the modeling exercise are summarized as follows:

- The model could replicate the trend of salinity and its variability on a daily time scale near the intake with reasonable accuracy during validation (i.e., with the Tunnel in place), although modelled salinities were generally higher than observed (i.e. more conservative). This may be partly explained by the high degree of variability in salinity near the intake that appears to be related to the presence of a shallow bench along the shore near the intake and turbulence as tides recede.
- Although model results varied from observations at the intake, it was assumed that the differences in river hydrodynamics with and without the Tunnel would be captured by the model since salinity trends were well represented on a daily time scale.

- Using a conservative criterion of 0.4 dS/m (i.e., 20% below the “cut-off” threshold of 0.5 dS/m), the model was able to predict the overall trend in the number of hours per day when water can be drawn from the river for irrigation. The model tended to be conservative, indicating fewer hours within the acceptable criterion (range of approximately 4 to 19 hours per day) than the observed (range of 4 to 24 hours per day).
- Under baseline conditions, (i.e., with the Tunnel in place) the salt wedge remains mostly downstream of the Tunnel until the Fraser River flow drops below 2,000 m³/s, usually in November.
- When the model was run continuously for the September to November period, there was only a small difference between salinity behavior with and without the Tunnel.
- The salt wedge advances slightly further in the case without the Tunnel than with the Tunnel, but the differences in salinity were slight, with most values about 0.1 ppt higher⁴. The greatest projected differences (up to about 0.38 ppt) occurred when the salinity levels were already above the threshold for irrigation.
- Natural features along the bottom of the Fraser River between the mouth and the intake (such as sand dunes) have similar topographic relief as the existing Tunnel. These dunes are constantly changing in size and locations, and any one feature (i.e. one dune or the tunnel) has a minor role in overall salt wedge behaviour.

The major conclusions drawn by the authors (Tetra Tech EBA 2016) are:

- The timing window during which the salinity of the water exceeds the threshold for irrigation is almost identical for the two cases (i.e. with and without the Tunnel).
- Tunnel removal will not affect the behaviour of the salt wedge.

5.4.3.2.3 Effects on Farm Infrastructure and Operations

Farm Parcel Fragmentation and Changes to Farm Parcel Boundaries

Fragmentation of existing farm parcels and farm parcel boundary changes have the potential to affect farm economics by making remaining parcels too small to be farmed, resulting in a shape that is impractical for farm machinery to operate. Based on the current Project design, no farm properties will be bisected or otherwise fragmented by the Project.

The Project will result in removal of narrow segments of land adjacent to Highway 99, potentially resulting in property boundary changes, somewhat smaller farm parcels on specific properties, and some changes to field configuration. For most parcels, this loss of land is considered

⁴ The provincial irrigation guidelines are based on electrical conductivity (EC), whereas the model results are presented using salinity units (parts per thousand, ppt). Tetra Tech-EBA has established a local conversion factor to enable comparison of the model results to guidelines.

relatively small and is not expected to significantly change field configurations since the boundary changes occur on the perimeter of fields. Therefore, the impact of the Project on farm configuration is expected to be neutral on the majority of the farm parcels affected, with the exception of the following properties:

- Property #62 (**Appendix A, Figure 1n and 1p**) – potato/vegetable farm located on the west side of Highway 99 on River Road
- Properties #67 and #68 (**Appendix A, Figure 1p and 1q**) – two parcels of land that are owned by the provincial government located along the southeast side of Highway 17A in Delta

Project activities on Property #62 will result in the reconfiguration of this parcel into a shape and size that is likely to affect the farm's operations. The parcel is currently 9.7 ha; and the Project will result in a reduction of approximately two hectares; however, the shape of the remaining area (7.7 ha) is such that a portion will be difficult to farm, reducing the area suitable for agricultural production to approximately 5 ha.

Project activities on Properties #67 and #68 will result in the reconfiguration of these two parcels into a shape and size that may affect current farming operations. These parcels are currently farmed under lease as part of a larger field unit with the contiguous property to the south (shown in **Appendix A, Map A-9**). Together, the two parcels are currently 6.2 ha. The Project will result in a reduction of these parcels by 3.6 ha; however, the remaining parcels are expected to continue to be farmed in concert with the adjacent, privately owned field.

The impact of the Project on Property #55 (a fill site that is under ALC reclamation approval) located at the Steveston Interchange in Richmond is not expected to significantly affect potential agricultural use on this relatively large property.

Changes to On-farm Utilities

With any highway construction project there is potential for temporary disturbance of on-farm utilities (e.g., power, telephone, gas, etc.). For the Project, this may occur within the Project footprint or on those properties located adjacent to the Highway 99 corridor where most utility lines are located. Although there are regional power lines that will have to be moved, there are no on-farm power lines that will be affected. Nevertheless, disruption of utilities can have a negative effect on livestock operations and greenhouses where even short-term loss of light or heat could have serious economic implications. If any disruption is necessary during construction, permanent restoration of services is straightforward.

Fencing, Public Access, and Security

During Project construction, some existing fences will need to be removed and relocated and, where applicable, new fencing will be installed in accordance with current highway design standards. Agricultural fencing is not only important for traffic safety and livestock protection, it also helps to deter trespassing, vandalism, theft, and dumping of waste into ditches or on farm land.

Changes in the Agricultural Landscape and Stakeholder Perceptions

In addition to food production, agricultural land in the RAA provides a number of other ecological and socio-community benefits including wildlife habitat (especially in winter), nutrient and organic matter recycling, carbon sequestration, climate regulation, and stormwater and flood management (Metro Vancouver 2011). Agricultural land also contributes aesthetically as a form of green space, and is considered to be part of the green zone within Metro Vancouver, along with parks and other undeveloped areas. In general, there is a correlation between the loss of ALR land and a decline in ecological and socio-community interests associated with green space.

With respect to wildlife, there are several programs that support habitat by minimizing financial effects on farms. For example, the Delta Farmland and Wildlife Trust helps to fund winter cover crops, grassland set-asides, and hedgerows, and compensates farmers of perennial forage crops for damage done by overwintering waterfowl. Effects of the Project on wildlife and wildlife habitat are addressed in **Section 4.8 Terrestrial Wildlife**.

Although not straightforward to quantify, there is potential for effects on agricultural use related to the perception that the Project alignment has become more developed, and its character is more urban. In general, farm properties along major transportation routes and in the urban-rural fringe are more likely to be farmed at a lower intensity or held by speculators despite being in the ALR. Mitigating this tendency is accomplished largely through the measures that will be implemented for other potential agricultural effects (see **Section 5.4.4**), especially minimizing the Project footprint, consolidating farm parcels into more economically-viable units, irrigation/drainage improvements, and installing visual landscape buffers where appropriate.

Transportation and Network Access

During construction, potential effects to agriculture include increased travel times for farmers and processors due to detours, wait times, and general Project-related congestion. This could result in reduced efficiency and added costs. Post construction, however, the utility of Highway 99 as a corridor for the transportation of agricultural goods and services would be significantly

improved, and have a positive effect on agriculture in the LAA, particularly for Richmond farmers and processors. Several farmers located in the vicinity of the Tunnel stated, during field interviews, that the new bridge would directly benefit their operations (see **Section 5.4.4**).

Noise and Air Quality Effects on Farm Animals

The potential effects of the Project on ambient air quality and atmospheric noise have been assessed and the results are presented in **Section 4.9** and **Section 4.10** of this Application. Those assessments focus on potential effects on humans; however, the results of these assessments can be used to evaluate the possibility of effects on farm animals, which include common livestock. At present (2016) there are very few livestock operations adjacent to Highway 99 in Richmond or Delta (there is a beef operation between 64th Street and Highway 17 in Delta).

For air quality, the evaluation of potential effects on farm operations is based on the findings of **Section 4.9 Air Quality**. The assessment concluded that implementation of the Project (i.e. during operation) will result in an overall improvement in air quality compared to existing conditions and future conditions without the Project, primarily due to a reduction in traffic congestion and better dispersion of emissions from traffic moving over an elevated bridge rather than through the Tunnel. Short-term changes in local air quality can be mitigated effectively. As such, no adverse effects on farm animals from the Project are anticipated.

Fuel-combustion pollutants degrade some of the chemicals that make up floral odors, and the absence of those floral chemicals affects honeybees' ability to recognize the scent and locate its source. The anticipated Project-related improvement in air quality could, therefore, be beneficial to bees and other pollinating insects as well.

Ground level ozone (O₃) has been shown to reduce agricultural yield and crop growth by reducing the resistance to fungi, bacteria, virus, and insects, thereby reducing growth and inhibiting yield and reproduction. Estimations of the change in O₃ concentrations, as summarized in the **Section 4.9 Air Quality**, suggest that the overall change in O₃ is negligible, with a worst-case estimate of a peak change of 0.1 µg/m³ in the 24-hour average concentration. This change falls within the typical limit of detection of monitoring equipment; therefore, there is no measureable change in O₃ anticipated as a result of the project.

There are currently very few farm animals within about one kilometre of the Project, any farm animals along the Highway 99 corridor will already be acclimatized to traffic noise. Given this, any increases in noise would have negligible effect on farm animals, specifically livestock.

Economic Considerations

Farmers that are directly affected by the Project (i.e., where there is permanent land loss or soil degradation) may experience reduced revenues due to their reduced land-base and/or lower crop yields where temporary disturbances result in soil degradation. While soil degradation is considered reversible, increased travel time during Project construction may temporarily result in reduced efficiencies, reduced revenue, and added costs associated with transporting agricultural goods and services.

Once the Project is operational, reduced travel time is expected to have a positive effect on agricultural revenues in the LAA and RAA due to reduced labour time and operating costs associated with the transportation of goods and services.

5.4.4 Mitigation Measures

A hierarchical approach based on the four types of mitigation as outlined below was used in identifying strategies to avoid or minimize potential Project-related effects:

- **Avoidance:** Measures to avoid potential effects on the VC have been/will be incorporated into project considerations such as site and route selection, project design, project scheduling, and construction and operation procedures and practices.
- **Minimization:** Where potential effects on the VC cannot be avoided through project considerations, standard mitigation measures, best practices, and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels.
- **Land Restoration and Reclamation:** Where potential Project-related effects cannot be avoided or minimized through standard mitigation measures, best practices, or implementation of EMPs, affected components will be restored to pre-Project conditions, or to an improved agricultural condition.
- **Enhancement or Compensation/Offset:** Where on-site restoration or land reclamation is not feasible, appropriate means to counteract, or make up for potential Project-related effects on the VC will be identified.

Selection of mitigation measures was based on current best management practices (BMPs), as well as information gathered through stakeholder meetings to identify strategies to offset potential Project-related effects on agricultural values. Stakeholder meetings involved discussions with individual farmers, Farmers' Institutes, municipalities of Richmond and Delta, and the ALC.

5.4.4.1 Avoidance

Minimizing direct effects on agricultural lands through avoidance of agricultural land and farm infrastructure was one of the key design goals for the Project. Avoidance measures integrated into Project design include accommodating Project components and activities within the Highway 99 ROW to avoid direct effects on agricultural land and incorporating drainage works (e.g. new ditching) and related rainwater management structures that meet provincial and local government standards for agricultural areas and purposes. Rainwater runoff from the new bridge over the Fraser River will be captured in pipes so it does not directly enter the river, with the runoff directed to ponds or wetlands on either side of the river. All bridge-related rainwater infrastructure will be located outside the ALR.

5.4.4.2 Minimization

Environmental protection measures that will be implemented during Project construction and operation to prevent or minimize potential effects on agricultural use will be outlined in a Construction Environmental Management Plan (CEMP), and subsequently in an Operation Environmental Management Plan (OEMP), as described in **Section 12.0 Management Plans**. The CEMP will include an Agricultural Management Plan that describes standard best practices and Project-specific mitigation measures to prevent or minimize potential effects on drainage, water quality and irrigation, farm infrastructure and operations, and soil conservation, storage, and reclamation. The best management practices (BMPs) and mitigation measures (summarized in the following subsections) have been widely used and successfully implemented on other transportation corridor projects (e.g. SFPR) to effectively minimize impacts on agricultural land and use. The BMPs will be customized for the site-specific conditions in the Project area.

The plans will also include an outline of monitoring programs to ensure that mitigation is effectively implemented. Key elements of the Agricultural Management Plan that will minimize the potential impacts to Land in the ALR, Irrigation and Drainage and Farm Infrastructure and Operations are outlined below.

5.4.4.2.1 Land in the ALR

The following mitigation measures will reduce the potential for degradation of agricultural soils during Project construction:

- Use non-arable areas for temporary laydowns and roads, where possible.

- Where possible, undertake construction activities during dry conditions to minimize soil erosion and compaction. Avoid working during high winds if exposed soils are subject to wind erosion.
- To the extent possible, avoid situations where construction vehicles or equipment would pass through agricultural fields.
- If construction equipment passing through agricultural fields is unavoidable, use the lowest acceptable tire pressure on heavy equipment or reduce load by keeping axle weight to a minimum.
- Salvage topsoil and subsoil along temporary roads or laydown areas. Stockpile soils to reclaim areas that could be improved for agriculture. Stockpile topsoils and subsoils separately to avoid admixing. Seed longer-term topsoil storage piles to avoid erosion, organic matter loss, and infestation by weeds. Store any excavated saline subsoils separately. As part of reclamation, disk all disturbed field areas or subsoil to alleviate compaction.
- Incorporate, as part of an Emergency Response and Spill Contingency Plan of the CEMP, measures to prevent accidental spills and contamination of soils during construction.
- Incorporate, as part of the Erosion and Sediment Control Plan of the CEMP, measures to reduce soil erosion and sediment transport.

5.4.4.2.2 Irrigation and Drainage

Drainage and irrigation effects will be mitigated by reconstructing or upgrading ditches in accordance with the B.C. Standard Specifications for Highway Construction (Ministry of Transportation and Infrastructure 2011), and by considering the B.C. *Agricultural Drainage Criteria* (B.C. MOAFF 2002) for areas where Project runoff could affect farm fields. The Project will be constructed in a way that enables key ditch systems to continue to function (i.e. maintain water levels during the stipulated design storm events to pre-construction levels or lower), and that water quality is suitable for irrigation in those locations where farmers currently obtain all or part of their irrigation supply from ditches that could be affected by the Project. The following specific drainage objectives will be incorporated into the design standards for the Project to mitigate identified risks:

- Provide improvements to infrastructure so that no increase in flooding occurs as a result of the 100-year design storm event.
- Provide improvements to infrastructure to mitigate flow volume increases to municipal pump stations.
- When replacing or installing new culverts, increase sizes to comply with current design criteria and consider possible climate change effects.

- Retain existing ditches at existing elevations and capacities. Increase capacity of ditches for additional storage and conveyance where possible.
- Deepen ditches in specific locations to improve drainage capacity and enable their use for irrigation.
- Re-grade and clean existing ditches within the corridor to improve hydraulic capacity and flow efficiency.
- Add stormwater management ponds where possible to capture highway runoff and control the flow release rates.
- Add temporary water management systems during construction, as needed.

If these steps are implemented, the relocation and reconstruction of drainage ditches along the Highway 99 corridor is expected to result in drainage improvements within the LAA.

5.4.4.2.3 Farm Infrastructure and Operations

Changes to On-Farm Utilities

Farm operators, particularly livestock or greenhouse operators, who may be affected by Project-related activities will be informed well in advance of any potential disruption to utility services—specifically power and natural gas supply—during construction. Alternative power sources (e.g., generators or temporary power lines) will be arranged to minimize potential effects of such disruption, where required. With proper planning and communication, residual effects to farm utilities are not expected.

Fencing, Public Access, and Security

Agricultural fences that are damaged or moved as a result of the Project will be replaced as appropriate. New fencing may be required in some locations where the highway ROW boundaries are altered. The following best practices related to access and security will apply:

- Move existing fencing just prior to construction, replace to Ministry standards (B.C. MOTI 2012), and to meet farm requirements.
- Consult with individual farmers of properties bordering the Project who have livestock, prior to installing the new or replacement fencing, to ensure that the fence is installed to maintain livestock and public safety. In some cases, fencing may have to be placed prior to the start of construction.

Provided existing fences are replaced to applicable standards, issues dealing with public access and security are considered negligible.

Agricultural Landscape and Stakeholder Perceptions

Measures implemented to mitigate other potential effects on agricultural use discussed in this section—specifically, minimizing the Project footprint and consolidation of farm parcels into more economically viable units will also mitigate for the effects of the Project on stakeholder perceptions of agricultural land in the LAA. Installation of visual landscape buffers at select locations will further reduce any Project-related effects on agricultural landscape and stakeholder perceptions. The ALC has published design guidelines for these types of buffers (ALC 1998). The need for, and specific locations of any buffers will be finalized during detailed design.

Transportation and Network Access

Traffic management during construction will be described in a Construction Traffic Management Plan that will be developed prior to construction. Traffic coordination along secondary roads in the LAA will be designed to facilitate the efficient movement of agricultural traffic and mitigate for temporary disruptions and increased traffic during construction. The plan will be shared with the agricultural community prior to implementation.

Once operational, the Project will improve traffic flow within the Highway 99 corridor, particularly during peak hours, as well as provide more reliable cross-highway access for farm traffic. This will improve the movement of agricultural goods and services.

Economic Considerations

Economic effects related to agriculture can be mitigated or offset by the strategies used to mitigate other potential effects (as outlined above) whereby the agricultural productivity and viability, or both, of existing farm parcels are improved. These mitigation measures include:

- Consolidation of small farm parcels.
- Salvaging topsoil from permanent disturbance areas for use in field levelling in other areas of the LAA.
- Improvement to on-farm and municipal drainage and irrigation ditches.
- Increased transportation efficiencies.

5.4.4.3 Enhancement

Enhancement strategies will be implemented on several properties directly affected by the Project to counteract potential effects on farm infrastructure and operations. This will be achieved through consolidation of parcels and working with stakeholders (particularly in the Richmond Backlands area) to enhance the agricultural viability of specific properties.

5.4.4.3.1 Farm Infrastructure and Operations

Farm Parcel Boundary Changes (Consolidation)

Since changes in field configuration are expected to affect farm operations at only three properties (Properties #62, #67, and #68; **Appendix A, Figures 1n, 1p, and 1q**), mitigation measures will be incorporated to address the needs of these specific parcels. The Ministry is currently developing farm-specific mitigation plans in consultation with the ALC and affected land owners.

Two of the potentially affected properties (Property #67 and Property #68) are provincial government lands that have been historically farmed by a local family that leases these parcels from the government and farm them in combination with two of their private parcels located directly to the south. These fields are currently (in 2015) farmed with a variety of crops. The current field units are not aligned with property boundaries; rather, they are configured to take advantage of field drainage and ease of farm equipment use.

The recommended mitigation strategy to reduce the effects of boundary changes on the lands owned by the provincial government is to consolidate the remainders of the affected parcels and to continue to allow the land to be farmed with the adjacent private land parcels to the east.

Consolidation of parcels is considered an effective way to enhance existing agricultural operations on those parcels because of the greater efficiency and flexibility afforded by larger parcels. Consolidation of parcels has been successfully used on other ALR exclusion/non-farm use applications throughout the LAA and RAA to offset impacts to agriculture. Specific details of the consolidation will be developed in consultation with the ALC and the land owners.

Mitigation Considerations for Richmond Backlands

The Project will require approximately 4.5 ha of land, made up of narrow portions of ten properties in Richmond (Property #36 to #45; **Appendix A, Figures 1h – 1k**), located along the Backlands. To ensure that the highway widening does not hinder future agricultural development, the Ministry will work with the City of Richmond in developing practical mitigation measures for the Backlands. Potential Project-related mitigation measures that may be considered include:

- Maintaining and/or improving drainage/irrigation ditches to meet Agricultural drainage criteria.
- Salvaging surplus topsoil from highway widening areas for use in the Backlands (to be negotiated on a farm by farm basis).
- Maintaining or improving farm infrastructure (including fencing and buffering).
- Exploring potential consolidation of parcels (led by the City of Richmond).
- Exploring long-term agricultural lease options (led by the City of Richmond).

5.4.4.4 **Offsetting**

5.4.4.4.1 Offset of Land in ALR

The Ministry has identified several parcels of Highway 99 ROW totalling 21.4 ha that are currently unused, are not required for the Project, and will be made available for future agricultural use (area shown as green crosshatched in **Appendix A, Figures 1k, 1l, 1p, 1q, 1v, 1y, and 1z**). This includes areas that are currently occupied by highway infrastructure, but will be made available for potential return to agricultural use as discussed below:

- Reconfiguration of the Highway 17A Interchange to reduce the amount of ALR land required in the north-east and south-west corners, removing the old roadway, and reclaiming the ground to connect portions of the old ROW with the adjacent fields. On completion, some of this land could be returned to production or other agricultural use (e.g. equipment or produce storage, livestock feeding).
- Reconfiguration of the Steveston Highway Interchange from the current cloverleaf design reduces the amount of ALR land required in the south east corner. The old roadbed and the filled median area would then be reclaimed and consolidated with the adjacent Richmond Farm parcel(s).

Most of the areas within the highway ROW identified for potential return to agricultural use would be restored and reclaimed to equal capability as adjacent cultivated areas in an effort to offset Project-related loss of agricultural land, in cooperation with local farmers. In most cases these parcels are located immediately adjacent to actively farmed lands and restoration would incorporate the “new” land into the adjacent field. In some limited locations, the site could be made available for agricultural infrastructure purposes such as processing or storage.

If all 21.4 ha of the available land within the Highway 99 ROW, as discussed above, are eventually developed for agricultural use, a net gain of approximately 1.4 ha of agricultural land will be achieved. Given that 2 ha out of the 20 ha that will be acquired for the Project is currently non-productive land, primarily paved, Project-related offsetting could result in an effective gain of up to 3.4 ha of land for agricultural use.

The practice of offsetting project-related removal of agricultural land by adding the same area of other land with equal or better agricultural capability is an effective method of reducing overall effects on agricultural use because it results in no net loss of capability. It is anticipated that the land that will be made available for agricultural use would be of similar or better capability in comparison to the land acquired for the Project, or improved such that there is no net loss in capability, ensuring effective mitigation.

In addition to returning available land within the highway ROW to agricultural production, other mitigation strategies that increase productivity and optimize use of existing agricultural lands in the ALR, as discussed below, will also be implemented:

- Construction of elevated guideways at Steveston Interchange and 17A Interchange to reduce the impacts to agricultural land on Richmond Country Farms in Richmond and provincial government properties in Delta.
- Salvaging topsoil from permanently disturbed areas for use in levelling depressional, poorly-drained areas of near-by farm fields and reclaiming ROW parcels for crop use.

The mitigation strategies that will be applied to the individual farm properties are currently being developed by the Ministry in consultation with the landowners. Detailed mitigation strategies (such as consolidation and reclamation plans) will be completed during detailed Project design, following submission of the application to the ALC.

5.4.5 Residual Effects and their Significance

Residual effects are those effects that remain after implementation of recommended mitigation measures. The preliminary design largely contains the Project within the existing highway ROW and thereby has limited the potential effects of the Project on agricultural use to the areas adjacent to the Project alignment, which make up a small portion of the LAA. With implementation of standard BMPs for highway construction and operation and the recommended mitigation measures (**Section 5.4.4**), it is expected that a number of the potential effects of the Project on agricultural use, as listed below, can be fully mitigated or offset.

Land in ALR

- It is anticipated that there will be a net gain in agricultural land with the return of available lands within the highway ROW to agricultural use following Project construction.

Irrigation and Drainage

- Potential effects of changes to drainage, irrigation, and irrigation water quality will be fully mitigated.

Farm infrastructure and Operations

- All potential Project-related effects, including the following, are expected to be fully mitigated
 - Degradation of agricultural soils
 - Changes to on-farm utilities
 - Effects on public access and security
 - Changes in the agricultural landscape and public perception

Only one potential residual effect of the Project on agricultural use is considered further in this assessment:

- Changes to farm parcel boundaries (Farm infrastructure and Operations Sub-Component). This includes changes to the shape, size and configuration of farm fields and access to farm property.

This potential residual effect was characterized by qualitatively assessing the direction, magnitude, geographic extent, duration, frequency, and reversibility of the effect. Definitions for the ratings applied to the residual effect are presented in **Table 5.4-10**. These ratings were developed with specific reference to agricultural use in the LAA and RAA, and reflect the importance of agriculture in the Lower Mainland, the relatively high productivity and value of agricultural land in the LAA, and the potential for on-going pressures on farm land from urban growth in the region.

Context: Agricultural land in the LAA and Project footprint are located in the ALR where agricultural is recognized as the priority use and is encouraged, and on which other land uses are controlled. Agricultural land in these areas are comprised of Class 1 and 2 lands that are considered some of the best agricultural lands in Canada as they are highly productive and can support a wide variety of crops. Even relatively small farm properties in the LAA can be economically viable for certain production systems, therefore the area has less resilience to development effects than other parts of BC with lower capability where farm properties tend to

be larger. Recognizing the importance of agricultural land in the Project area and the drainage and irrigation infrastructure that supports it, the Ministry has designed the Project to accommodate the proposed works predominantly within the existing Highway 99 ROW, minimizing the need for land acquisitions in the ALR, and identified land parcels within the highway ROW that will be returned to agricultural production, resulting in a net gain in agricultural land. In this context, agricultural use in the LAA is expected to be resilient to minor changes in land parcel boundaries of a limited number of farms.

Table 5.4-10 Criteria Used to Characterize Residual Effects on Agricultural Use

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|--|
| Direction | Overall nature of the residual effect | Adverse | Measureable negative effect on agricultural capability or farm viability |
| | | Positive | Measureable positive effect on agricultural capability or farm viability |
| | | Neutral | No or non-detectable effect on agriculture |
| Magnitude | Amount of the effect relative to natural or baseline conditions | Negligible | Effect not detectable at farm or LAA scale |
| | | Low | Effects detectable but will not affect farm viability |
| | | Moderate | Effects could affect viability of individual farms |
| | | High | Effects could influence farm activity in LAA |
| Extent | Geographic extent / distribution of the residual effect | Site | Limited to directly affected farm properties |
| | | Local | Effect detectable on farms beyond footprint in LAA |
| | | Regional | Effect detectable on farms beyond footprint in RAA |
| Duration | Length of time over which the residual effect is expected to persist | Transient term | Limited to field investigations or <1 month during construction |
| | | Short term | Limited to Project construction phase |
| | | Moderate term | Will affect VC during first five years of operation |
| | | Long term | Effect is permanent |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|--|
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor impacts the VC) | Once | Residual effect will occur once. |
| | | Rare | 1-2 times per year and intermittently |
| | | Uncommon | 3-5 times per year and intermittently |
| | | Frequent | More than 5 times per year or for extended periods |
| | | Continuous | Continuous or ongoing |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or following a period of time after the disturbance has ceased) | Reversible | Existing conditions will be restored after effect has ceased |
| | | Irreversible | Existing conditions will not be restored after effect ceases |
| | | Change | Effect may fluctuate between positive and adverse for the duration |
| Likelihood | Likelihood that the residual effect may occur | Low | Likelihood of residual effect is less than 25%. |
| | | Moderate | Likelihood of residual effect is between 25% and 75%. |
| | | High | Likelihood of residual effect is greater than 75%. |

5.4.5.1.1 Changes to Farm Parcel Boundaries

Changes to farm parcel boundaries resulting from the Project will be limited to three farm fields; however, parcel boundary changes can potentially affect the viability of these farm operations. This is primarily related to changes in field size and configuration or shape, which can make it challenging to farm a parcel.

A summary of criteria ratings to determine the significance of changes to farm parcel boundaries and field configurations on agricultural use is provided in **Table 5.4-11**. In general, boundary changes will reduce the agricultural viability of some individual farms that are directly affected by the Project by permanently changing the configuration of fields and reducing their land base. Boundary changes are not expected to affect agricultural viability of lands outside of the areas that overlap with the Project alignment.

Table 5.4-11 Summary of Criteria Ratings for Changes to Farm Boundaries

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|---|
| Direction | Adverse | Changes to farm parcel boundaries may result in adverse effects on individual farm viability due to revised field configuration and reduced land-base. |
| Magnitude | Moderate | Effects may affect viability of the farm configuration on one farm and potentially affect the viability of other individual farms. Three individual farms fields will be directly affected. |
| Extent | Limited | Changes to farm parcel boundaries are limited to directly affected farm properties. |
| Duration | Long term | Changes to farm parcel boundaries are considered permanent since the affected areas will be used for expansion of Highway 99, and upgraded drainage and utility infrastructure. |
| Frequency | Once | One-time change in farm boundaries. |
| Reversibility | Irreversible | Changes to farm parcel boundaries are considered permanent. |
| Likelihood | High | Based on current Project design concept, the likelihood of changes to three farm parcel boundaries is greater than 75%. |

5.4.5.2 Proponent's Determination of Significance

5.4.5.2.1 Significance Definition

Agricultural use of lands in the LAA and RAA has been subject to pressures from land and infrastructure development for more than 50 years. The existing provincial and local government regulatory frameworks for agricultural land management do not specify quantitative thresholds that, if exceeded, would indicate significant effects. Therefore, the significance definitions for this effects assessment are based on the ability for agricultural land use to continue, consistent with the B.C. Environmental Assessment Office guidelines (B.C. EAO 2013). For an adverse residual effect to be considered significant, one or more of the following conditions would apply:

- It results in one or more farms becoming non-viable as an agricultural business because of land loss, soil damage, long-term alteration of drainage or water supply, or constraints on farm operations.
- The collective effect on individual farms is comparable to an effect that would make a farm business non-viable.
- The geographic extent of residual effects goes beyond farms that directly overlap with Project components and extends into the LAA or RAA such that the additive constraints on agricultural use are detectable.

5.4.5.2.2 Significance Determination

The residual effects on farm parcel boundaries are not considered significant because they affect only three farm fields (Properties #62, #67, and #68; **Appendix A, Figures 1n, 1p, and 1q**) within the Project alignment, and these effects can be offset to a substantive degree. Residual effects on Properties #67 and #68, which are provincially-owned, can be offset by parcel consolidation with adjacent properties. The details of the planned consolidation will be developed with the ALC as part of the process to obtain Project authorization under the ALR Regulation. Project construction/operation on Field #62 would result in the removal of 2.0 ha and leave approximately 7.7 ha in a triangular shape that may create some practical challenges for farming a portion of the parcel. The Ministry will work with the property owner to develop mitigation measures to ensure the property remains as a viable farm.

5.4.5.3 Confidence and Risk

Prediction of confidence was based on the assumption that the alignment shown on **Appendix A** is a reasonably accurate representation of the Project footprint, that the information obtained from farm owner/operator meetings is reliable, and that the recommended mitigation measures will be implemented. With respect to mitigation measures, the confidence associated with the effectiveness of the mitigation measures is that most have been tested on other highway projects in B.C. by the Ministry, with proven success.

Low, moderate, or high confidence reflects the level of uncertainty associated with determinations of likelihood and significance. The level of confidence in the effects prediction for agricultural use, associated with both the significance determination and the likelihood, is high because the final project footprint will be subject to only very minor revisions during detailed Project design.

Given the confidence level in the effects prediction and the anticipated negligible residual effects, risk is determined to be low and risk analysis is not required (see methods **Section 3.9 Confidence and Risk**).

5.4.5.4 Summary of Residual Effects

Changes to farm parcel boundaries can affect the viability of a farm operation by making the remaining area of the parcel too small to be farmed and/or by resulting in a shape that is impractical for farm machinery to operate. Residual effects associated with farm parcel boundary changes will be limited to three farm fields (Properties #62, #67, and #68; **Appendix A, Figures 1n, 1p, and 1q**) located in Delta. These residual effects can be largely offset by consolidating the parcels with adjacent properties, such that the parcels can continue to be farmed. Based on this, Project-related residual effects related to change in farm parcel boundaries is assessed to be not significant.

5.4.6 Cumulative Effects

As discussed in **5.4.5**, the only residual effect of the Project on agricultural use is changes to farm parcel boundaries on three farm parcels. Influence of this residual effect on agricultural viability can largely be mitigated through consolidation with adjacent properties such that the impact to the overall agricultural viability of these farm operations is minor.

The residual effect to the three parcels was compared to the Project inclusion list in **Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**, with particular attention to the spatial overlap of these projects. No overlap or interaction is expected; thus, no cumulative effects are expected to occur that will further contribute to the reduction of agricultural viability of these farms.

5.4.7 Follow-up Strategy

An Agriculture Management Plan will be developed and implemented as part of the construction and operations-phase environmental management plans (CEMP and OEMP, **Section 12.0 Management Plans**). The plan will include a monitoring program and the involvement of qualified professional environmental monitors (e.g., Professional Agrologists). Where soil stockpiling activities are required (such as topsoil recovery and in temporary laydown areas located in the ALR), an environmental monitor will be present during soil salvaging operations to

ensure that soils are salvaged and stockpiled appropriately and to record volumes of salvaged material. Stockpiled soils will include erosion protection measures and will be inspected after heavy rainfall events to ensure erosion and sedimentation measures are effective.

Reclamation plans will be prepared for all temporary work areas and following restoration, the temporary work areas will be inspected by qualified professionals to ensure compliance with the reclamation plans.

Erosion and Sediment Control Plans will be prepared during detailed design of the Project, and qualified professionals will monitor the installation and operational effectiveness of sediment and erosion control structures and measures.

The Project team will work with municipal staff and individual farm operators to schedule relocation or disruptions of highway ditches that also serve as drainage/irrigation ditches to periods when potential effects on farming operations will be minimal. The environmental monitor will also inspect field drainage ditches on affected properties to make sure that this network continues to function properly during construction. This will include regular consultation with affected property owners, particularly during the growing season, to ensure that ditches are functioning properly and that fields are not being flooded or damaged. The environmental monitor will also ensure farm access to the existing ditches (for irrigation), or the new ditches, when sufficient water is available in the ditch system during the irrigation season.

Following Project construction, on-going monitoring will be conducted to ensure reconstructed ditches are functioning as intended. During this period, follow-up meetings with affected property owners will be held to address any outstanding issues related to drainage and irrigation.

5.4.8 References

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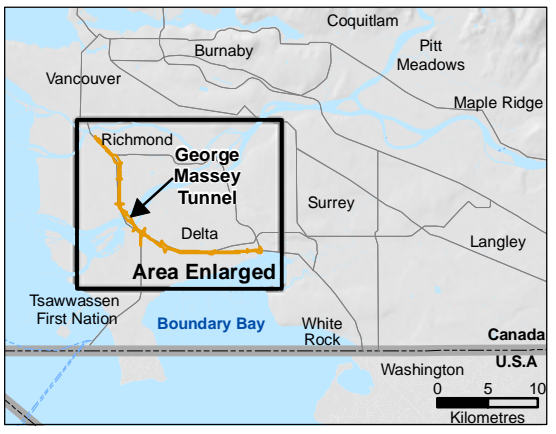
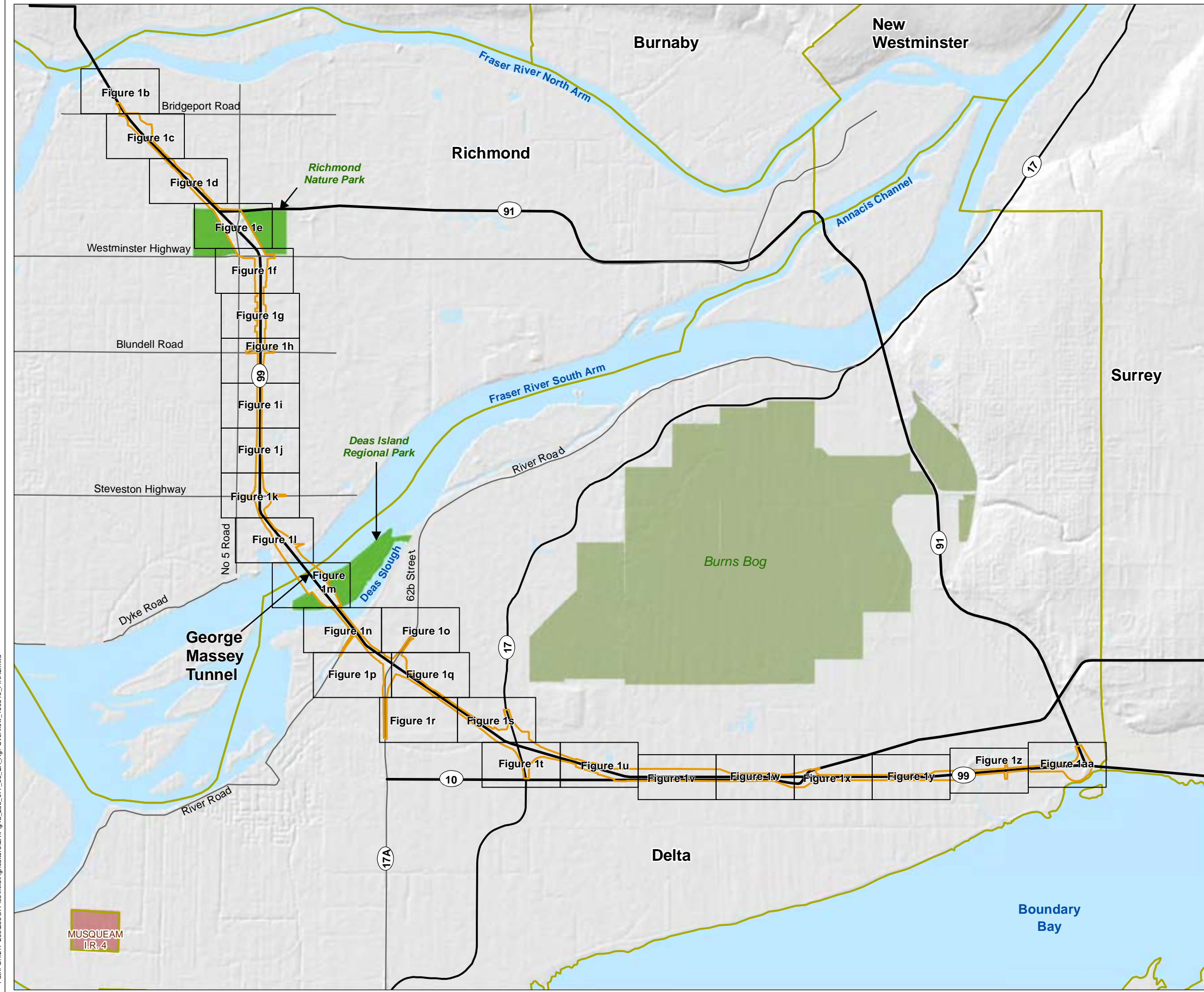
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APPENDIX A

Maps

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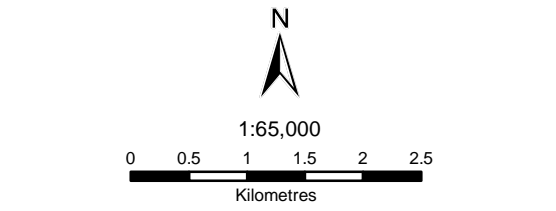


Legend

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

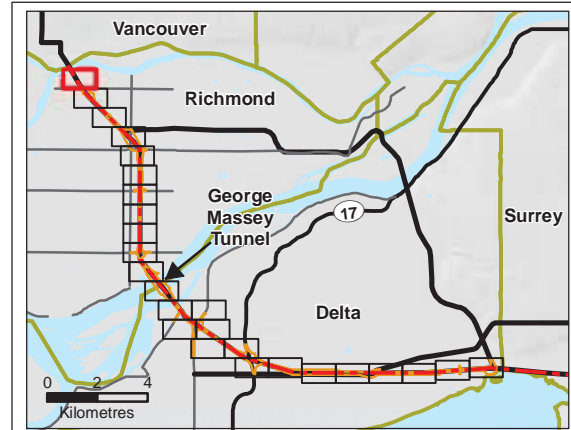
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY OVERVIEW

| | |
|-----------|------------|
| Figure 1a | 16/05/2016 |
|-----------|------------|



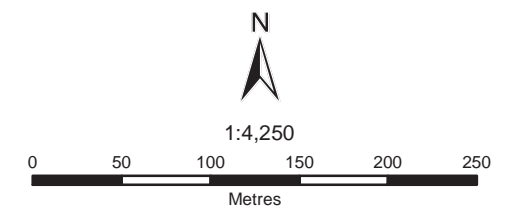
Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon
 dominant agricultural class (unimproved) **Crescent**
 polygon no. 3/1
 agricultural class (improved) 742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



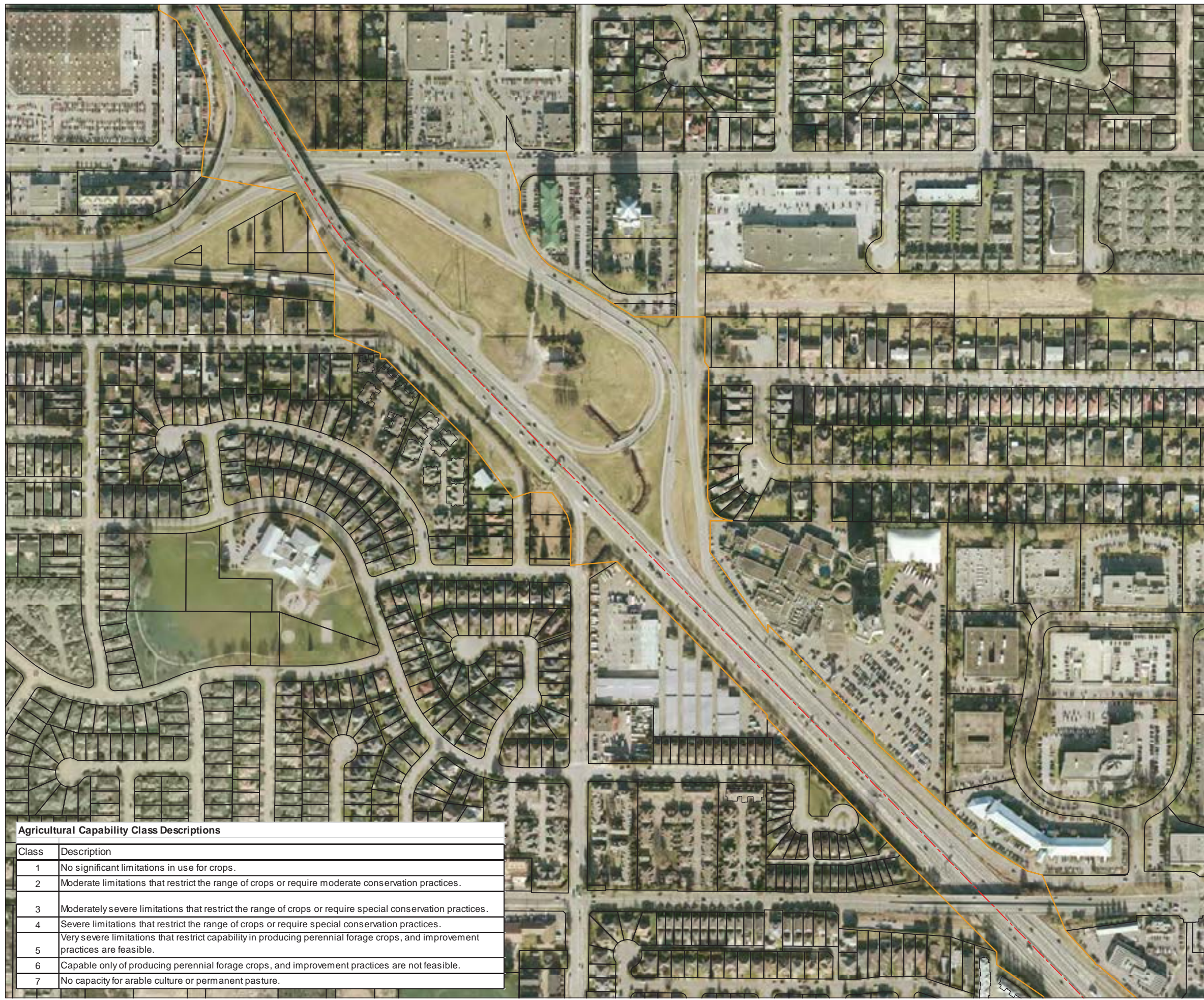
| Agricultural Capability Class Descriptions | |
|--|---|
| Class | Description |
| 1 | No significant limitations in use for crops. |
| 2 | Moderate limitations that restrict the range of crops or require moderate conservation practices. |
| 3 | Moderately severe limitations that restrict the range of crops or require special conservation practices. |
| 4 | Severe limitations that restrict the range of crops or require special conservation practices. |
| 5 | Very severe limitations that restrict capability in producing perennial forage crops, and improvement practices are feasible. |
| 6 | Capable only of producing perennial forage crops, and improvement practices are not feasible. |
| 7 | No capacity for arable culture or permanent pasture. |

**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

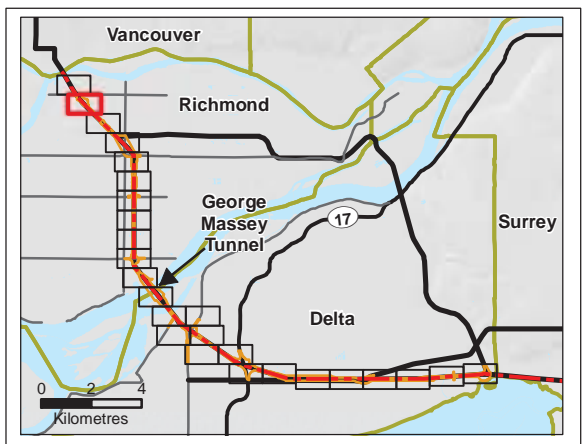
Figure 1b 18/5/2016

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Agricultural Capability Class Descriptions

| Class | Description |
|-------|---|
| 1 | No significant limitations in use for crops. |
| 2 | Moderate limitations that restrict the range of crops or require moderate conservation practices. |
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| 7 | No capacity for arable culture or permanent pasture. |



Legend

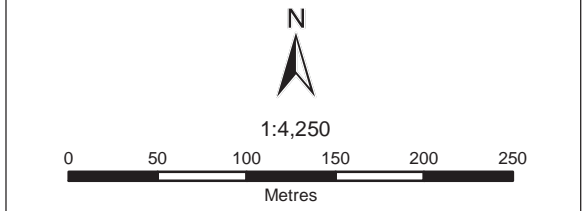
- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon
 Soil type
 dominant agricultural class (unimproved)
 polygon no.
 agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

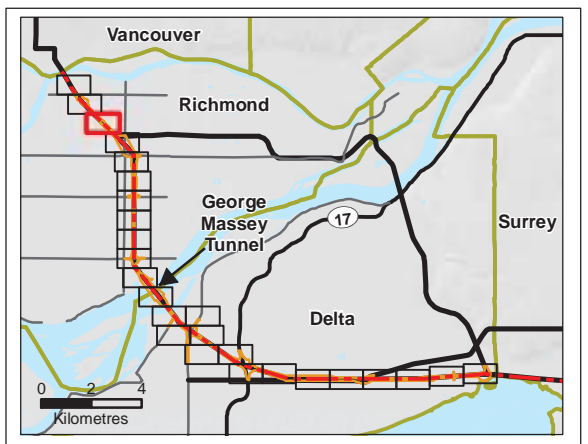
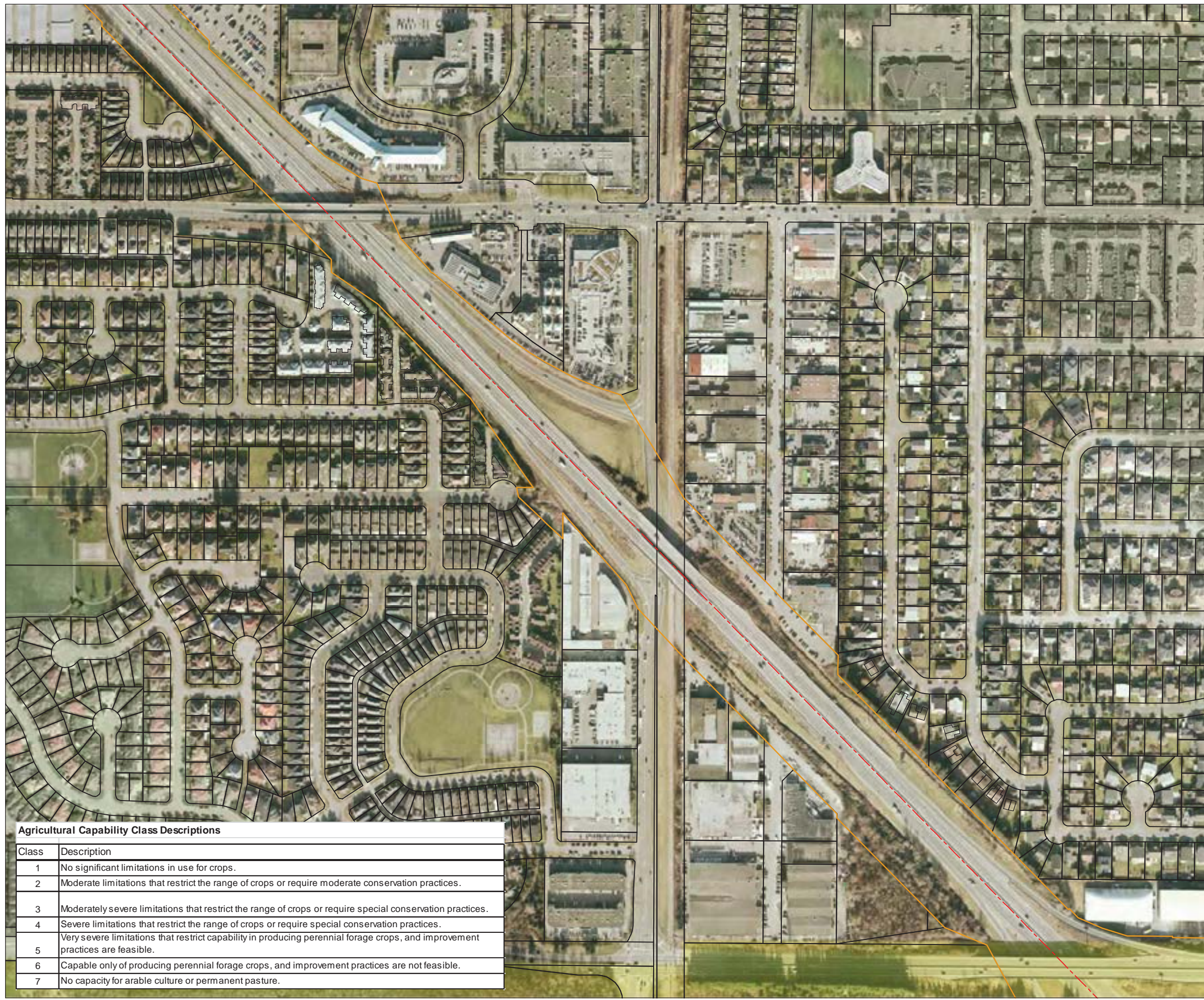


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1c 18/5/2016

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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

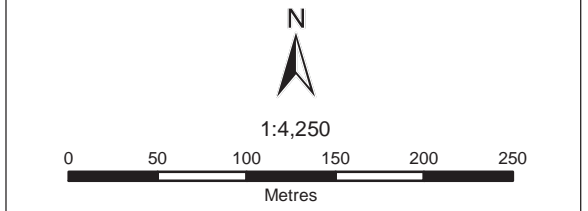
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



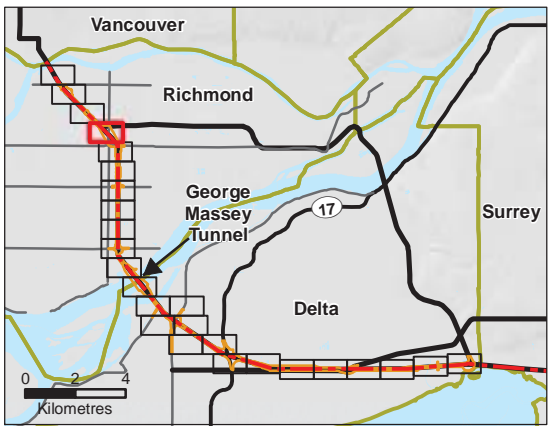
Agricultural Capability Class Descriptions

| Class | Description |
|-------|---|
| 1 | No significant limitations in use for crops. |
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| 5 | Very severe limitations that restrict capability in producing perennial forage crops, and improvement practices are feasible. |
| 6 | Capable only of producing perennial forage crops, and improvement practices are not feasible. |
| 7 | No capacity for arable culture or permanent pasture. |

**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1d 18/5/2016



Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

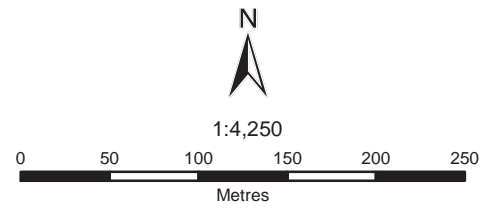
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3 / 1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

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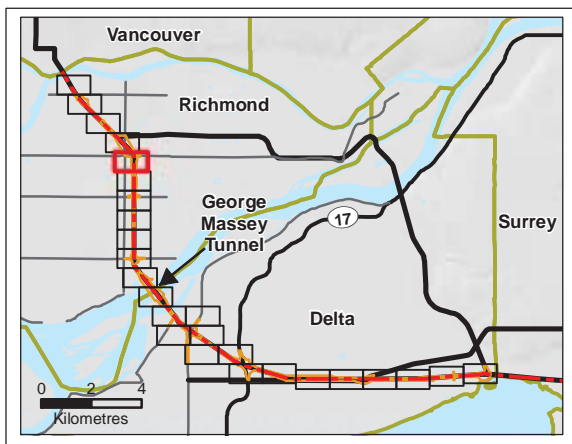
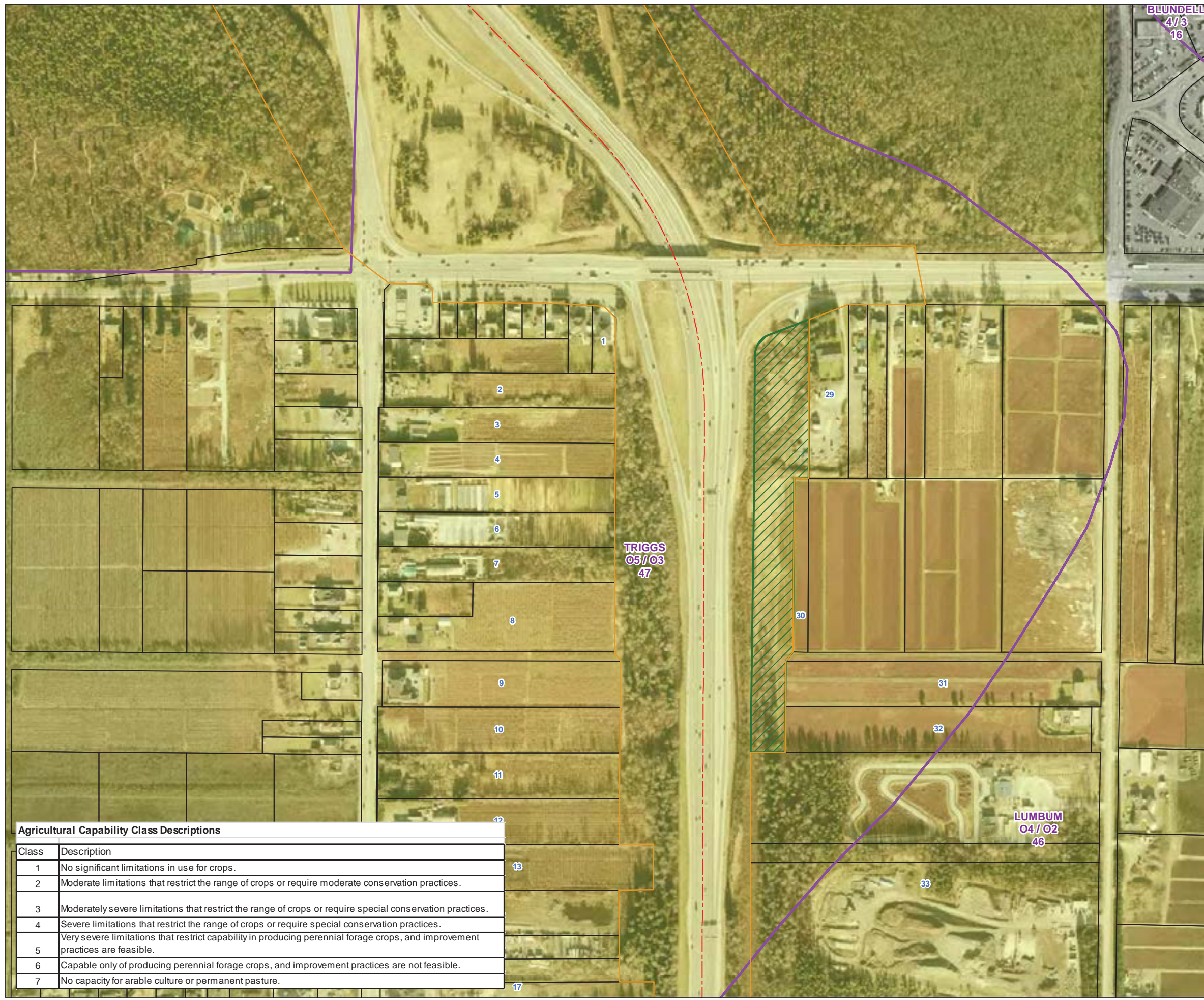
**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1e 18/5/2016

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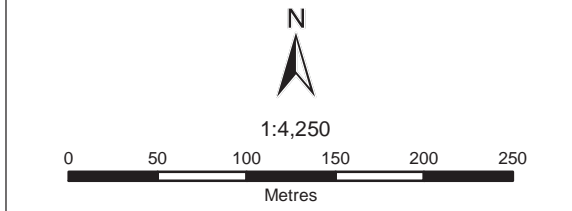
- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon
 Soil type
 dominant agricultural class (unimproved)
 polygon no.
 agricultural class (improved)

Crescent
 3 / 1
 742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



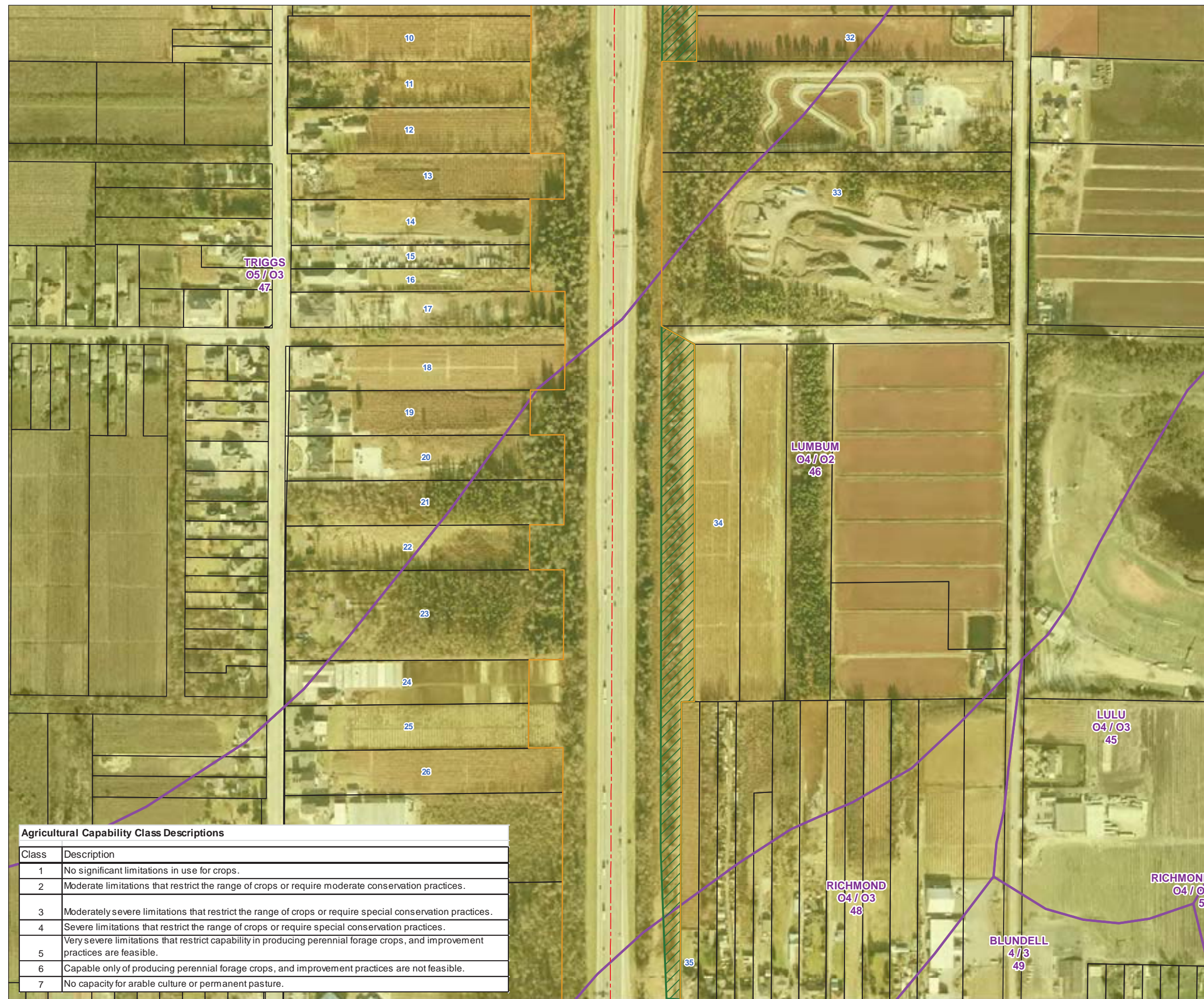
Agricultural Capability Class Descriptions

| Class | Description |
|-------|---|
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

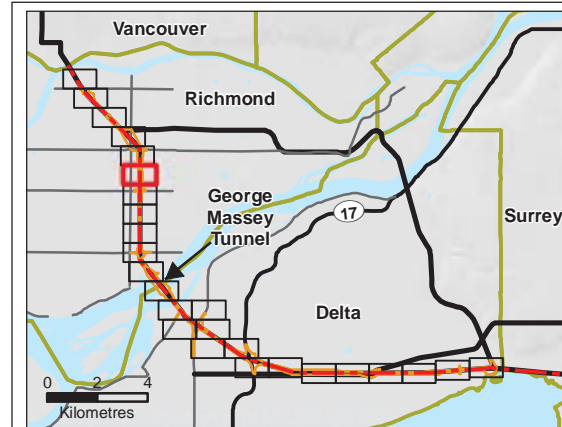
AGRICULTURAL USE STUDY

Figure 1f 18/5/2016



Agricultural Capability Class Descriptions

| Class | Description |
|-------|---|
| 1 | No significant limitations in use for crops. |
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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

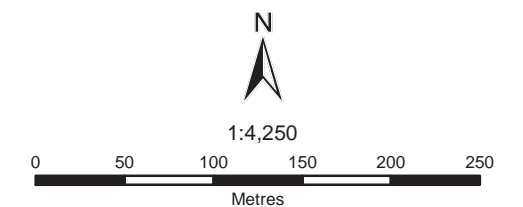
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3 / 1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

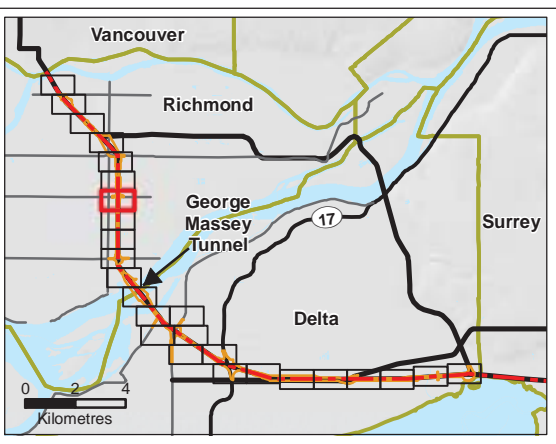
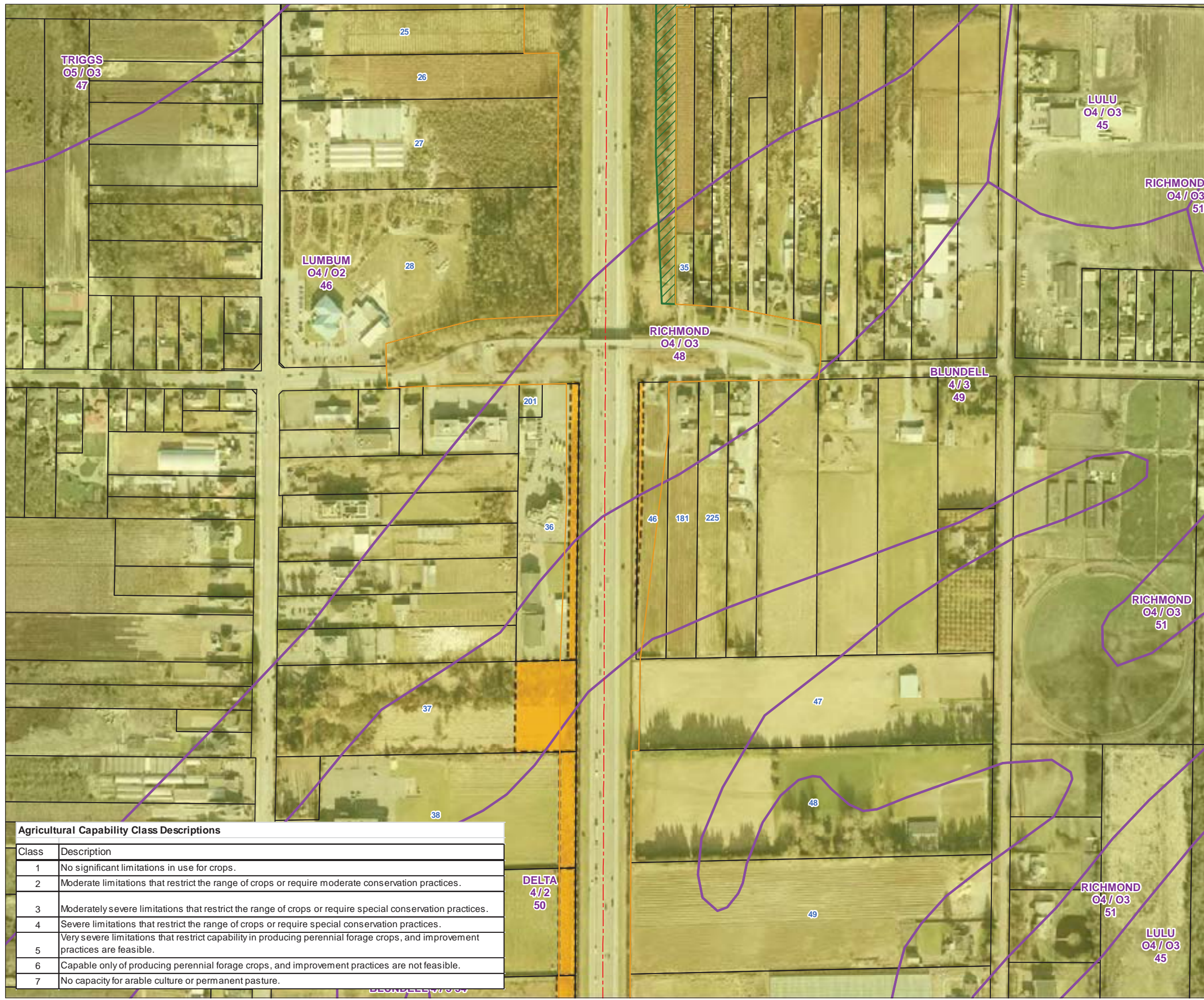


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1g 18/5/2016

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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

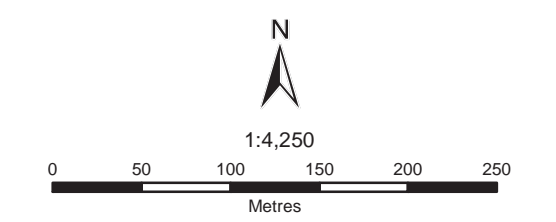
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

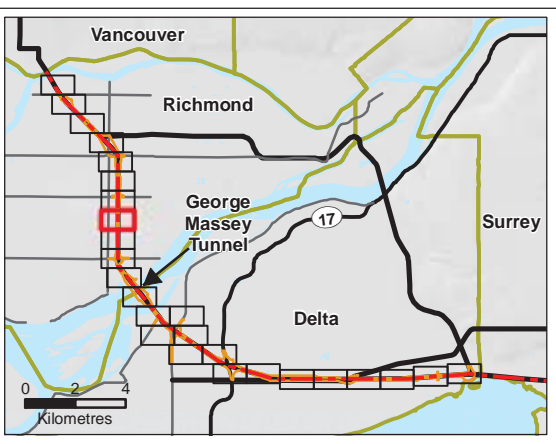
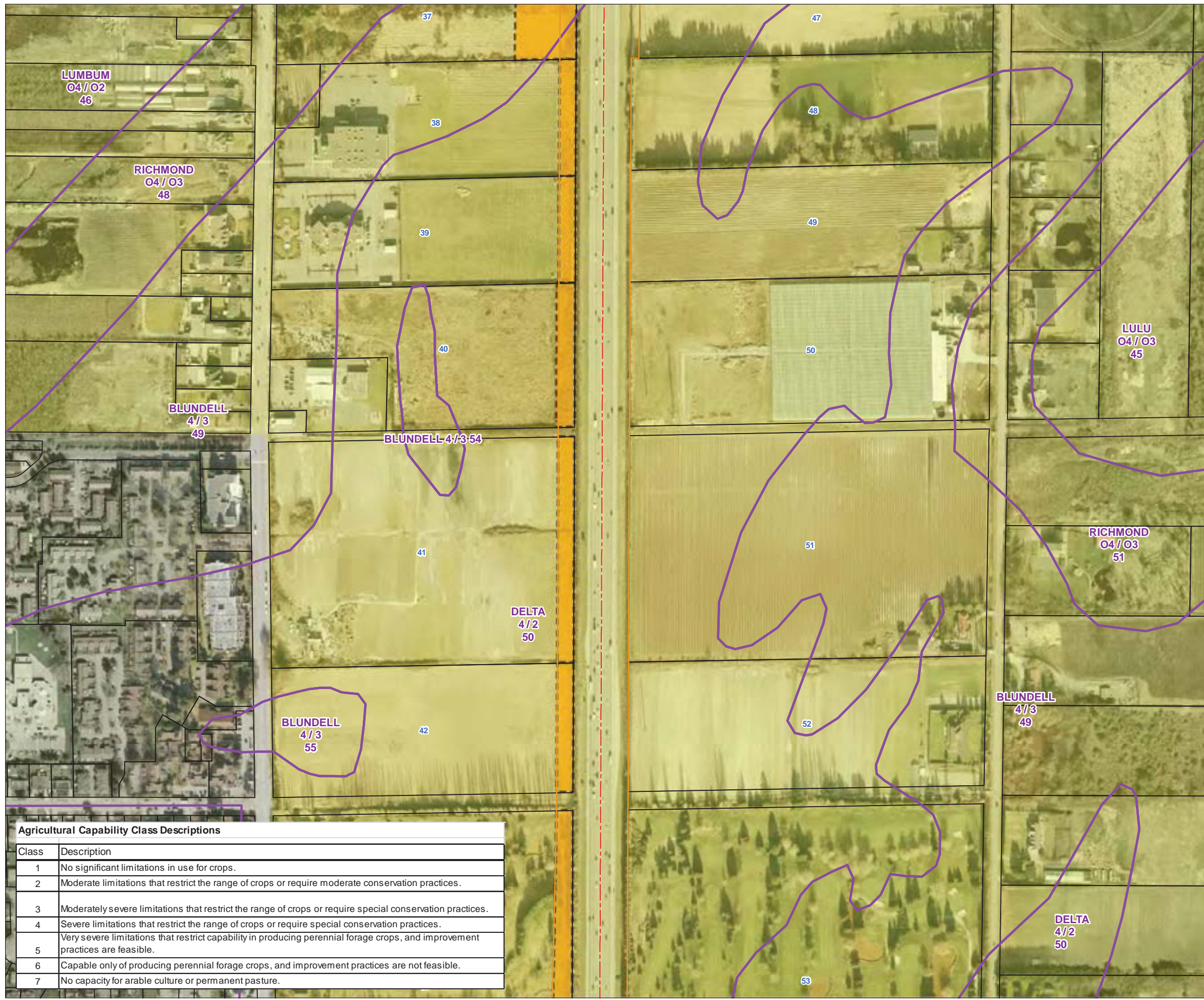
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| 7 | No capacity for arable culture or permanent pasture. |

**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

| | |
|-----------|-----------|
| Figure 1h | 18/5/2016 |
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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

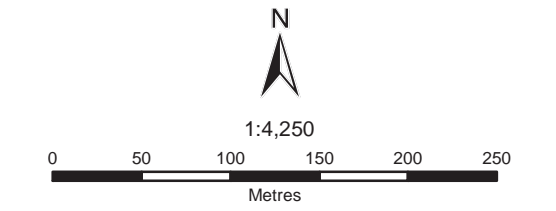
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

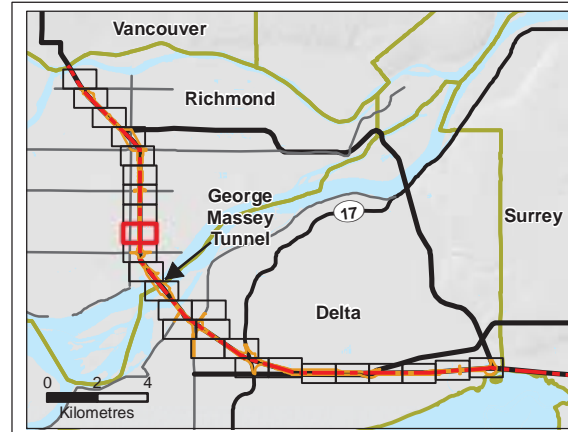
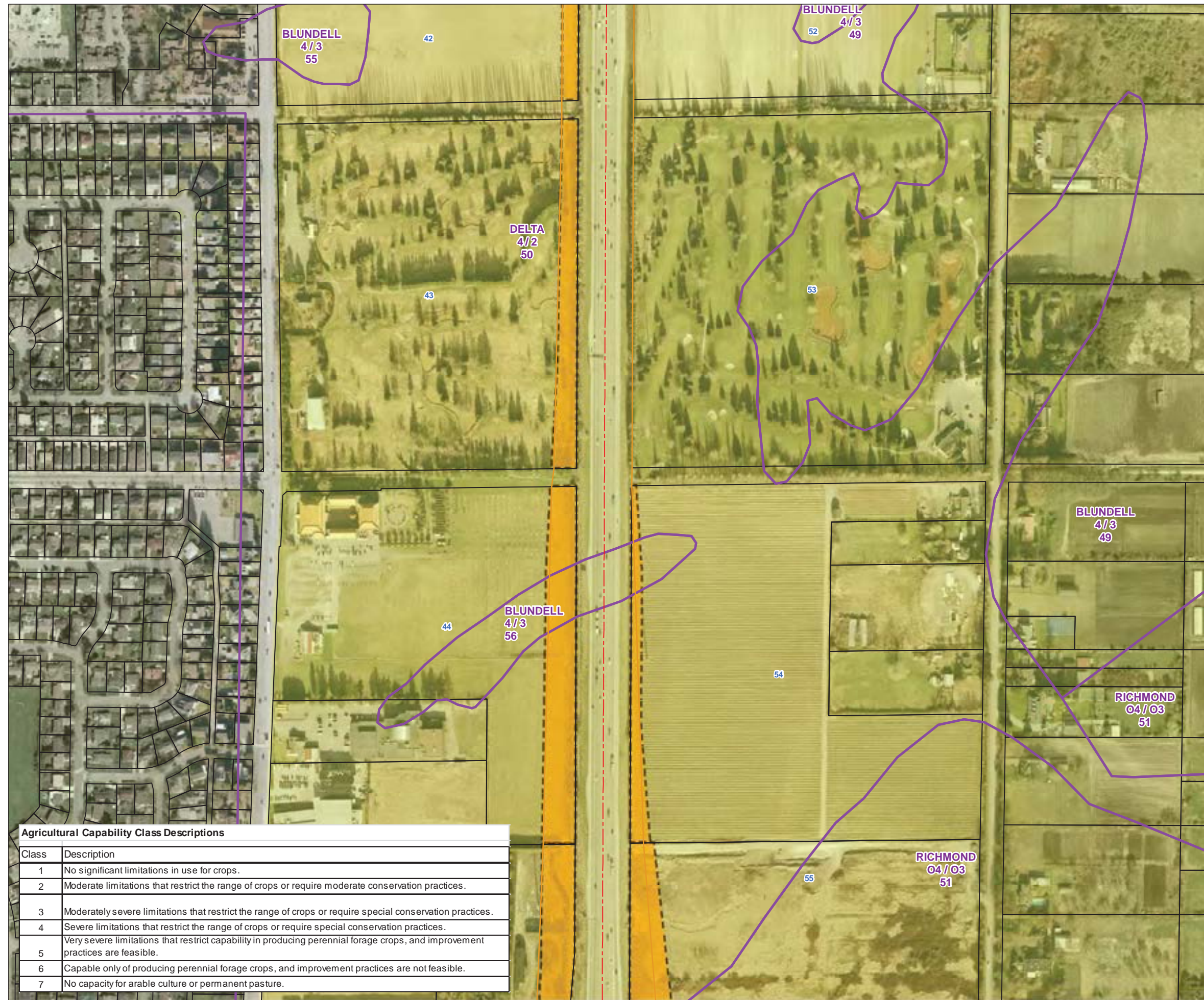
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| 7 | No capacity for arable culture or permanent pasture. |

**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1i 18/5/2016

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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

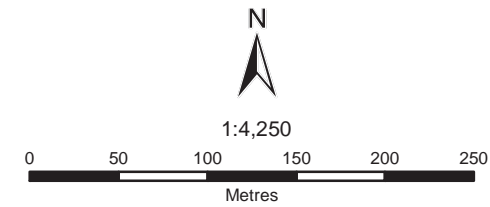
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



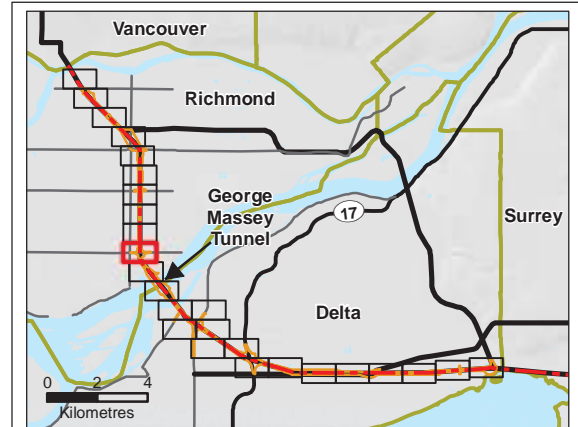
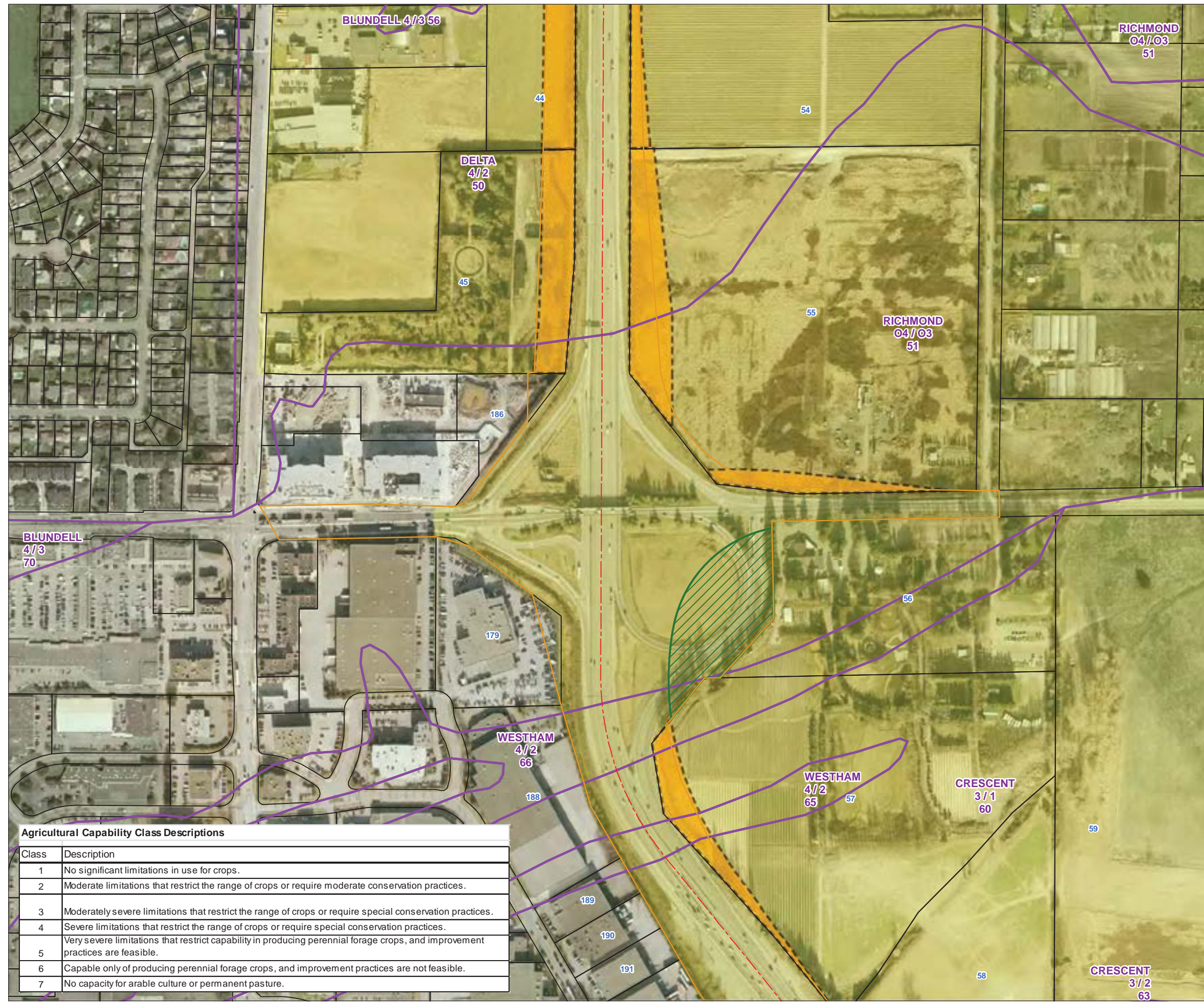
Agricultural Capability Class Descriptions

| Class | Description |
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1j 18/5/2016



Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

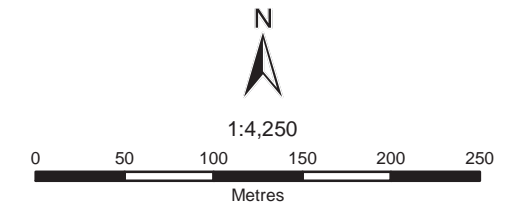
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Example: Crescent 3/1 742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| 6 | Capable only of producing perennial forage crops, and improvement practices are not feasible. |
| 7 | No capacity for arable culture or permanent pasture. |

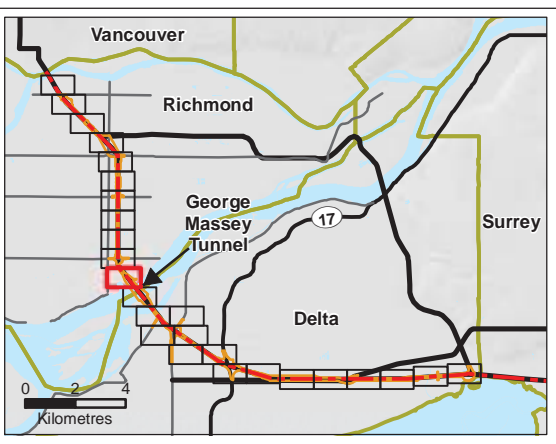
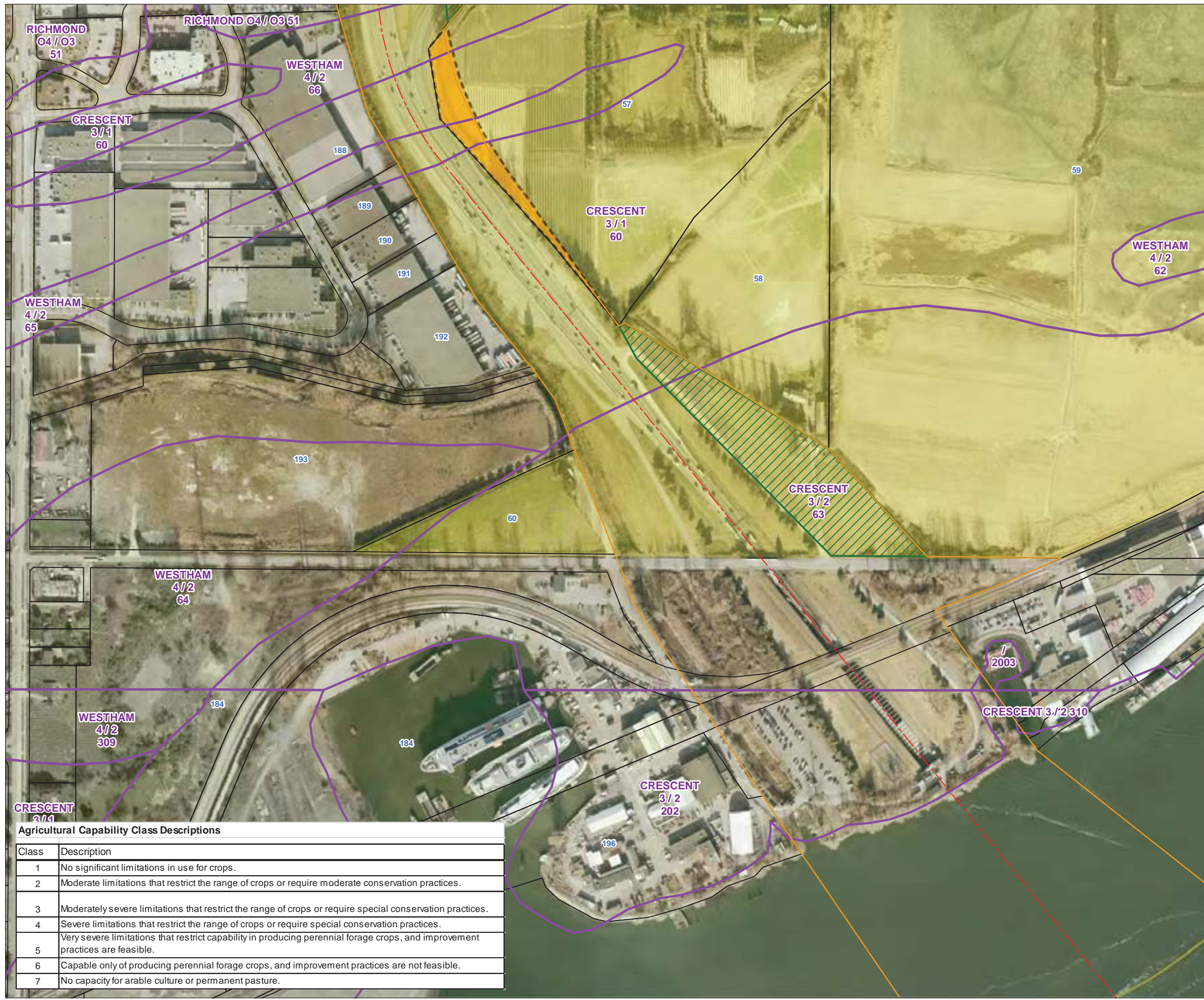
**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1k 18/5/2016

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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

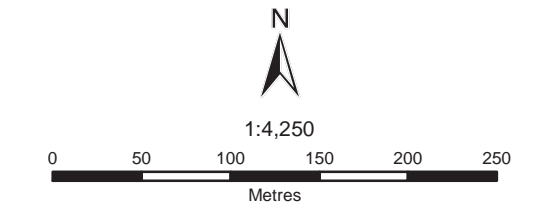
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Example: Crescent 3/1 742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

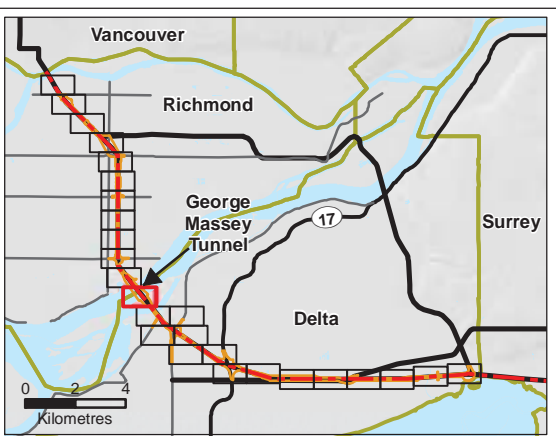
| Class | Description |
|-------|---|
| 1 | No significant limitations in use for crops. |
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 11 18/5/2016

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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

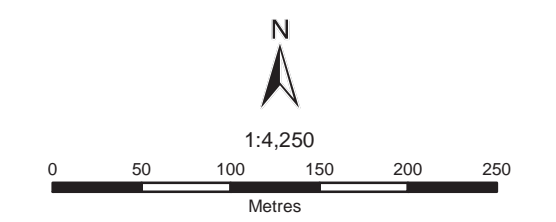
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent 3/1 742

SOURCES

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Agricultural Capability Class Descriptions

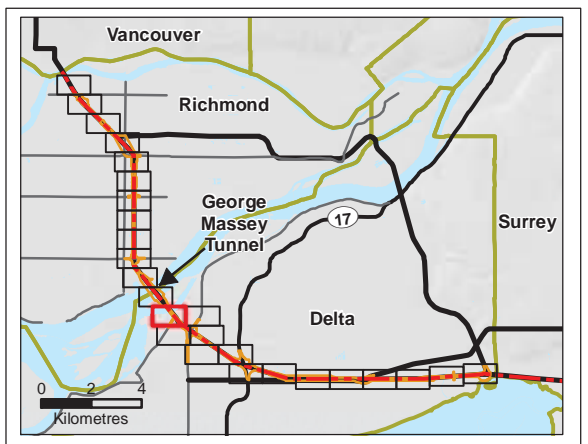
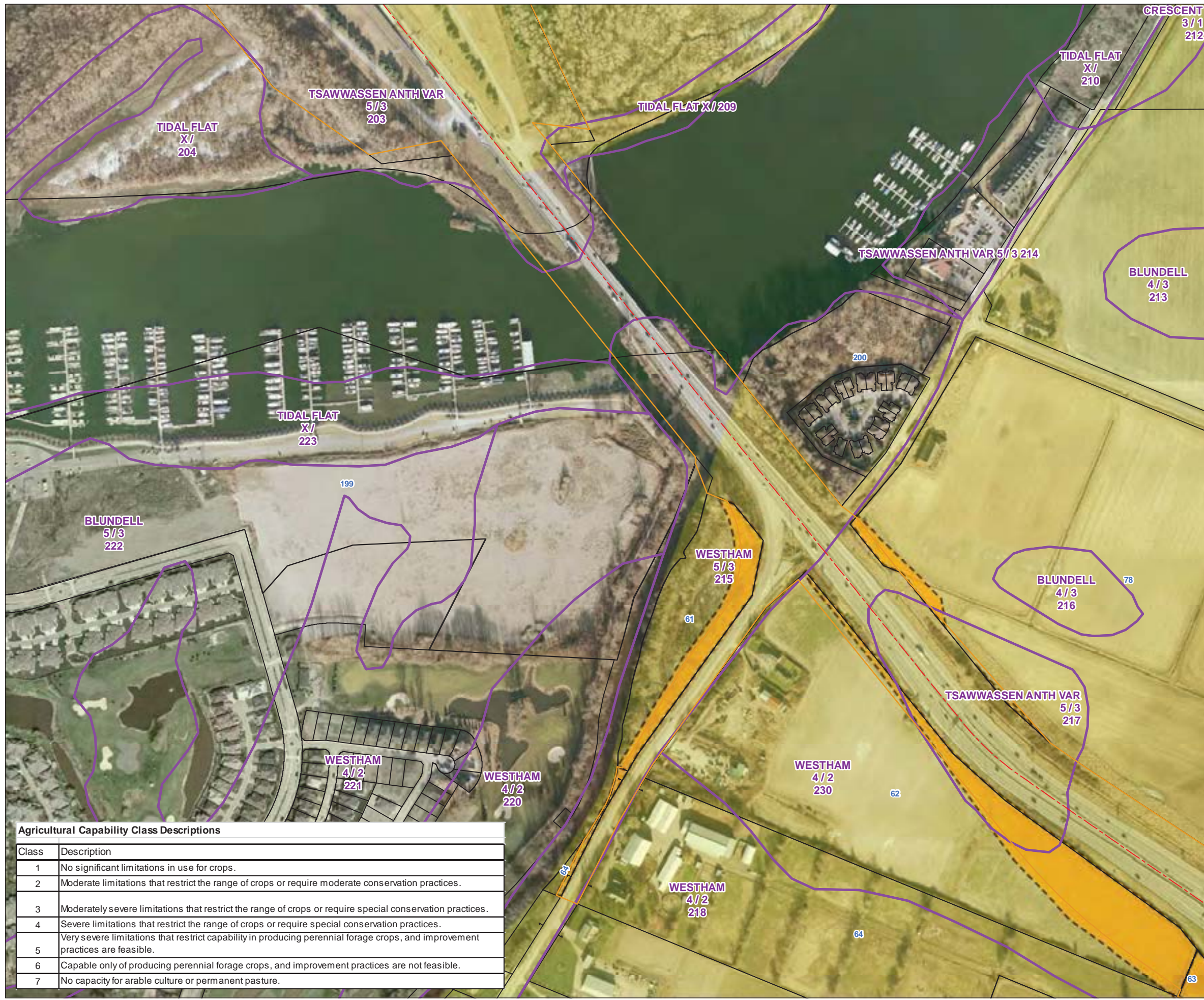
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

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| Figure 1m | 18/5/2016 |
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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

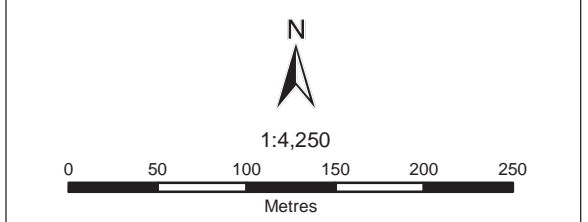
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



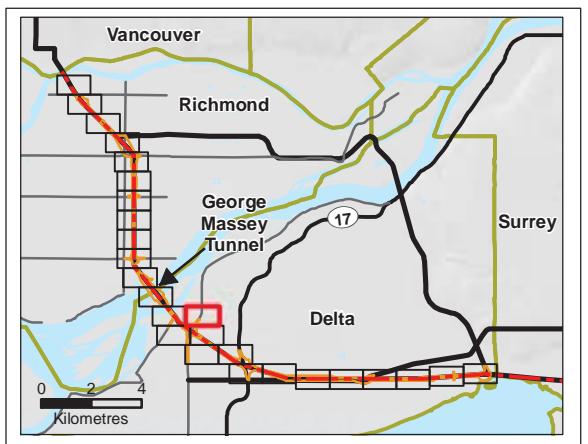
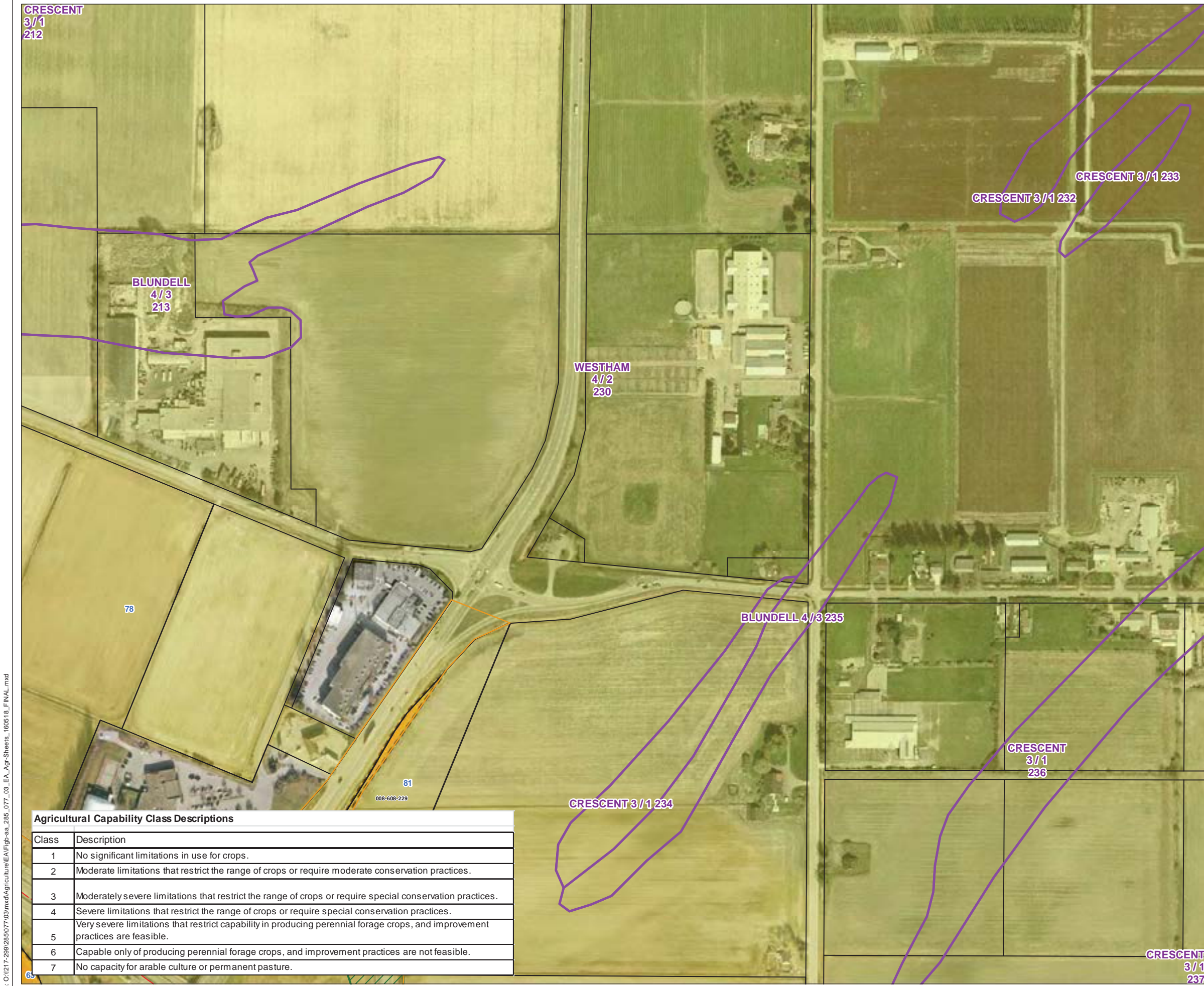
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1n 18/5/2016



Legend

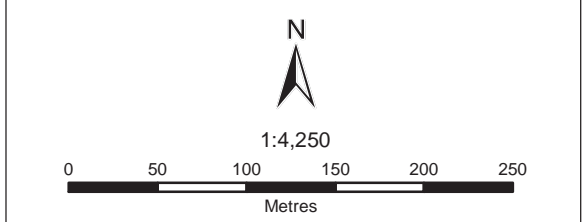
- Project Alignment
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- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

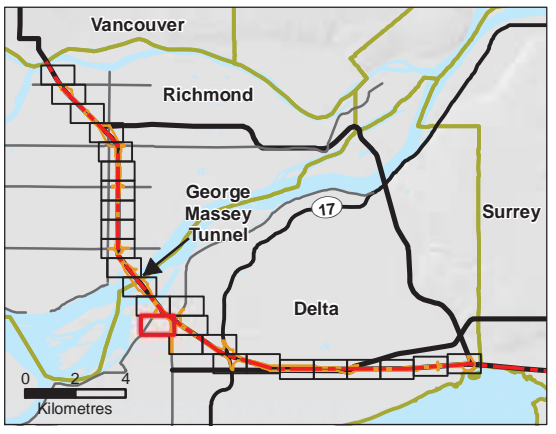
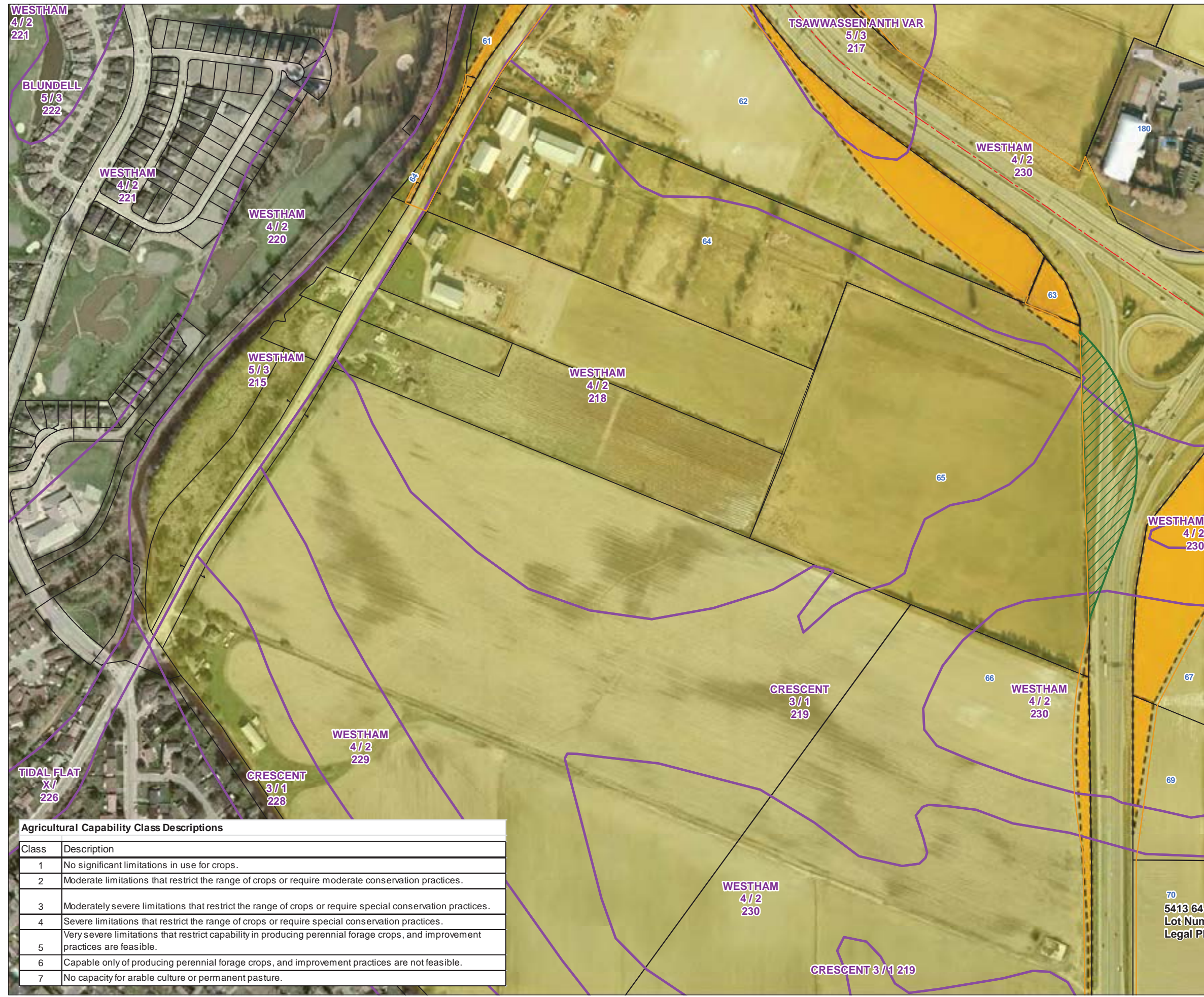
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Agricultural Capability Class Descriptions

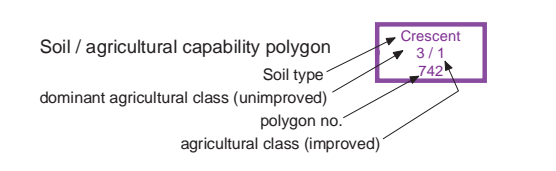
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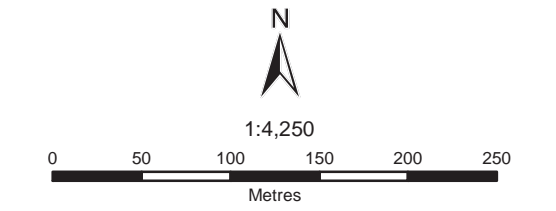


- Legend**
- Project Alignment
 - Hwy 99 centreline
 - Soil / agricultural capability polygon
 - Lands available for agriculture
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 - Parcels
 - Municipal Boundaries



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Agricultural Capability Class Descriptions

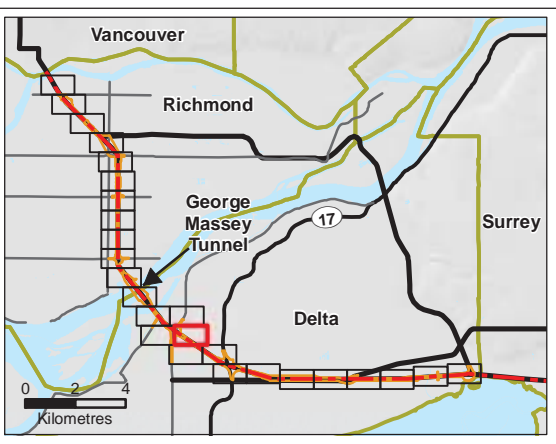
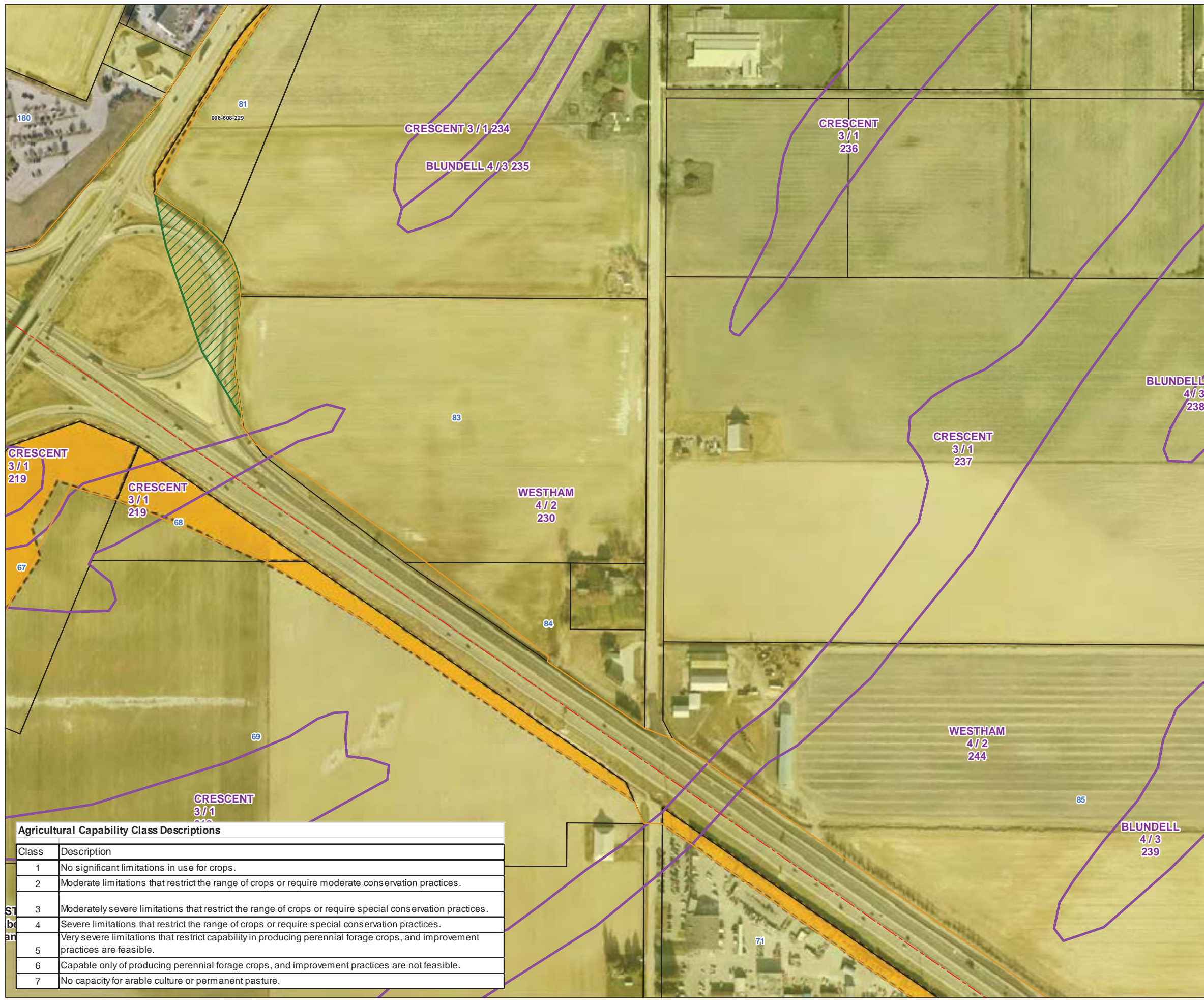
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

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| Figure 1p | 18/5/2016 |
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Legend

- Project Alignment
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- Soil / agricultural capability polygon
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- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

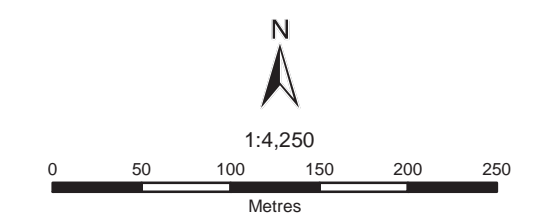
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent 3/1 742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

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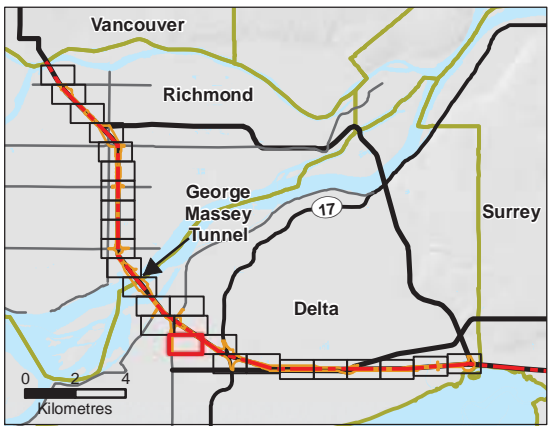
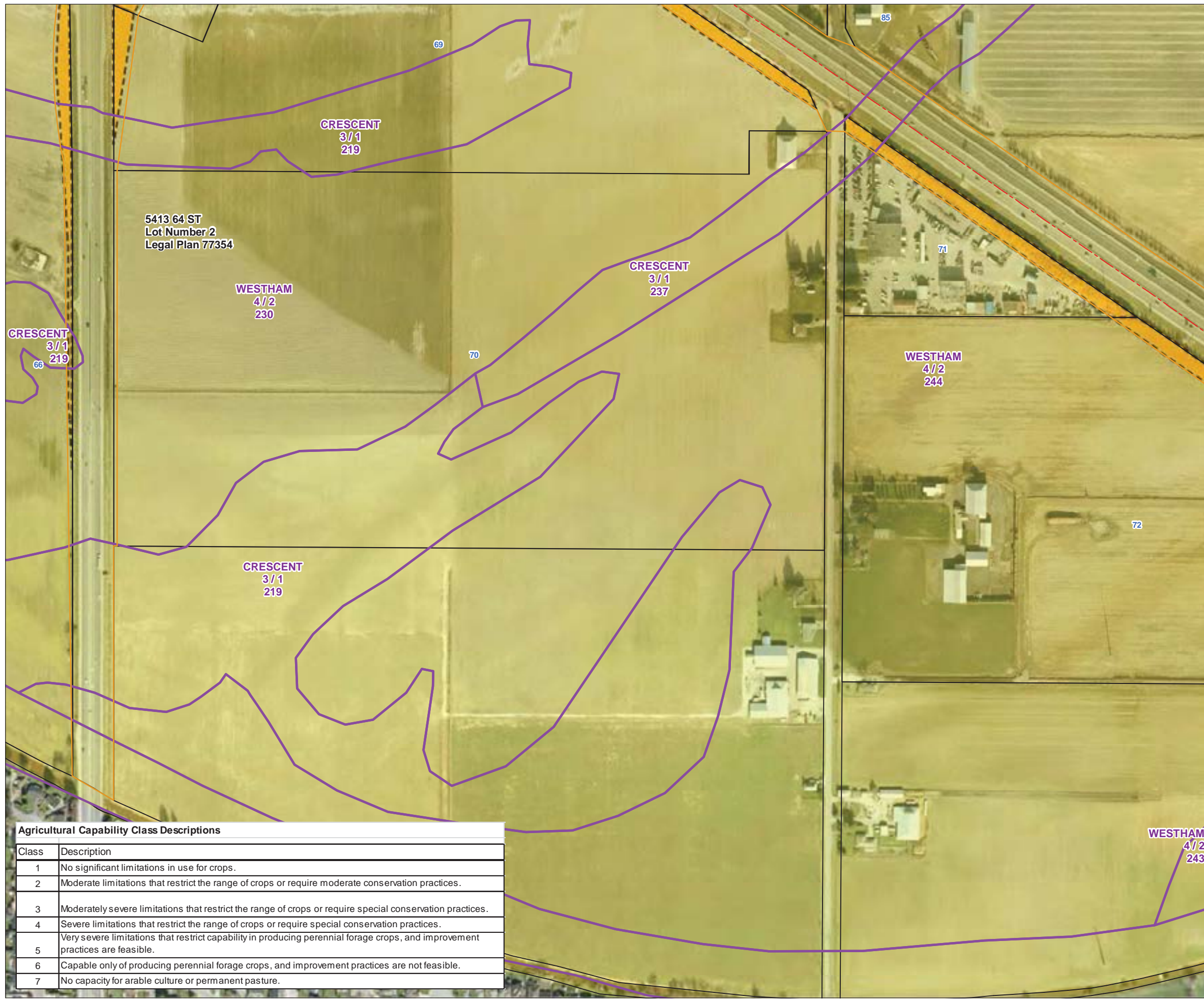
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

AGRICULTURAL USE STUDY

Figure 1q 18/5/2016

George Massey Tunnel Replacement Project BC 095 PLR B.C. on the Move

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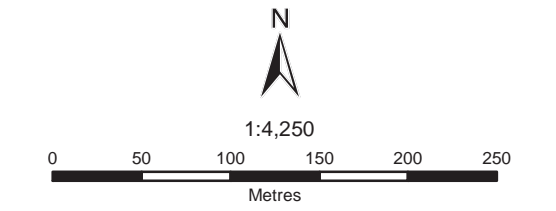
- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

SOURCES

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Agricultural Capability Class Descriptions

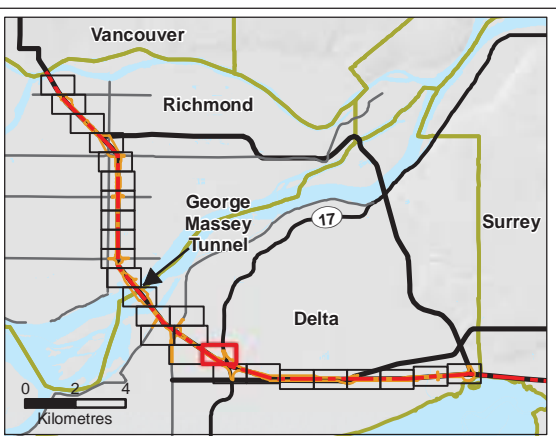
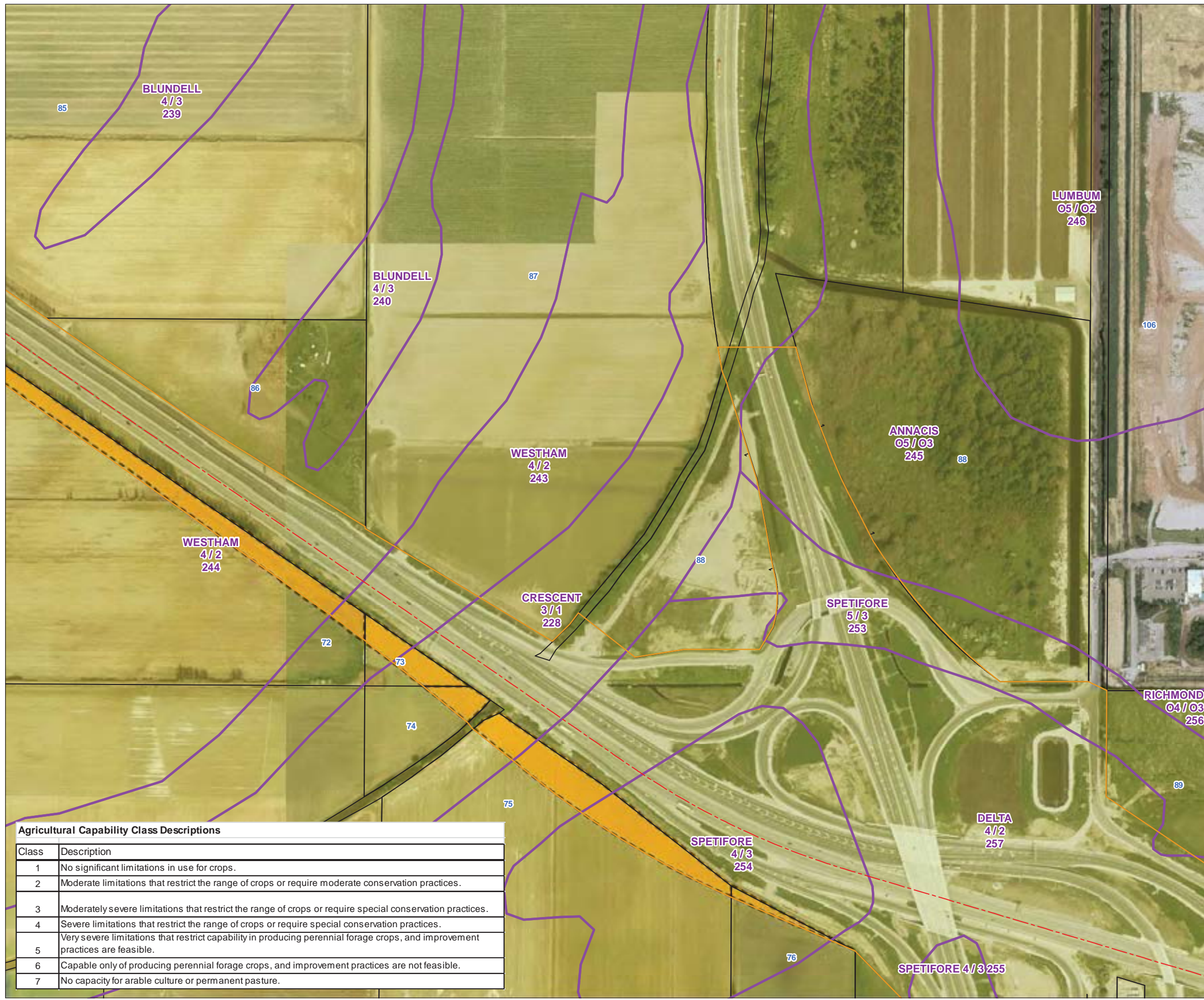
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1r 18/5/2016

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Legend

- Project Alignment
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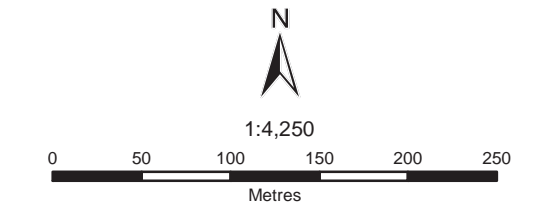
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Example: Crescent 3/1 742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

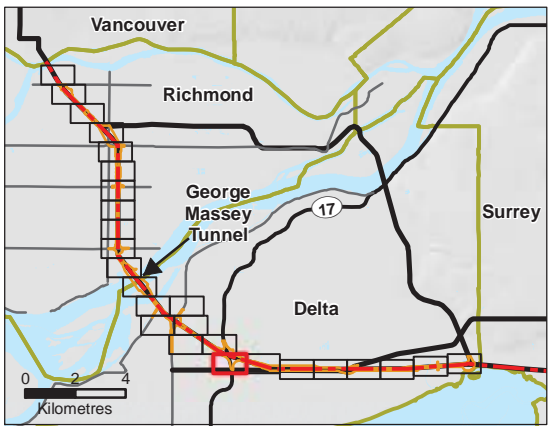
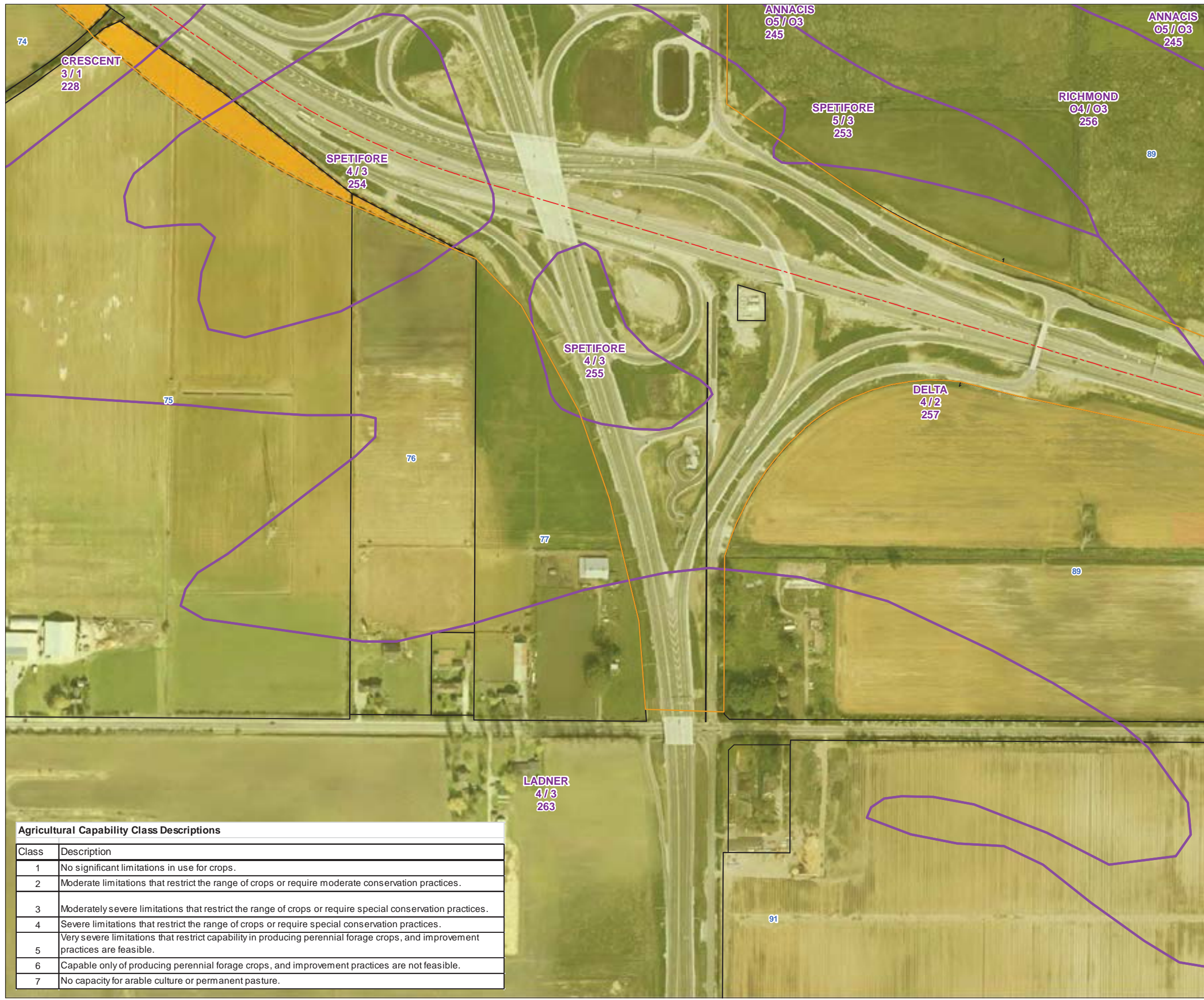
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1s 18/5/2016

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Legend

- Project Alignment
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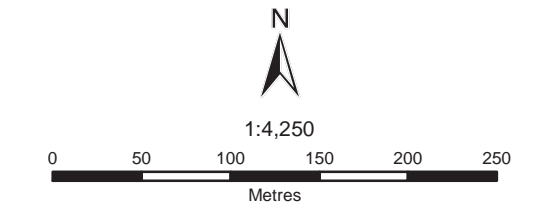
Soil / agricultural capability polygon

- Soil type
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- polygon no.
- agricultural class (improved)

Crescent
3/1
742

SOURCES

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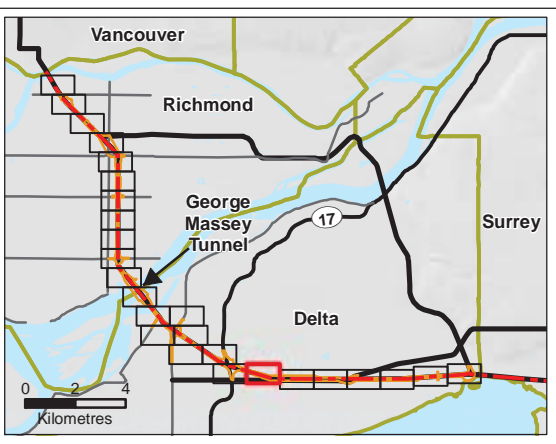
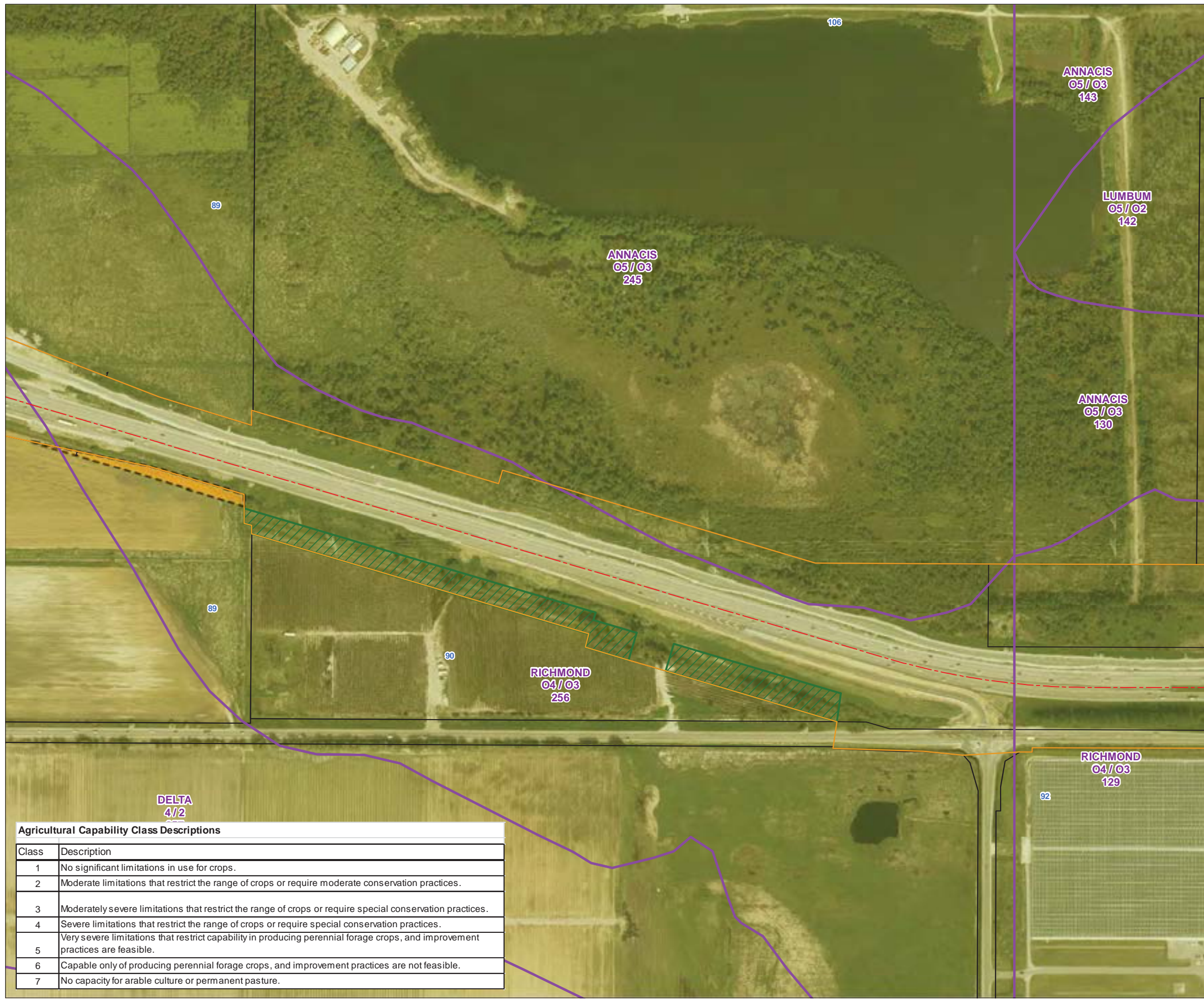
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

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| Figure 1t | 18/5/2016 |
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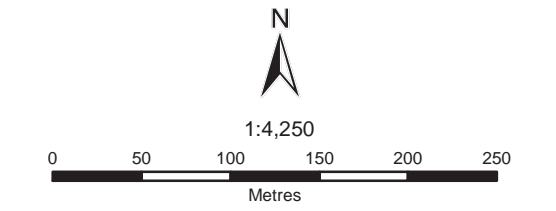
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Soil / agricultural capability polygon
 Soil type
 dominant agricultural class (unimproved)
 polygon no.
 agricultural class (improved)

Crescent 3/1 742

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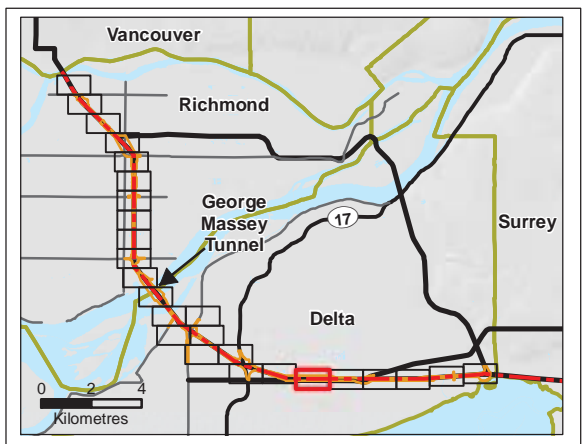
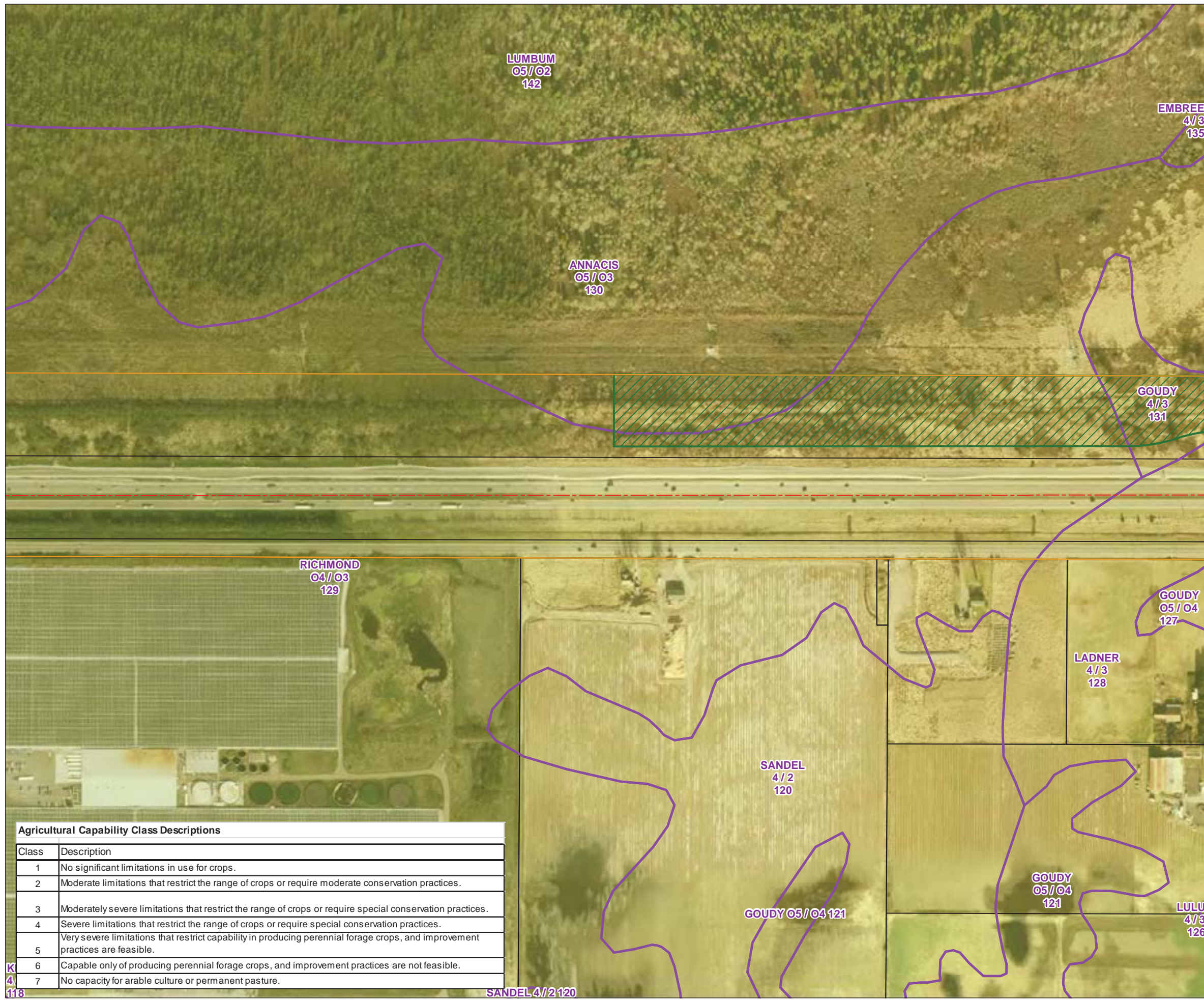
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1u 18/5/2016

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Legend

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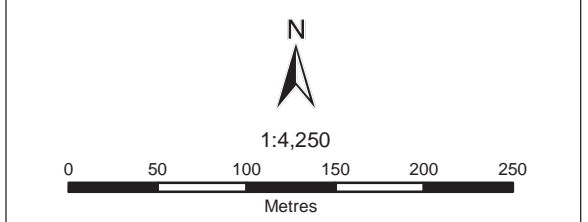
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Crescent 3/1 742

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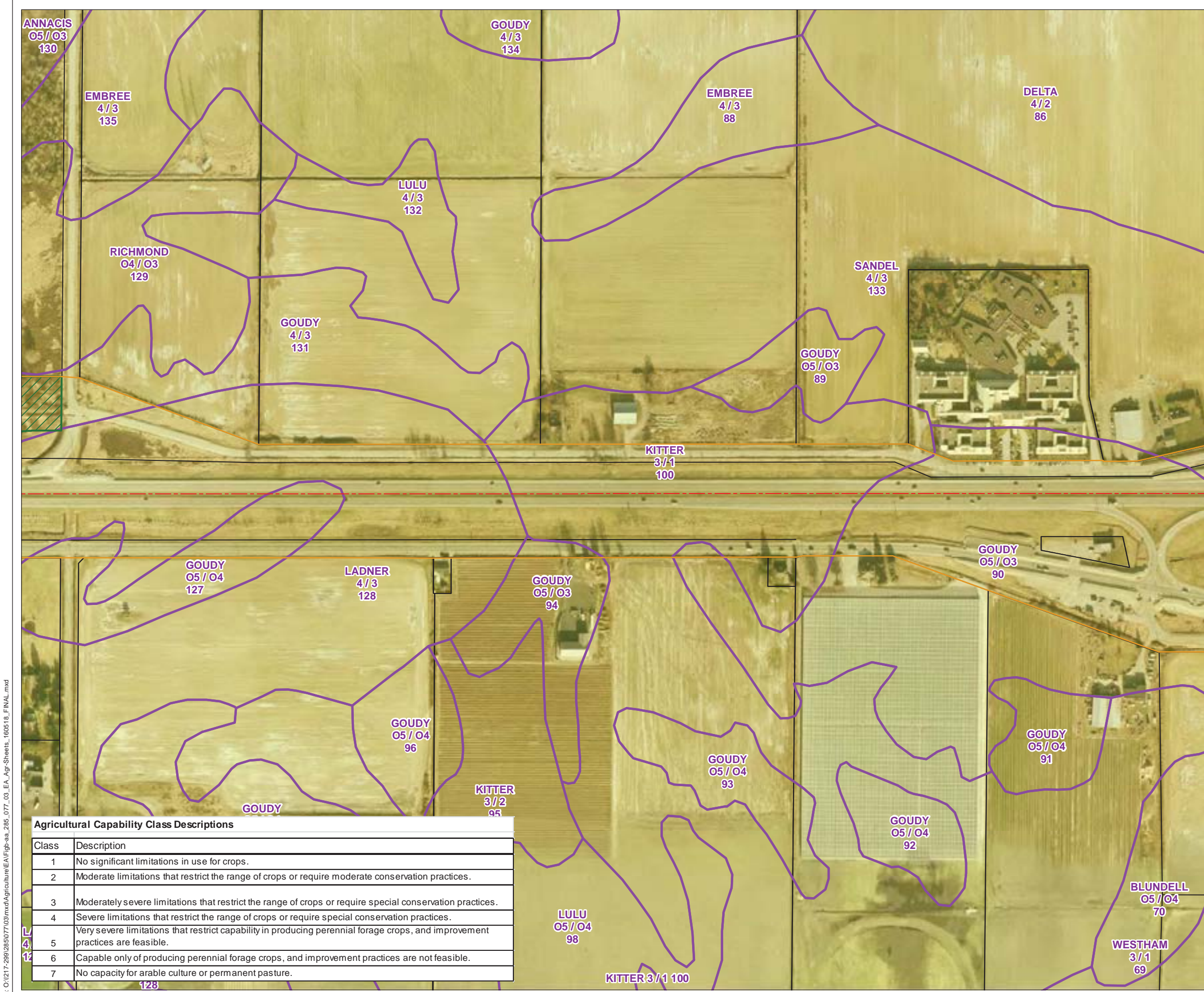
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

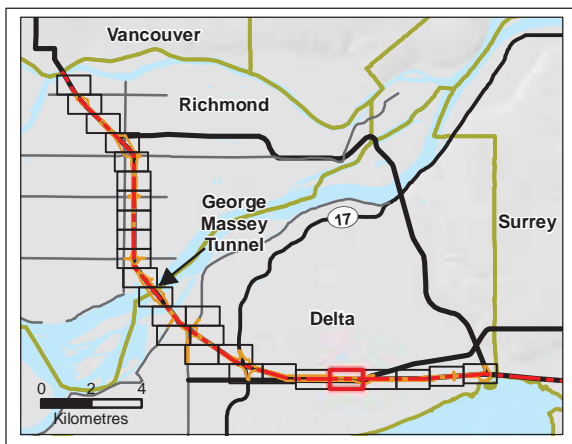
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Agricultural Capability Class Descriptions

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| 6 | Capable only of producing perennial forage crops, and improvement practices are not feasible. |
| 7 | No capacity for arable culture or permanent pasture. |



Legend

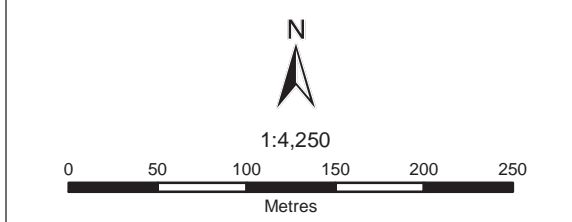
- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon
 dominant agricultural class (unimproved) polygon no.
 agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

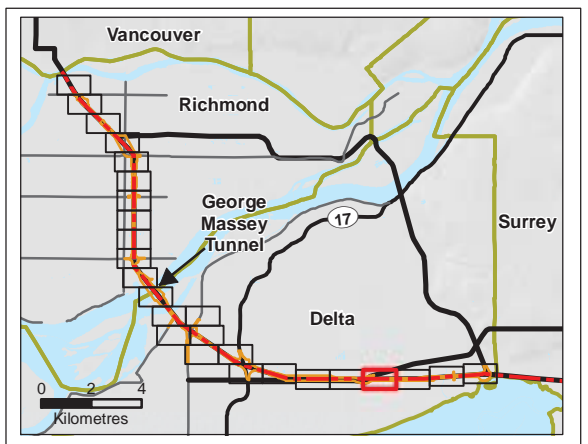
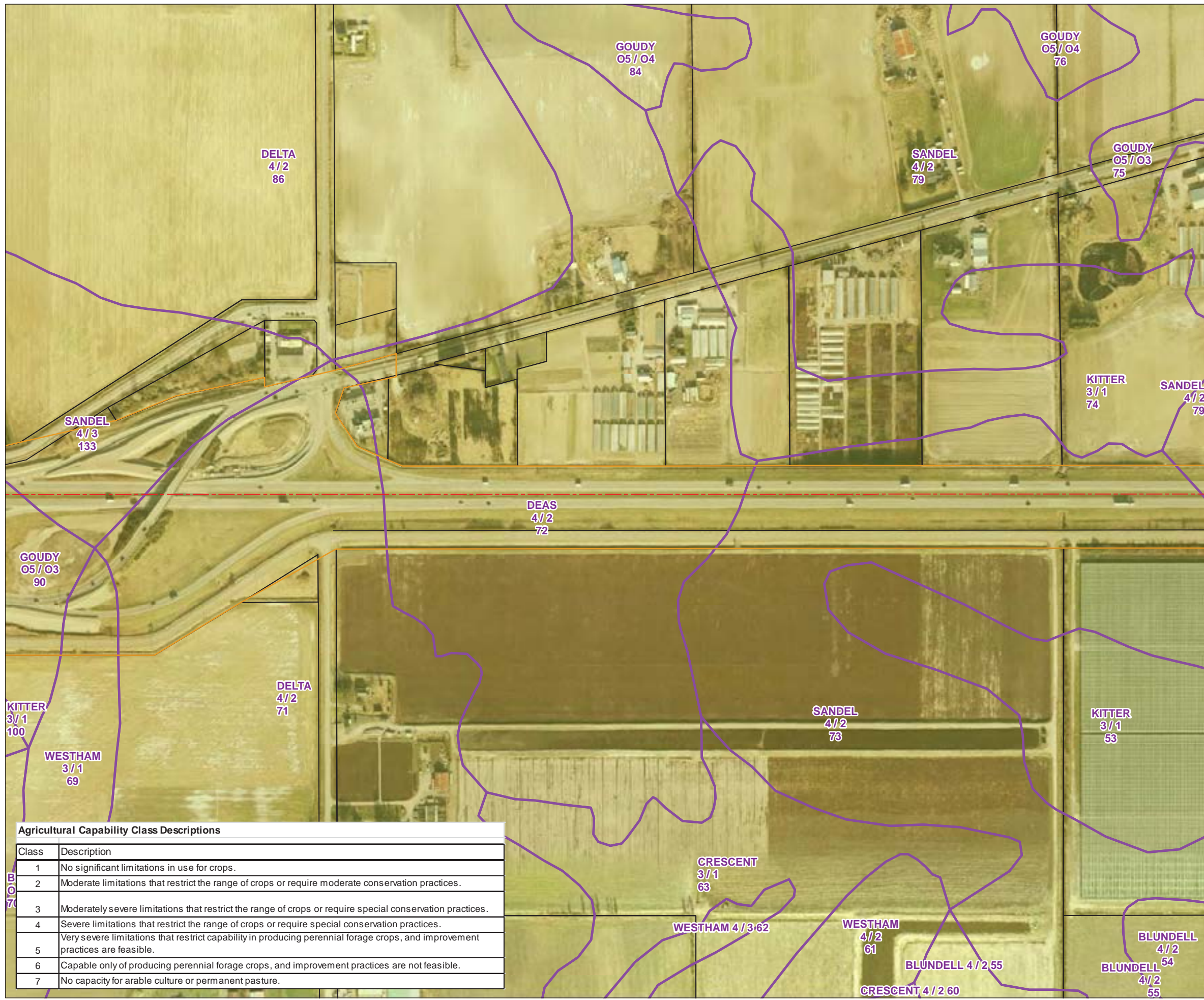


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REPLACEMENT PROJECT**

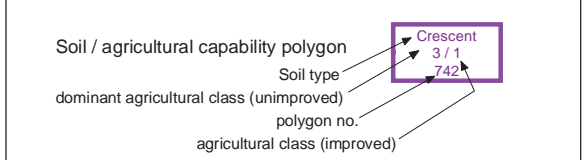
AGRICULTURAL USE STUDY

| | |
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| Figure 1w | 18/5/2016 |
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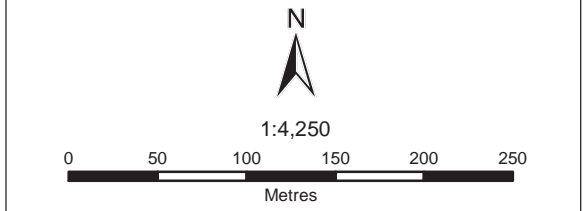


- Legend**
- Project Alignment
 - Hwy 99 centreline
 - Soil / agricultural capability polygon
 - Lands available for agriculture
 - Property acquisition
 - Agricultural Land Reserve
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 - Municipal Boundaries



SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

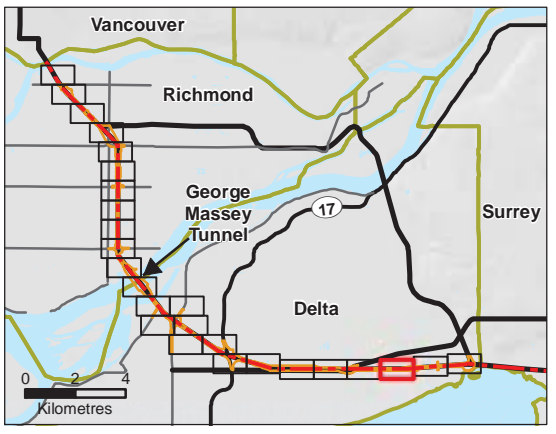
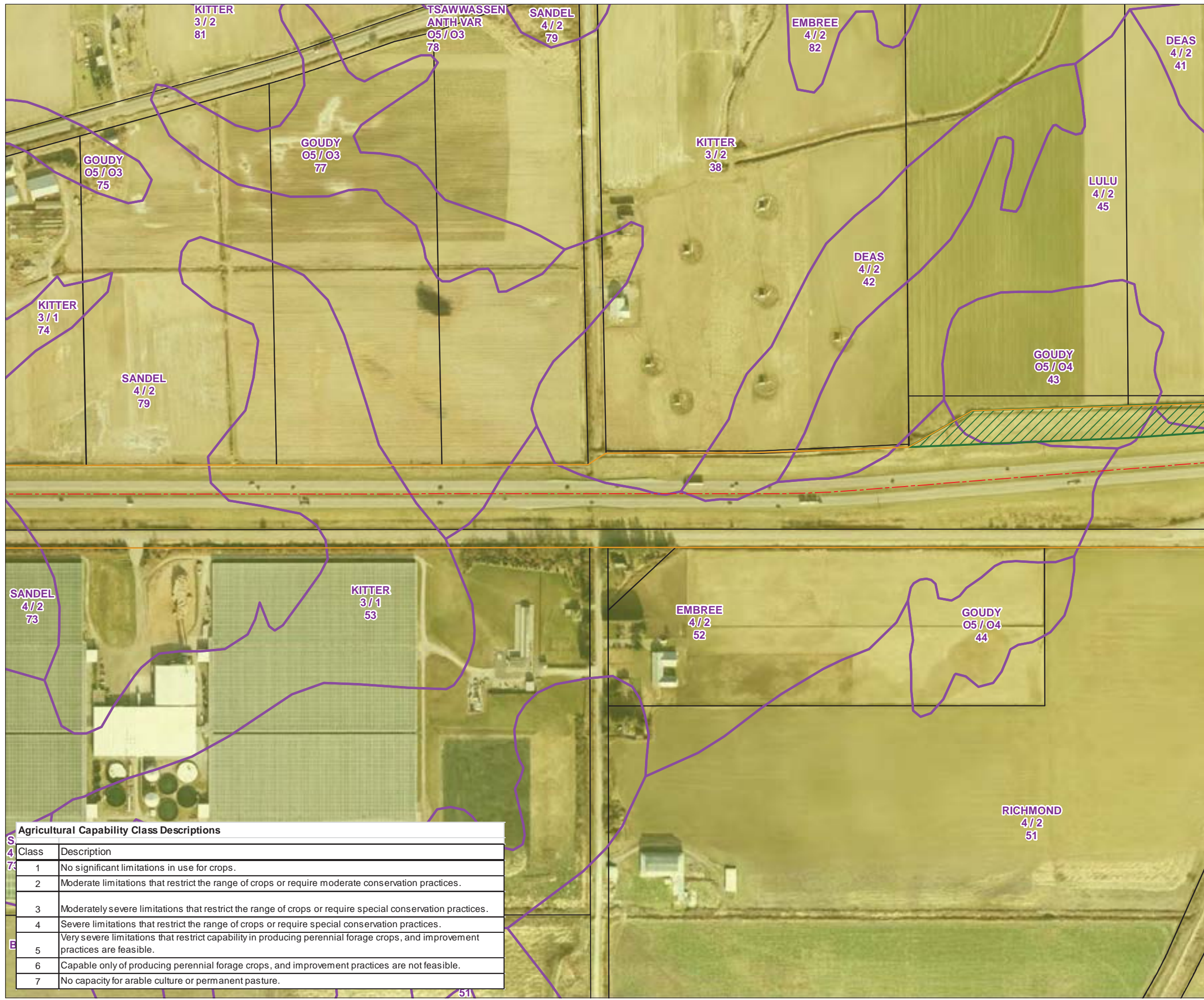
| Class | Description |
|-------|---|
| 1 | No significant limitations in use for crops. |
| 2 | Moderate limitations that restrict the range of crops or require moderate conservation practices. |
| 3 | Moderately severe limitations that restrict the range of crops or require special conservation practices. |
| 4 | Severe limitations that restrict the range of crops or require special conservation practices. |
| 5 | Very severe limitations that restrict capability in producing perennial forage crops, and improvement practices are feasible. |
| 6 | Capable only of producing perennial forage crops, and improvement practices are not feasible. |
| 7 | No capacity for arable culture or permanent pasture. |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

AGRICULTURAL USE STUDY

Figure 1x 18/5/2016

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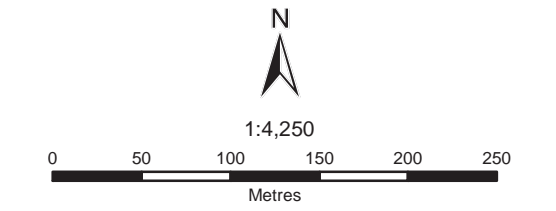
- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon
 Soil type
 dominant agricultural class (unimproved)
 polygon no.
 agricultural class (improved)

Crescent
 3/1
 742

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Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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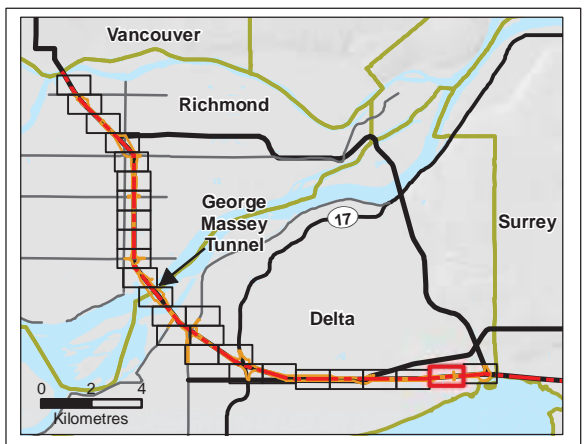
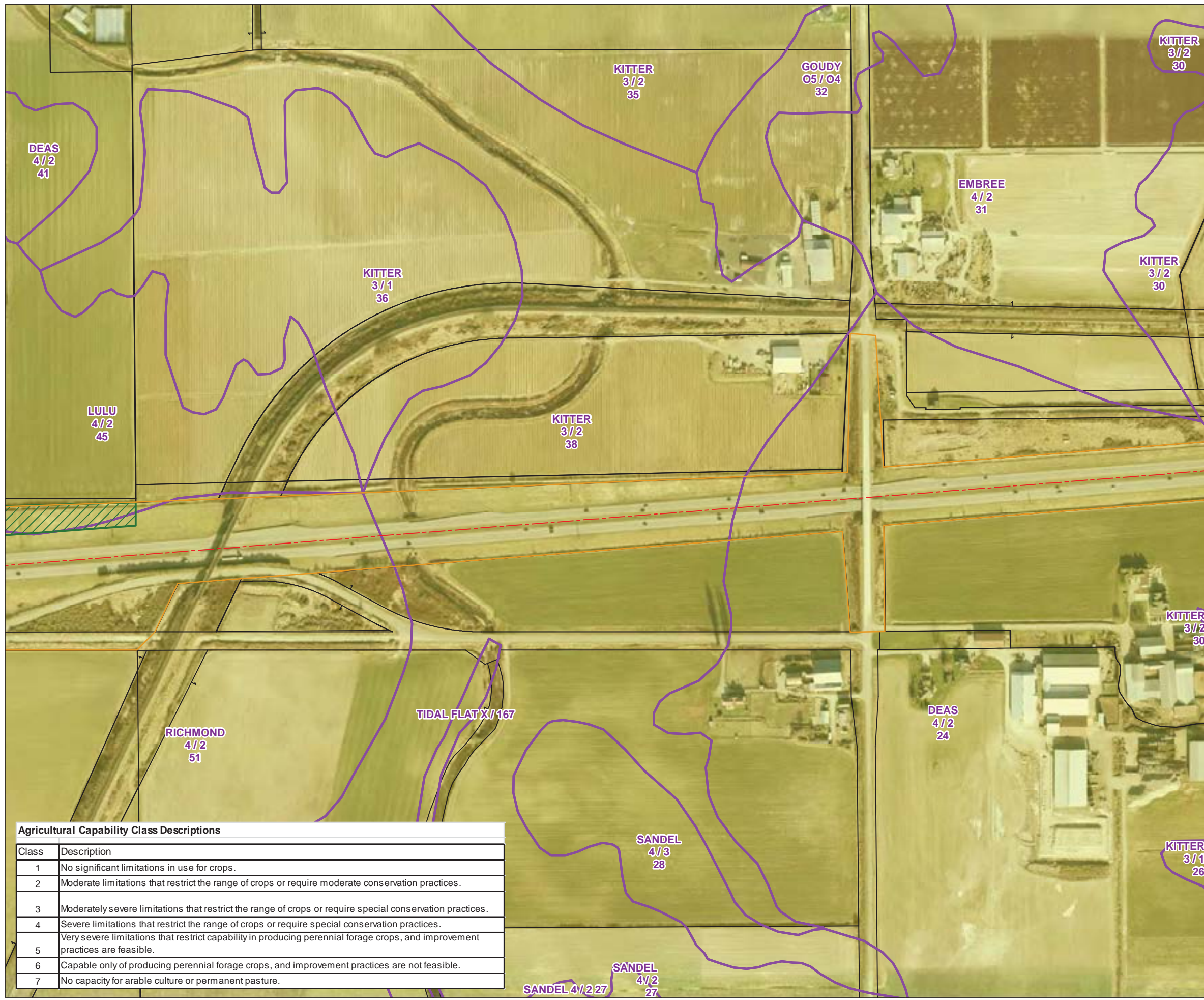
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

AGRICULTURAL USE STUDY

Figure 1y 18/5/2016

George Massey Tunnel Replacement Project BC 0965 PL 88 B.C. on the Move

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Legend

- Project Alignment
- Hwy 99 centreline
- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

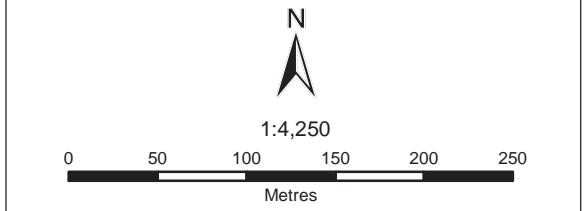
Soil / agricultural capability polygon

- Soil type
- dominant agricultural class (unimproved)
- polygon no.
- agricultural class (improved)

Crescent
3/1
742

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



Agricultural Capability Class Descriptions

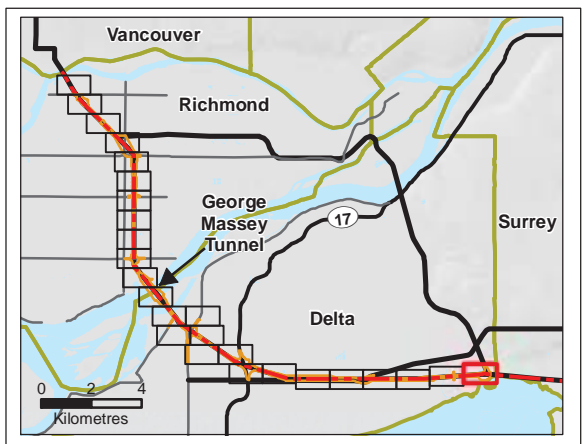
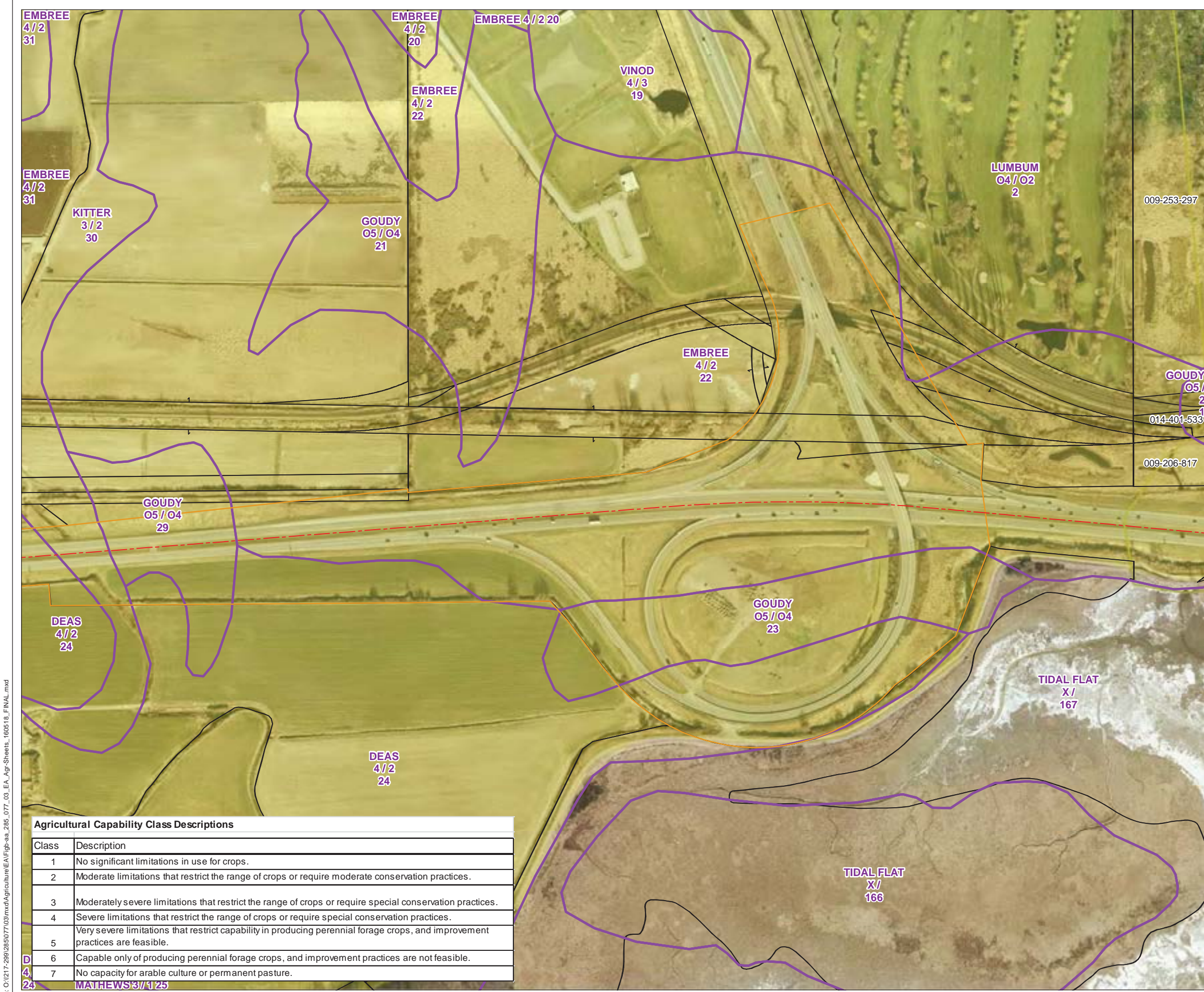
| Class | Description |
|-------|---|
| 1 | No significant limitations in use for crops. |
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REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1z 18/5/2016

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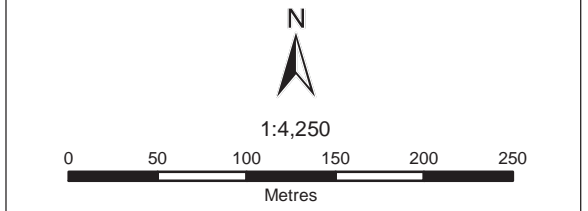
- Project Alignment
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- Soil / agricultural capability polygon
- Lands available for agriculture
- Property acquisition
- Agricultural Land Reserve
- Parcels
- Municipal Boundaries

Soil / agricultural capability polygon
 Soil type
 dominant agricultural class (unimproved)
 polygon no.
 agricultural class (improved)

Crescent
3/1
742

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Agricultural Capability Class Descriptions

| Class | Description |
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AGRICULTURAL USE STUDY

Figure 1aa 18/5/2016

APPENDIX B

Overview of Potential Project Interactions with Agricultural Use

Table 1 Overview of Potential Project Interactions with Agricultural Use

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|--|---|
| Agricultural Use | | | |
| Pre-Construction / Site Preparation | | | |
| Pre-construction / site preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Installing temporary bridges and barging facilities • Restoration of Green Slough to its historic alignment | <p>Nature of interaction: No interactions anticipated</p> <p>Rationale: Activities to be undertaken away from agricultural land and upland drainage ditches</p> |
| | No effect | <ul style="list-style-type: none"> • Conducting additional site investigations (i.e., a geotechnical drilling program) | <p>Nature of interaction: Activities with the potential to cause degradation of agricultural soils</p> <p>Rationale: Potential effects include soil degradation on a small area that can be mitigated by careful site selection and implementation of standard reclamation practices</p> |
| | Potential effect | <ul style="list-style-type: none"> • Acquiring property for the Project • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction • Installing temporary drainage structures and diversions | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Degradation of agricultural soils on an extended area, which can be mitigated by proper planning and monitoring • Temporary disturbance of utilities that may require relocation, resulting in disruption to greenhouse and indoor livestock operations, and adverse effect to annual revenues • Degradation of drainage, water quality, and irrigation • Increased travel times during transportation of agricultural goods and services and farm supplies/materials |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|---|---|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Installing upland piers, including pile installation • Ground improvements associated with new bridge piers • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: No interactions anticipated</p> <p>Rationale: Activities to be undertaken away from agricultural land and upland drainage ditches</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Installing drainage structures/settling ponds • Traffic management | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Potential temporary interference with farm drainage • Increased travel times during transportation of agricultural goods and services and farm supplies and materials |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Sedimentation in agricultural ditches and disruption of drainage patterns • Damage to agricultural fencing • Disruption or changes to farm utilities • Short-term disturbance to livestock • Accidental spills of deleterious substances (e.g., concrete debris, asphalt, hydraulic fluids) into drainage ditches (see Section 8.0 Accidents and Malfunctions) |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|--|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity Removing electrical/mechanical/utilities equipment from the Tunnel | <p>Nature of interaction: No interactions anticipated</p> <p>Rationale: Activities to be undertaken away from agricultural land and upland drainage ditches</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> Removing of four Tunnel segments and associated scour protection Backfilling of onshore portions of Tunnel approaches | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> Increased salinity of the Fraser River at the up-river extent of the salt wedge following Tunnel removal, degrading the quality of irrigation water drawn at 80 Street in Delta and thereby reducing time available for obtaining water |
| Decommissioning of Deas Slough Bridge | No interaction | <ul style="list-style-type: none"> Removal of Deas Slough Bridge including substructures | <p>Nature of interaction: No interactions anticipated</p> <p>Rationale: Deas Slough Bridge activities will occur away from agricultural land and upland drainage ditches</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-----------------------------------|------------------------|---|--|
| Operations and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Permanent loss of agricultural land within the Project alignment • Changes to farm parcel boundaries that may affect economic viability of the parcel • Increased runoff from new pavement that may affect soils and crops • Sedimentation in agricultural drainage ditches and temporary disruption of drainage during ditch maintenance • Long-term improvements to drainage and irrigation patterns in the area after reconstruction or upgrade of relocated drainage ditches • Alleviation of traffic volumes during peak hours, increasing efficiency of farming operations |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|-----------------------------|------------------------|---|--|
| New bridge | No interaction | <ul style="list-style-type: none"> • Operating the new bridge • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: No interactions anticipated</p> <p>Rationale: New bridge will span the Fraser River South Arm and Deas Slough with no potential effects on agricultural land and upland drainage ditches</p> |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • N/A | N/A |

"N/A" indicates that no Project works and/or activities are applicable to the category

5.5 Visual Quality Assessment Overview

- The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions at these locations.
- At distances greater than one kilometre, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers.
- Vegetated buffers will minimize visual effects to residential developments within close proximity to the bridge in Delta.
- Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.
- No significant Project-related residual or cumulative effects on visual quality are expected.

5.5 Visual Quality

This section presents the results of the assessment of potential effects of the Project on visual quality, and includes a description of existing conditions, potential Project-related effects and proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects.

The Project will introduce new visual features to the landscape that have the potential to change local and regional visual conditions; construction of the new bridge and upgraded interchanges (Westminster Highway, Steveston Highway, and Highway 17A).

A visual quality assessment was undertaken to evaluate the potential effects of these changes. The findings in this assessment are subjective as different viewers will have different opinions of the aesthetics of the new bridge and interchanges in relation to the landscape. A method based on the application of qualitative visual quality classifications has been used as a framework for assessment of these effects.

5.5.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on visual quality in terms of Project setting and defines the spatial and temporal assessment boundaries. The rationale for selecting the chosen assessment boundaries is also provided.

No jurisdictional, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects, or accessibility constraints or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore, administrative or technical boundaries are not considered.

5.5.1.1 Assessment Context

Visual Quality Objectives are established through the *Government Action Regulation*, B.C. Reg. 582/2004, to the *Forest and Range Practices Act*, S.B.C., 2002, c. 69. Visual Quality Objectives identify levels of scenic quality based on physical characteristics and social considerations for a given area.

No provincially-designated scenic areas exist in the Project or surrounding assessment areas, and there are no Visual Landscape Inventory classifications for the Project alignment or surrounding areas. The Visual Landscape Inventory rating for the area is listed as Unclassified (DataBC 2014).

Visual quality was selected as a valued component (VC) due to its importance to Aboriginal Groups, the public, and other stakeholders, as evidenced in the feedback received during pre-Application consultation on the Project. During consultation, Aboriginal Groups expressed an interest in visual disturbance to the cultural landscape, in the context of potential change in quality of experience tied to traditional uses. Additional information on the selection of visual quality as a VC is provided in **Section 3.1 Issues Scoping and Selection of Valued Components** and **Appendix A**. Potential influence of the Project on cultural landscape and associated effects on quality of experience tied to traditional uses are discussed in **Part C-Section 10 Aboriginal Consultation** of this Application

5.5.1.2 Methodology

The assessment of visual quality follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. The assessment of visual quality is primarily focused on the new bridge, which will introduce tall infrastructure into the landscape and change visual conditions from nearby residential and recreational areas. In addition, visual impact assessments for the Westminster Highway, Steveston Highway, and Highway 17A interchanges are also included.

Visual conditions represent daytime viewing opportunities as seen from selected viewpoints and are evaluated in terms of the colour, shape, texture, and scale of anthropogenic features in relation to characteristics of the natural environment.

For the new bridge, change in visual quality from sensitive locations was used as an indicator to assess trends of visual quality and evaluate potential Project-related effects. This provides a qualitative classification of the change between existing and post-Project visual quality as seen from a viewpoint.

For interchange upgrades, changes in visual quality were assessed taking into account the nature of the existing visual quality classifications in the general area of the interchanges. This provides a qualitative classification of the change between existing and post-Project visual quality taking into account current and proposed future landscape and land uses.

5.5.1.3 Assessment Boundaries

The assessment boundaries for visual quality are defined below.

Spatial Boundaries

The local assessment area (LAA) for visual quality is defined as the area within a six-kilometre radius centered on the highest point of the new bridge deck, as shown on **Figure 5.5-1**. This distance represents views of the new bridge as seen in the foreground and mid-ground from various viewpoints.

The boundaries of the assessment area encompass the area within which the bridge portion of the Project is expected to interact with and potentially have an effect on visual quality. This selection was based on the nature and characteristics of existing visual quality in relation to the maximum extent of potential effects as a result of the bridge and interchanges.

The Westminster Highway interchange is located immediately north of the LAA. Modifications to this interchange are expected to be minor and only visible from the immediate surrounding area. Thus, the study area for upgrades to this Project component is the immediate area surrounding the interchange. The Steveston Highway and Highway 17A interchanges are contained within the LAA.

No regional assessment area has been defined because in a flat landscape, such as in City of Richmond (Richmond) and Corporation of Delta (Delta), beyond six kilometres the views of the bridge and interchanges will be mostly screened by intermediate structures and vegetation. If the bridge is visible outside the LAA, it will be from elevated locations and will be in the background rather than forming a substantial element of the viewscape.

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on visual quality were established based on the potential for each phase of the Project to interact with and have an effect on visual quality. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect visual quality within the Project alignment; therefore, the following temporal boundaries were defined for the visual quality assessment:

- Existing conditions
- Project construction (including Tunnel decommissioning)
- Project operation (including maintenance)

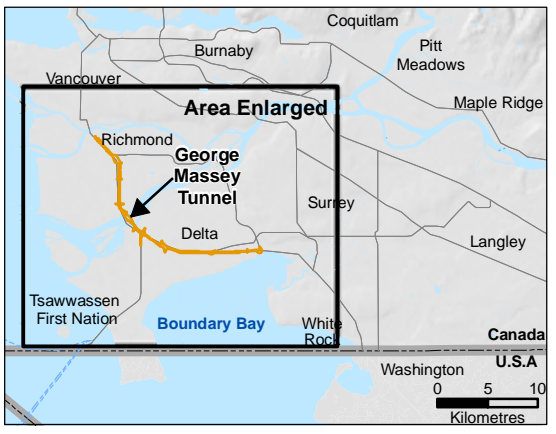
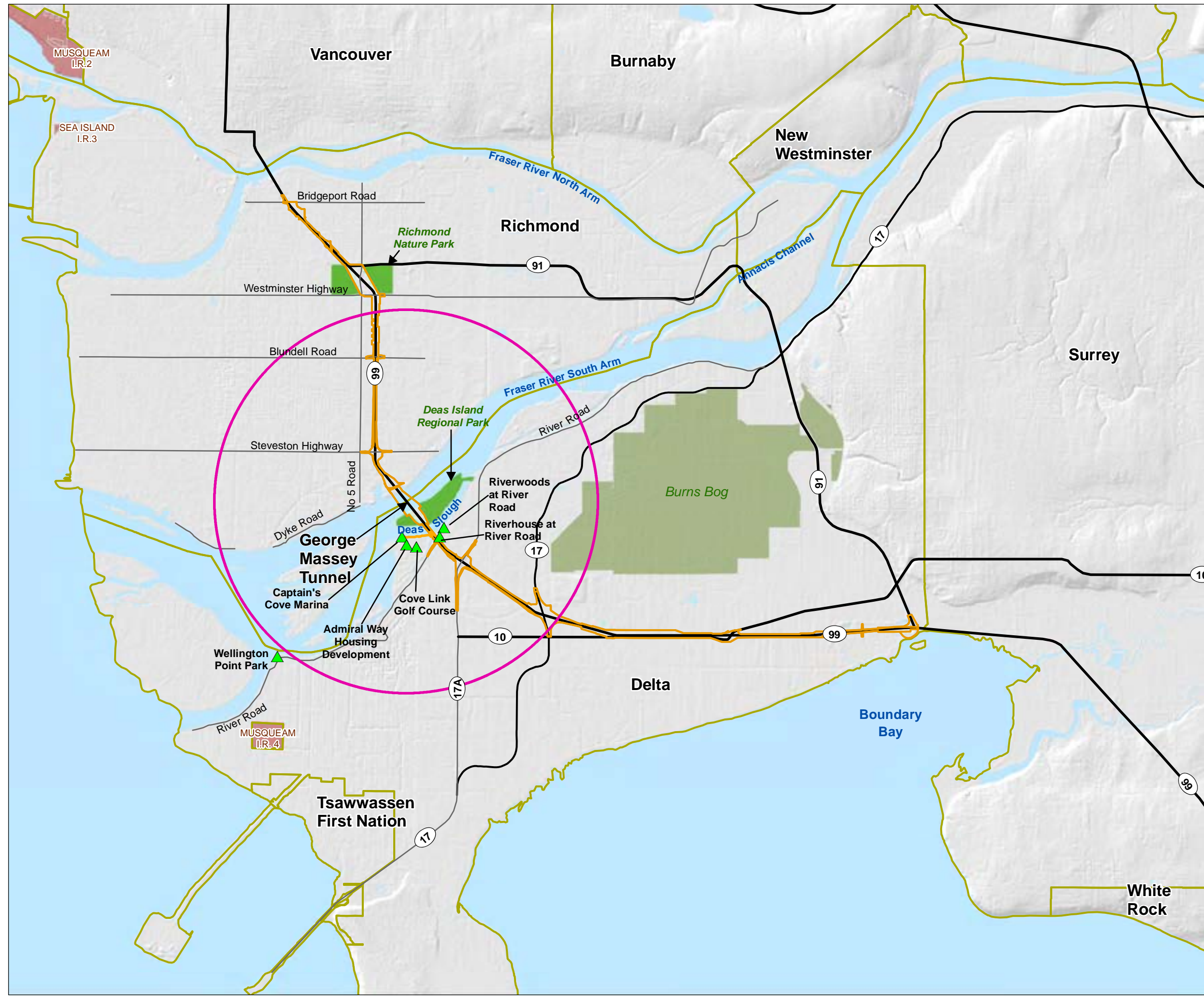
Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of Proposed Project**. Specific temporal considerations for the assessment of visual quality and its sub-components are discussed in the context of Project interactions and potential effects in **Section 5.5.4**.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on visual quality have been identified; therefore, no administrative boundaries are defined.

Technical Boundaries

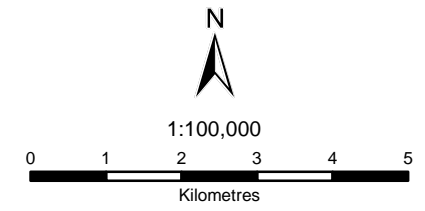
Established visual quality objectives and scenic area designations, as well as procedures and standards for conducting visual quality assessments, are geared towards non-urban forestry applications. These have been adjusted, based on information from comparable past projects, to meet the needs of Project-related visual quality assessment. No other technical boundaries have been identified that could influence the assessment of potential Project-related effects on visual quality.



- Legend**
- ▲ Point of Interest
 - Millennium Trail
 - Visual Resources Local Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

VISUAL QUALITY
LOCAL AND REGIONAL ASSESSMENT AREAS

| | |
|--------------|------------|
| Figure 5.5-1 | 13/05/2016 |
|--------------|------------|

5.5.3 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of visual quality within the assessment areas. An overview of the regulatory context for management of visual quality as relevant to the Project is also provided.

5.5.3.1 Baseline Data Collection

In 2014, the Ministry initiated visual quality studies to support Project planning and environmental assessment. Building on available information, these studies were designed to:

- Identify an appropriate approach for assessing potential effects of the new bridge.
- Document existing visual conditions at viewpoints selected to represent sensitive receptors (e.g., residents).

Desktop and field studies conducted with respect to visual quality are summarized in **Table 5.5-1** and described in detail below.

Table 5.5-1 Desktop and Field Studies Related to Visual Quality

| Study Name | Purpose of Study |
|----------------|--|
| Desktop review | <ul style="list-style-type: none">• Identify existing management objectives.• Identify the appropriate method for assessing the effects of the Project on visual quality. |
| Field studies | <ul style="list-style-type: none">• Characterize and document the existing conditions at viewpoints selected to represent sensitive receptors. |

Visual Conditions

A review of relevant government documents and databases was undertaken to determine what management objectives for visual quality may already exist. The provincial Visual Landscape Inventory map layer, available through iMapBC (DataBC 2014), revealed no provincially established visual quality objectives within a six-kilometre radius of the new bridge. A review of the local government (Richmond and Delta) websites did not identify any applicable plans or policies regarding the protection of visual quality in the LAA.

A review of the existing information and the state of knowledge pertaining to visual quality assessment was undertaken to identify the appropriate analysis methods for the Project. The Province has established criteria for conducting visual quality effectiveness evaluations (*Protocol for Visual Quality Effectiveness Evaluation*, B.C. MOF 2008). These methods are based on, and used for, non-urban forestry applications, with only peripheral utility for infrastructure projects in urban settings. As such, provincial methods informed this study; however methods used for recent visual quality evaluations on similar infrastructure projects nearby and across North America are considered more relevant. This approach is considered appropriate for this assessment, as the Project is located within an already developed urban corridor, within a substantially altered visual landscape.

Studies for the Port Mann/Highway 1 Improvement project (B.C. MOTI 2007), Deltaport Third Berth project (VPA 2005), Deltaport Terminal Road and Rail Improvement project (PMV 2012), and the California Incline Bridge Replacement Project (ICF Jones and Stokes 2010) were deemed most relevant to the Project. For the interchanges, the method was adjusted to account for differences in the modification of existing interchange structures versus those applied to the visual assessment of the new bridge, which represents a new element in the local and regional viewscape.

No formal attributes exist for visual quality indicators in the urban setting as they do for rural areas (i.e. crown land scenic areas). For the assessment of visual resources, the methodology used to establish baseline conditions is based on a rating system for visual sensitivity.

A key step in the visual quality assessment was determining visual sensitivity for the Project alignment, which is the overall sensitivity of the viewscape to human alteration as measured by visual sensitivity class (B.C. MOF 1997). A viewscape is the visual connection between a person and the spatial arrangement of natural and urban landscape features that they are viewing. The visual sensitivity class rates the likelihood that new or additional human alteration within a viewscape would elicit some degree or type of criticism or concern. This could be of an economic nature (e.g., adverse effect on a tourism operation) or a social nature (e.g., adverse effect on a public recreation opportunity or the public's enjoyment of an existing natural or previously altered viewscape). The visual sensitivity class is defined for the object of the view, in this case the new bridge, rather than for each viewer or viewpoint, and provides the context for the assessment.

Based on professional judgement and experience from other projects, and drawing from the visual sensitivity classes and definitions in **Table 5.5-2**, a visual sensitivity rating, from perspective of typical viewers, has been assigned for the Project. At one end of the spectrum, viewers who can see a change in visual conditions from their residence would have a relatively high sensitivity to the change. At the other end of the spectrum, typical commuters driving

through an area to and from work are presumed to have a low level of sensitivity because they perceive the landscape in a different manner from those viewing it for pleasure. Pedestrians, tourists, and motorists who view the landscape as part of a recreational activity would likely have a moderate sensitivity. The perspectives of all viewer types are considered when selecting a visual sensitivity class (VSC) to rate the viewscape.

Table 5.5-2 Visual Sensitivity Classes and Definitions

| Visual Sensitivity Class | Description |
|--------------------------|---|
| Very High | Views of and from the area are managed through public regulations and plans. The public has great potential to react strongly to small modifications in the viewscape because the affected views are unique or special to the region or locale. |
| High | The viewscape includes distinctive qualities that are important to viewers. There is considerable potential for public concern over major changes in the viewscape. |
| Moderate | The affected views may be secondary in importance or are similar to other views commonly available to the public. Noticeable changes may be tolerated by the public if the distinctive qualities of the viewscape remain dominant. |
| Low | The views are seen by a small minority of the public who may have concerns about additional changes to the viewscape, which has been subject to constant change. |
| Very Low | The affected views are either not publicly assessable or there are no indications that the visual resources within the potentially affected viewscape are valued by the public. |

Note: Adapted from B.C. Ministry of Forests (1997).

Field surveys were completed to characterize the existing viewscape from select viewpoints. Viewpoints were identified based on local knowledge and experience, giving consideration to residential as well as recreational areas (e.g., municipal parks). Field work was conducted during clear, sunny days to provide optimal viewing conditions. Each viewpoint was visited twice between May and September 2014, or on August 15 or 17, 2015. Photographs were taken from each viewpoint using a Nikon D7100 with a 200 mm zoom set at 18 mm.

Another purpose for the field visit was to determine a baseline visual quality class (VQC) of the viewscape from each viewpoint. The VQC is a qualitative rating based on visual characteristics that describe the existing level of human development in the area being viewed. The five-point classification scheme used in this assessment is based on the *Protocol for Visual Quality Effectiveness Evaluation* (B.C. MOF 2008) and presented in **Table 5.5-3**.

Table 5.5-3 Visual Quality Classes and Definitions

| Visual Quality Class | Definition |
|----------------------|---|
| Preservation | <ul style="list-style-type: none"> • Largely natural landscape. • Any human development on the landscape is very small in scale. |
| Retention | <ul style="list-style-type: none"> • Mostly natural landscape. • Any human development on the landscape is difficult to see and small in scale. |
| Partial Retention | <ul style="list-style-type: none"> • Part of the landscape is natural. • Human development is easy to see and is small to medium in scale. |
| Modification | <ul style="list-style-type: none"> • The natural landscape is marginally present. • Human development is very easy to see and large in scale. |
| Maximum Modification | <ul style="list-style-type: none"> • Human development dominates the landscape. |

Note: Adapted from Protocol for Visual Quality Effectiveness (B.C. MOF 2008).

A general assessment of the visual quality at interchange locations was conducted. This reflects the generally lower visual sensitivity class at the interchanges where existing development, including the presence of transportation infrastructure, commercial properties reliant on transportation, and agriculture are prevalent. The existing visual conditions in the landscape, including the presence of interchanges, is considered consistent with the existing land uses in the Highway 99 corridor.

The assessment considers potential changes in visual conditions at interchanges against visual sensitivity and visual quality classification criteria including:

- Proximity to existing residential and recreation areas.
- Relative change from existing infrastructure including elevations of proposed works.
- The existing visual environment.

5.5.3.2 Regulatory Context

In B.C., Visual Quality Objectives are established through the *Government Action Regulation*, B.C. Reg. 582/2004 under the *Forest and Range Practices Act*, S.B.C., 2002, c. 69. Visual Quality Objectives identify levels of scenic quality based on physical characteristics and social considerations for a given area. No provincially-designated scenic areas are located in the visual quality assessment area for the Project.

Richmond, Delta, and Metro Vancouver do not have specific plans or policies on the protection of cultural landscapes, view corridors, or other visual resource values that are applicable to the Project alignment.

5.5.3.3 Existing Conditions

The Project traverses the Fraser River South Arm, which flows westerly through a relatively flat landscape that has been extensively modified by human activity (e.g., agriculture, river training, road, rail and air transportation, commercial and residential). In addition to the river, Highway 99 is also a prominent visual feature and includes the highway, interchanges, and the existing infrastructure associated with the Tunnel.

The Highway 99 alignment is largely surrounded by agricultural and recreational areas, with clusters of residential, commercial, and industrial development nearby. Mature vegetation is present around older developments, in larger parks, and along the river banks. Detailed description of existing land uses is provided in **Section 5.3 Land Use**. Most residential and commercial developments adjacent to Highway 99 exist in close proximity to the existing interchanges and have developed in parallel to growth in population in the adjacent municipalities since the Tunnel opened in the 1950s, and earlier when the route was served by a ferry crossing on the Fraser River.

Within the LAA, Highway 99 connects Richmond and Delta through the existing four-lane Tunnel that passes under the Fraser River South Arm from the south shore of Lulu Island and emerges on Deas Island. South of the Tunnel, the Deas Slough Bridge carries traffic over Deas Slough. From there, Highway 99 continues to the Canada–U.S. border. Further details of the Project context are provided below.

Lulu Island: At the north end of the proposed new bridge, there are several areas of agricultural land holdings with a commercial farm market to the east. To the west of the new bridge are commercial developments and residential properties. Richmond's south shore (of the Fraser River) is characterized by industrial development, immediately adjacent to and on either side of Highway 99. Further to the west, a pedestrian and cycling trail follows the Fraser River shoreline.

Fraser River: The Fraser River is a notable visual feature in Metro Vancouver, with cultural, commercial, and recreational values. Views of the river and marine traffic are available upstream and downstream of the current Highway 99 corridor crossing. With the exception of Deas Island Regional Park and Finn Slough, a small historic fishing village at the south end of No. 5 Road in Richmond, none of these view locations are specifically managed for recreation. The Fraser River channel is heavily used by commercial and industrial traffic, commercial and recreational fishing vessels, and recreational boats.

Deas Island: The Tunnel entrance and exit on Deas Island is surrounded by Deas Island Regional Park. The park encompasses all of Deas Island with the exception of the land allotted to the Highway 99 ROW, and it offers recreational trails, tidal fishing areas, aquatic recreational areas, and heritage buildings. Along the south shore of Deas Slough in Delta, there are various recreational, residential, and commercial developments, including the recreational Millennium Trail. The trail connects Deas Island Regional Park to downtown Ladner and provides access to scenic viewpoints, recreational fishing areas, historical structures, and park amenities.

5.5.3.4 Selected Viewpoints

No provincial visual quality objectives have been assigned within the LAA. However, public consultation conducted for the Project indicates that there are visually important areas within the LAA (i.e., high VSC). These include residential areas, restaurants, marinas, parks, trails, golf courses, and beaches. During pre-Application consultation activities for the Project, Aboriginal Groups noted that a historical village, Tle'tinus (also Tq'ltinus and Tl'uqtinus), was located within 5 km of the Project, with associated harvesting areas as well as areas used for bathing and spiritual practices. Commenters noted that this village “was a major trade centre and the elders called it little New York”, and that an area in proximity to this village site exists where one of the practices was bathing, mourning, and spiritual practices. Harvesting areas were also identified to have occurred near the village site. A viewpoint (see Viewpoint 17 in **Section 5.5.3**) was selected to represent this location, which also has visual quality aspects for recreational use.

Based on potential visibility of the new bridge alignment and informed by public consultation, 17 viewpoints were selected to represent sensitive receptors in the LAA (**Figure 5.5-2**). The viewpoints selected represent areas identified as having the greatest potential for change for individuals using such areas and include areas with residential development, in close proximity to the bridge, and areas that attract recreational activities linked to the large rural areas and natural values in the Project area (e.g., river, agricultural land, wildlife values).

A brief overview of the setting of the selected viewpoints is provided in **Table 5.5-4**.

Table 5.5-4 Viewpoint Location and Description

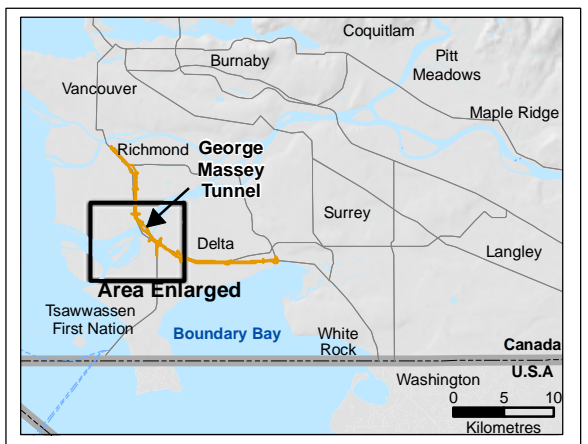
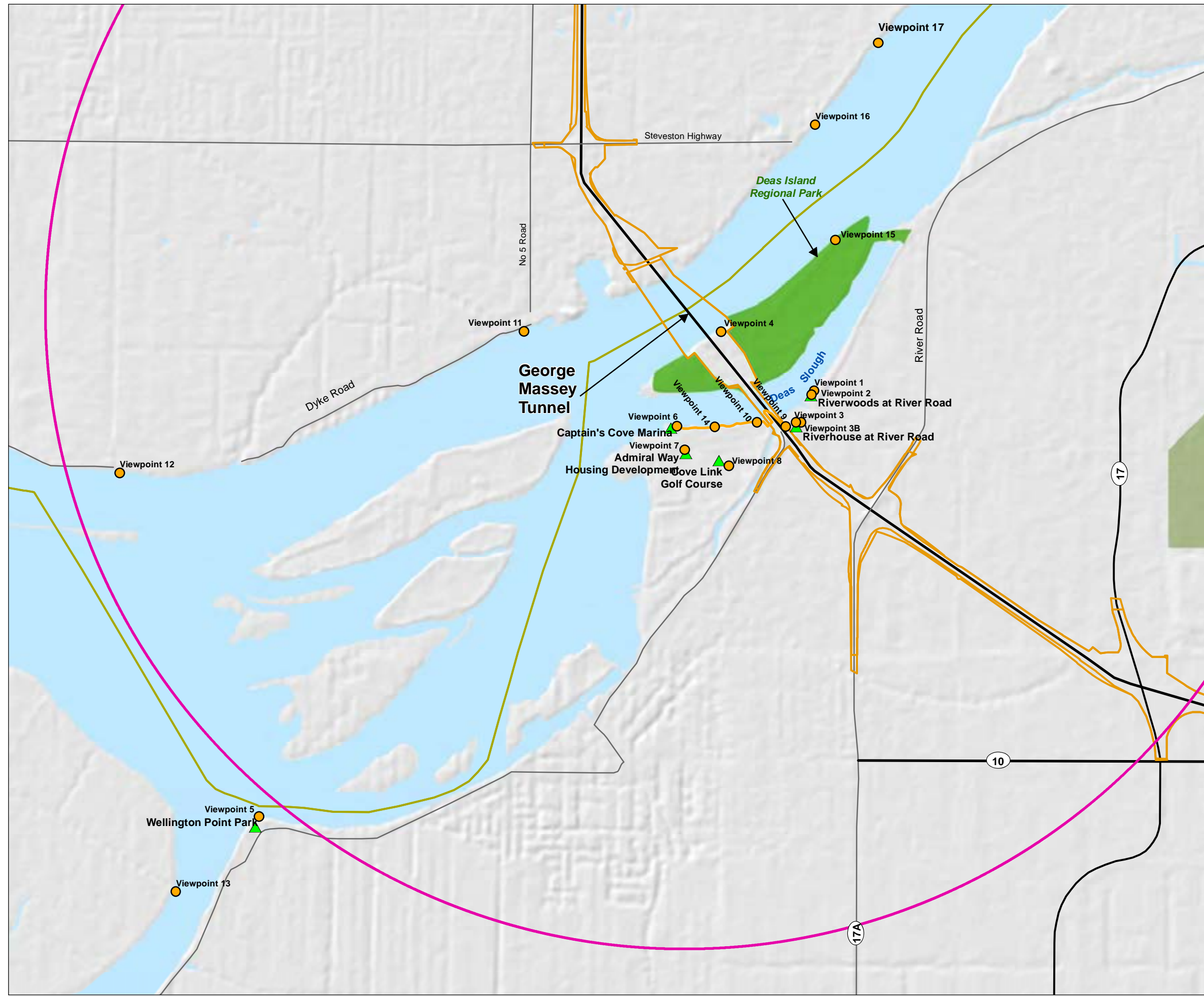
| Viewpoint ID | Location Description | Distance to Project (m)¹ |
|---|--|--|
| Viewpoint 1: River House Restaurant and Marina | Located near River House Restaurant and Marina, less than one kilometre southeast of the Tunnel entrance on Deas Island, in Delta. A large number of people access this location via vehicle, boat, and by cycling or walking on the Millennium Trail. | 1,200 |
| Viewpoint 2: River House Restaurant and Marina | Located southwest of Viewpoint 1 on the Millennium Trail. | 1,200 |
| Viewpoint 3: River Woods neighbourhood | Located within the River Woods neighbourhood at River Road, in Delta, the neighbourhood consists of a 21-unit residential complex built in 2005, situated between River House Restaurant and Marina to the east and Highway 99 to the west. The Millennium Trail runs along the property. The existing views of the Highway 99 right-of-way (ROW) are screened by over 30 m tall deciduous trees to the north and west of the complex. This viewpoint is located in the centre of the neighbourhood, on the street facing northwest towards the ROW. | 1,270 |
| Viewpoint 3B: River Woods neighbourhood | Located in River Woods neighbourhood, this viewpoint represents a backyard view of the Highway 99 ROW, partially screened by vegetation, from between two housing units. | 1,240 |
| Viewpoint 4: Tunnel Access Road (south side) | Located in Deas Island Regional Park, in Delta, near the Tunnel entrance. This viewpoint is accessible via a road intended primarily for use by emergency vehicles and maintenance trucks, but it is open for public access. | 340 |
| Viewpoint 5: Wellington Point Park | Located in Wellington Point Park, near River Road West, in Delta. The park is located about five kilometres to the southwest of the new bridge location and contains trails, recreational fishing areas, historical structures, and other park amenities. This location has a boat launch, picnic tables, and parking. | 5,180 |

| Viewpoint ID | Location Description | Distance to Project (m) ¹ |
|--|--|--------------------------------------|
| Viewpoint 6: Captain's Cove Marina | Located at Captain's Cove Marina, in Delta. The marina is adjacent to Deas Slough, less than one kilometre southwest of the Tunnel entrance on Deas Island. The marina is a commercial development used by commercial and recreational users. It is about 150 m north of Cove Links Golf Course. | 910 |
| Viewpoint 7: Admiral Way, south of Captain's Cove Marina | Located at the residential development in Ladner on Admiral Way and Ferry Road, in Delta. This residential development is situated near Captain's Cove Marina, and adjacent to Cove Links Golf Course, with views of the Fraser River to the north. | 1,100 |
| Viewpoint 8: Cove Links Golf Course | Located at Cove Links Golf Course, in Delta. This nine-hole golf course is surrounded by several residential developments. | 1,270 |
| Viewpoint 9: Millennium Trail between River Woods and Highway 99 | Located along the Millennium Trail, in Delta, on the south shore of the Fraser River and Deas Slough, this viewpoint was selected for its proximity to the River Woods neighbourhood and frequency of use. | 1,210 |
| Viewpoint 10: East of Captain's Cove Marina | Located beside the existing Deas Slough Bridge, this viewpoint was selected due to the future housing development currently under construction adjacent to the location. | 1,050 |
| Viewpoint 11: Benches on Dyke Road (West of No.5 Road) | Located along an off-street unpaved path paralleling Dyke Road, just west of the south end of No.5 Road in Richmond. The trail is an informal pedestrian and cycling trail that follows Dyke Road and forms part of the Richmond Trails network. This part of the trail is near benches, offering clear views of the Fraser River South Arm. | 1,270 |
| Viewpoint 12: No.3 Road and Dyke Road (dog park and public pier) | Located near the Dyke Trail Dog Park east of a public pier in Richmond. The trail runs along the Fraser River South Arm and is well-used for walking and cycling. The trail also includes benches along the river. As part of the Richmond Trails network, this viewpoint is a popular location for year-round fishing. | 4,600 |

| Viewpoint ID | Location Description | Distance to Project (m) ¹ |
|--|--|--------------------------------------|
| Viewpoint 13: Westham Island Road near the single-lane bridge | Located near Westham Island Road, in Delta, this viewpoint represents a travel corridor and is near the single-lane bridge that connects Westham Island to Delta. The Alaksen National Wildlife Area and George C. Reifel Bird Sanctuary are located on the northwest corner of the island. This location was chosen due to the large number of visitors that use Westham Island Road to access the George C. Reifel Bird Sanctuary. | 6,040 |
| Viewpoint 14: Millennium Trail beside Captain's Cove | Located along the Millennium Trail, west of the Project, this viewpoint was chosen because of the frequency of use observed during field studies. | 950 |
| Viewpoint 15: Deas Island Regional Park Lookout | Located on the northwest corner of Deas Island Regional Park, in Delta, this viewpoint was selected as it is a popular lookout of the Fraser River South Arm along the Tinmaker's Walk trail within the Riverside Picnic Area. | 1,300 |
| Viewpoint 16: Waterstone Pier residential complex | Located adjacent to Waterstone Pier residential complex along Riverport Way in Richmond, on the southeast bank of the Fraser River at No. 6 Road and Steveston Highway. The complex was built in 2006 and consists of three four-story buildings containing a total of approximately 140 units. This viewpoint represents the view of the Fraser River from the perspective of a pedestrian walking on the path adjacent to the complex. | 1,770 |
| Viewpoint 17: Dyke and Williams Road | Located near the corner of Dyke and Williams Rd. This area is an unofficial parking lot on long the north side of the Fraser River. This viewpoint represents the view from a walking area to the west of the parking lot. This area also represents the view from the historical village Tle'tinus (also Tq'ltinus and Tl'uqtinus) that has been identified by Aboriginal Groups as culturally important area. | 2,560 |

Notes: 1. Straight-line approximate distances from each viewpoint to the center point of new bridge, estimated from Figure 5.5-2.

Path: C:\1217-299\285\077\03\mxd\Lighting_Visual\EA\Figs-5-2_285_077_03_EA_Viewpoints_160522\2_FINAL.mxd



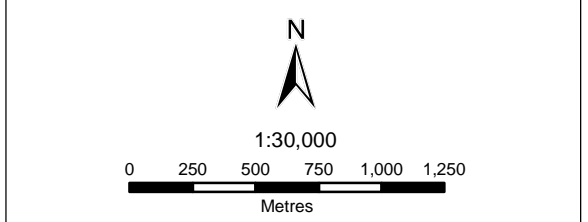
Legend

- Viewpoint
- ▲ Point of Interest
- Millennium Trail
- Visual Resources Local Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

Note:
 - Study areas based on alignment chainage 110+070.553 at an elevation of 67.871m

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

VIEWPOINT LOCATIONS

| | |
|--------------|------------|
| Figure 5.5-2 | 22/05/2016 |
|--------------|------------|

5.5.3.5 Existing Visual Quality

New Bridge

Existing VQC of the viewscape from selected viewpoints, shown on **Figure 5.5-2**, are presented in **Table 5.5-5**. The viewpoints with the least visual alteration from human development are Viewpoint 5 (Wellington Park), and Viewpoint 13 (Westham Island Road near the one-lane bridge). Currently Viewpoints 5 and 13 have a VQC rating of Retention since predominant views from this location are of natural features and any human development on the landscape is difficult to see and of small and scale.

The remaining viewpoints have existing views of marinas, housing, commercial or industrial buildings, integrated with views of natural vegetation and the Fraser River. The existing viewscape from these viewpoints have a VQC rating of Partial Retention, Modification, and Maximum Modification. The Deas Slough Bridge can be clearly viewed in the mid-ground from Viewpoint 9 (Millennium Trail) and from Viewpoint 10, east of Captain's Cove Marina. The Deas Slough Bridge is screened from direct view by mature vegetation from Viewpoint 14 as this low elevation bridge merges with adjacent topographic features. Viewpoint 17 has an existing view of a vacant industrial lot and jetty together, with views of natural vegetation along Deas Island, along the south side of the Fraser River.

The viewpoints with the most visual alteration to their viewsapes from human development are Viewpoint 1 (River House Restaurant and Marina), Viewpoint 2 (River House Restaurant Marina), Viewpoint 6 (Captain's Cove Marina), Viewpoint 7 (Admiral Way, south of Captain's Cove Marina), Viewpoint 8 (Cove Links Golf Course), Viewpoint 9 (Millennium Trail between River Woods and Highway 99), Viewpoint 10 (East of Captain's Cove Marina), Viewpoint 11 (Benches on Dyke Road (west of No.5 Road), Viewpoint 14 (Millennium Trail beside Captain's Cove), Viewpoint 15 (Deas Island Regional Park Lookout) and Viewpoint 16 (Waterstone Pier residential complex). The viewsapes from these viewpoints have a VQC rating of Maximum Modified since human development dominates the views.

Table 5.5-5 Viewpoint Locations and Existing Visual Quality Class of Viewscape

| Viewpoint | Existing Visual Quality Class |
|--|--------------------------------------|
| Viewpoint 1: River House Restaurant and Marina | Modification |
| Viewpoint 2: River House Restaurant and Marina | Modification |
| Viewpoint 3: River Woods neighbourhood | Partial Retention |
| Viewpoint 3B: River Woods neighbourhood | Partial Retention |
| Viewpoint 4: Tunnel Access Road (south side) | Modification |
| Viewpoint 5: Wellington Point Park | Retention |
| Viewpoint 6: Captain's Cove Marina | Modification |
| Viewpoint 7: Admiral Way, south of Captain's Cove Marina | Maximum Modification |
| Viewpoint 8: Cove Links Golf Course | Maximum Modification ¹ |
| Viewpoint 9: Millennium Trail between River Woods and Highway 99 | Partial Retention |
| Viewpoint 10: East of Captain's Cove Marina | Partial Retention |
| Viewpoint 11: Benches on Dyke Road (west of No.5 Road) | Modification |
| Viewpoint 12: No.3 Road and Dyke Road (dog park and public pier) | Modification |
| Viewpoint 13: Westham Island Road near the single-lane bridge | Partial Retention |
| Viewpoint 14: Millennium Trail beside Captain's Cove | Modification |
| Viewpoint 15: Deas Island Regional Park Lookout | Retention |
| Viewpoint 16: Waterstone Pier residential complex | Modification |
| Viewpoint 17: Dyke and Williams Road | Partial Retention |

Note: 1. Classified as Maximum Modification due to the amount of vegetation that was removed for the new residential development.

The rating system for visual sensitivity is based on potential viewer responses to changes in visual conditions. Viewer response to changes in the viewscape as a result of installing the bridge will be variable. A small number of viewers, including residents, workers, recreationists, and tourists, will experience the changed views over relatively long periods of time, and are assumed to have a high sensitivity to changes in visual conditions. However, the majority of viewers within the LAA are likely to be vehicle drivers or passengers using Highway 99. These short-term users generally have low sensitivity to changes in visual conditions. In addition, the affected views are similar to those available upstream and downstream of the Project alignment. Therefore, the overall visual sensitivity class for the LAA is rated as low, based on the majority of the typical viewers of the views being transient and the availability of similar views nearby.

Other factors that contribute to the low visual sensitivity classification are the relatively flat topography of the area around the new bridge, the mature trees that will limit views of the new bridge from a distance, and the existing level of human alteration in the LAA, which includes the major traffic corridor of Highway 99. In future, with regional population growth and further development, the visual change caused by a new bridge is likely to have a fairly high level of acceptance and low level of concern. Within this context of low visual sensitivity within the LAA, the assessment focuses on the potential effects of the Project on visual quality from the perspective of the most sensitive receptors (i.e. long-term users).

Interchange Upgrades

For all three interchanges, the landscape is currently dominated by human development, both at the existing interchanges and through extensive land use changes for agriculture, commercial, and residential. Naturalised greenspace is marginally present in the surrounding areas, as per the definitions provided in **Table 5.5-3**. However, at Westminster Interchange there is substantial forest in the immediate area around the interchange (Richmond Nature Park). The areas adjacent to the Steveston Highway and Highway 17A interchanges have substantial agricultural, commercial, and residential development adjacent to their right-of-way, which have occurred following the establishment of the Highway 99 corridor. The Westminster interchange, by comparison, has relatively low levels of development in its vicinity. Key features of the existing conditions for the three interchanges where improvements are proposed include the following.

Westminster Highway Interchange

The visual assessment of improvements to the Westminster Highway interchange focused on existing development on Westminster Highway between Sidaway Road to the east and Number 5 Road to the west. Also associated with this is the lane widening activities on the Highway 99 and Highway 91 Interchange to the north, though the changes there are minor and do not result in any substantial changes in the nature of the infrastructure.

Current land use south of Westminster Highway, on both sides of Highway 99, is dominated by agricultural developments many of which include a residence. West of Highway 99, Westminster Highway supports some commercial and residential development. Virtually all development on Westminster Highway is oriented to have north or south facing views rather than viewscapes facing the existing interchange. Northeast and northwest of the existing infrastructure, land use includes forested areas within the Richmond Nature Park where there is recreational use. The existing visual environment is defined by largely undeveloped areas (i.e., Richmond Nature Park and agricultural land) that will remain undeveloped, and transportation infrastructure associated with Highway 99 and Westminster Highway.

The visual sensitivity class in this area is high, reflecting the forest area in Richmond Nature Park, to low, reflecting the existing interchange and overpass structure, maintained rights-of-way and absence of residential areas facing the Project area. The opportunities for visual receptors to view the Westminster Interchange area are low as there are few locations for residential or recreational viewpoints that look toward the highway.

Visual Quality Classification: For Westminster Interchange, the VQC ranges from Partial Retention adjacent to the Richmond Nature Park (i.e., where part of the landscape is natural and human development is easy to see and is small to medium in scale) to Modification in other areas (i.e., where the natural landscape is marginally present and human development is very easy to see and large in scale).

Steveston Highway Interchange

The visual assessment of improvements to the Steveston Highway interchange focused on existing development east of Highway 99 to Sidaway Road and west to Number 5 Road. Current land use on the east side of Highway 99 includes agricultural development north and south of Steveston Highway and commercial produce sales southeast of the interchange. On the west side of Highway 99, land use is primarily commercial and includes auto sales, logistics and transportation businesses to the south and mixed retail and residential to the north.

The closest residential development faces directly onto Steveston Highway and is approximately 100 metres from the southbound off ramp from Highway 99 and 200 m from the centre line and existing over/underpass. The residential development in this area, which is part of a mixed used retail development, has developed in recent years during which time the existing visual conditions have been strongly influenced by transportation activities in the area including the local road network.

The existing visual conditions are influenced by transportation infrastructure including over/underpass and on/off ramps to support north and south bound traffic movements off of Steveston Highway. Eastward views include transportation infrastructure in the foreground and agricultural land beyond the Highway 99 corridor. Due to existing congestion, views in all directions are influenced by the presence of slow moving/congested traffic. The VSC in this area is low to very low, which reflects the presence of existing interchange and overpass structures, prevalence of commercial and industrial areas that are not expected to be influenced by visual changes, and developed agriculture. Given the limited number of residential or recreational viewpoints that look over or toward the highway, opportunities to view the Steveston Interchange area are low. Recent residential developments have views that are dominated by transportation infrastructure.

Visual Quality Classification: for Steveston Interchange, the VQC ranges from Modification in agricultural areas (i.e., where the natural landscape is marginally present and human development is very easy to see and large in scale) to Maximum Modification in other areas (i.e., where human development dominates the landscape).

Highway 17A Interchange

Current land use surrounding the existing Highway 17A interchange is primarily for agricultural development. There is limited commercial or retail development in the area with the closest and primary development being a mixed commercial development (Delta Town and Country Inn), to the east of the existing Highway 99/17A over/underpass. Additional commercial developments exist to the east along 62B Street. The closest residential development in proximity to the existing interchange is approximately 500 m to the north (River Woods) with developments primarily facing the Fraser River and views influenced by the proposed bridge rather than the interchange at Highway 17A.

The existing visual environment directly adjacent to the existing over/underpass is defined by developed agricultural areas, and transportation infrastructure associated with the Highway 99 corridor. There are few to no opportunities for public viewpoints in this area and the visual sensitivity class is considered low.

Visual Quality Classification: In this area, the VQC is considered Modification (i.e., where the natural landscape is marginally present and human development is very easy to see and large in scale).

5.5.4 Potential Effects

This section discusses anticipated interactions of Project components and activities with visual quality, and the potential effects of such interactions. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 5.5.4**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 5.5.6**. A discussion of potential for cumulative effects on visual quality is presented in **Section 5.5.7**.

5.5.4.1 Project Interactions

An overview of potential interactions between Project activities and visual resources during the construction and operation of Project components is provided in **Appendix A**. A preliminary evaluation of the potential effects of Project interactions on visual resources, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: While construction activity associated with the bridge and interchanges represents an addition to the visual landscape, these works are temporary and of short duration, therefore, they are considered of negligible magnitude when compared to the more-substantive long-term changes associated with the completed infrastructure during operations. As such, visual effects specific to the construction phase, are not considered further in this assessment.

Operation: Once construction of the new bridge is complete, its towers, piers, and deck will appear as prominent features in a flat, vegetated landscape with a major river channel. The surrounding landscape supports a wide variety of human developments and activities, from recreational to residential, commercial and industrial, along the shoreline as well as inland. Visual quality effects on recreational users during Project operation is discussed in **Section 5.3 Land Use**. The potential effect on quality of experience (i.e., cultural heritage) tied to Traditional Uses due to visual disturbance to the cultural landscape that informs and supports those uses is discussed in **Section 10.0 Aboriginal Consultation**.

The new bridge piers and towers will be situated on the south shore of Richmond and the north shore of Deas Island. The highest point on the deck of the new bridge will be near the centre of the Fraser River South Arm, making it visible over a relatively long distance. On the Delta side, the deck of the new bridge, as it approaches ground level, will be higher, and consequently visible from a greater distance, when compared to the existing Deas Slough Bridge. The supporting piers of the new bridge on Deas Island will also be visible over a greater distance due to their height above the ground. Contrast created by the geometric structure and light colour of the piers against the background vegetation could influence the effect of visual changes.

Modifications of interchanges on Highway 99, at Westminster Highway and Steveston Highway and at Highway 17A, will include changes to existing structures that currently influence visual conditions in these areas. The modified structures will be minimally visible at long distances because the modifications are generally low in elevation and the landscape is flat.

5.5.4.2 Potential Effects

The methodology adopted for this study combined approved visual standards and procedures from the B.C. MOF (1997) and other methodologies used on comparable projects to assess the nature and degree of potential Project-related changes in visual quality.

The assessment involved a qualitative evaluation of the degree to which overall visual quality would change as a result of the Project, and followed the three main steps listed and described in detail below:

- 1. Select and characterize viewpoints:** Seventeen viewpoints with viewsapes that may be sensitive to visual changes resulting from the Project were identified based on local knowledge and experience surrounding the new bridge. Consideration was given to nearby residential and recreational areas. As discussed in **Section 5.5.2** and listed in **Table 5.5-5**, the existing VQC was assigned for the viewscape from each viewpoint. All potential viewpoints were considered for the interchange upgrades.
- 2. Simulate future visual conditions:** To identify Project-related changes in visual conditions from the selected viewpoints, simulations of the potential views with the new bridge were created using AutoCAD design and drafting software. To create the simulations for each viewpoint, photographs of existing landscape features taken from the viewpoints were incorporated into AutoCAD, along with elevation data (height contours) of the surrounding landscape, and reference concept drawings of the new bridge.

The result is a realistic three-dimensional visual simulation of the views with the new bridge as seen from each viewpoint. The simulated views present what would be seen at the time of the day when the original viewpoint photos were captured. For each viewpoint, features of reference that are in close proximity to the new bridge and visible from the viewpoint were identified and annotated on maps (**Figure 5.5-2**). The new bridge and the reference points were combined within the software to create the simulations.

Aerial views of each of the interchanges were rendered using AutoCAD to include the interchange upgrades. These renderings provide an overhead view of the locations of the upgrades and provide a perspective to assess surrounding viewpoint locations.

- 3. Assess effects:** The simulations with the new bridge in place were used to rate the future VQC from each viewpoint, based on the classifications defined in **Table 5.5-3**. The anticipated future VQC ratings were compared with the VQC ratings under existing conditions to determine changes in visual quality expected as a result of the Project. Those changes were reviewed in the context of overall sensitivity of the viewscape to alteration, as measured by VSC (B.C. MOF 1997).

New Bridge

The potential effect of the new bridge on visual quality is characterised as increased visibility of anthropogenic features and variable change in VQC rating, as seen in the visual simulations for each viewpoint. Existing and potential views from each of the viewpoints (**Table 5.5-4**), along with their VQC ratings (**Table 5.5-3**), are presented in **Table 5.5-6**. High resolution images of the existing conditions and simulated future conditions with the Project are provided in **Appendix B**.

Existing views from the majority of the viewpoints include small-scale anthropogenic features such as marinas and low-rise buildings in the foreground or mid-ground, which provide visual interest. The scale and characteristics of these features blends in with the surrounding mature vegetation. Views that include Deas Slough and the Fraser River provide additional interest.

Given the relatively flat topography of the Fraser River delta, construction of the new bridge will introduce prominent visual features into existing viewscales. The new bridge will be of a much larger scale, both in height and width, than the existing roadway and Deas Slough Bridge.

Viewscales from Viewpoint 9 (Millennium Trail between River Woods and Highway 99) and Viewpoint 10 (east of Captain's Cove Marina) will experience the most change as a result of the new bridge. The VQC ratings of the viewscales from these viewpoints are likely to change from Partial Retention to Maximum Modification once the new bridge is in place. The views from these locations currently contain mostly natural views of the Fraser River South Arm and Deas Slough, respectively, with human development small to medium in scale. Once the Project is completed and operational, the views from these viewpoints will be dominated by the new bridge as it will be directly adjacent to these viewpoints.

With the new bridge, the viewscape from Viewpoint 15 (Deas Island Regional Park Lookout) will likely experience a change in VQC rating from Retention to Partial Retention. This viewpoint is located relatively far from the new bridge (approximately 1,300 m) but will experience changes in the views from the distant appearance of the bridge towers and cables against the relatively flat existing landscape. Discernable details of the bridge are more difficult to perceive as distance increases from the Project.

Due to its large scale and linear features, the VQC ratings in other locations close to the new bridge are likely to change from Modification to Maximum Modification once it is in place. The viewpoints where the VQC rating of the viewscape is likely to change from Modification to Maximum Modification are:







- Viewpoint 4 (Tunnel Access Road).
- Viewpoint 6 (Captain's Cove Marina).
- Viewpoint 14 (Millennium Trail beside Captain's Cove).







River House Restaurant and Marina (Viewpoints 1 and 2), currently have a modified viewscape. With the new bridge, the viewscape will remain modified—the bridge towers, deck, and piers will be visible; however the view of the bridge deck and piers will be partly screened by trees. River Woods (Viewpoints 3 and 3B) have views towards the new bridge partially or fully screened by mature trees. Because of this, the VQC ratings of the viewscapes from these viewpoints will likely not change with the addition of the new bridge, and any change in visual quality resulting from the presence of the new bridge will be negligible for most of the year (i.e., when the trees have leaves).







Viewscales from the following viewpoints have an existing VQC rating that is not anticipated to change with the presence of the new bridge:







- Viewpoint 1 (River House Restaurant and Marina)
- Viewpoint 2 (River House Restaurant and Marina)
- Viewpoint 3 (River Woods Neighborhood)
- Viewpoint 3B (River Woods Neighborhood)
- Viewpoint 5 (Wellington Point Park)
- Viewpoint 7 (Admiral Way, south of Captain's Cove Marina)
- Viewpoint 8 (Cove Links Golf Course)
- Viewpoint 11 (Benches on Dyke Road)
- Viewpoint 12 (No.3 Road and Dyke Road)
- Viewpoint 13 (Westham Island Road near the single-lane bridge)
- Viewpoint 16 (Waterstone Pier residential complex)
- Viewpoint 17 (Dyke and Williams Road)







Table 5.5-6 Summary of Characteristics and Effects on Visual Quality for the New Bridge







| Viewpoint ID | Existing Visual Quality Class of Viewscape | Existing Conditions | Visibility of the New Bridge | Future Visual Quality Class of Viewscape with the Project | Simulated Potential Conditions | Change in Visual Quality Class? |
|---|--|--|--|---|---|---------------------------------|
| Viewpoint 1: River House Restaurant and Marina | Modification |  | This location will have views of the bridge towers, deck, and piers from the marina and restaurant. | Modification |  | No |
| Viewpoint 2: River House Restaurant and Marina | Modification |  | This location will have views of the bridge towers, deck, and piers from the marina and restaurant. | Modification |  | No |
| Viewpoint 3: River Woods neighbourhood | Partial Retention |  | This location will have views of the bridge towers through trees on River Woods property. Views of the bridge will be partially screened when the trees have leaves. | Partial Retention |  | No |

| Viewpoint ID | Existing Visual Quality Class of Viewscape | Existing Conditions | Visibility of the New Bridge | Future Visual Quality Class of Viewscape with the Project | Simulated Potential Conditions | Change in Visual Quality Class? |
|---|--|--|--|---|---|---------------------------------|
| Viewpoint 3B: River Woods neighbourhood | Partial Retention |  | This location will have screened views of the bridge deck and cables through the trees. Views of the bridge will be partially screened when the trees have leaves. | Partial Retention |  | No |
| Viewpoint 4: Tunnel Access Road (south side) | Modification |  | This location is directly adjacent to the bridge and will have clear views of the bridge towers, deck, and piers. | Maximum Modification |  | Yes |
| Viewpoint 5: Wellington Point Park | Retention |  | This location will have distant views of the bridge towers, against a background with tall buildings in Burnaby and New Westminster and the coastal mountains. | Retention |  | No |

| Viewpoint ID | Existing Visual Quality Class of Viewscape | Existing Conditions | Visibility of the New Bridge | Future Visual Quality Class of Viewscape with the Project | Simulated Potential Conditions | Change in Visual Quality Class? |
|--|--|--|--|---|---|---------------------------------|
| Viewpoint 6: Captain's Cove Marina | Modification |  | This location will have clear views of the bridge towers and deck and screened views of the piers. | Maximum Modification |  | Yes |
| Viewpoint 7: Admiral Way, south of Captain's Cove Marina | Maximum Modification |  | This location will have clear views of the bridge towers. The view of the bridge deck and piers is partially screened by trees, and would be nearly fully screened when the trees have leaves. | Maximum Modification |  | No |
| Viewpoint 8: Cove Links Golf Course | Maximum Modification |  | This location will have clear views of the bridge towers. The view of the bridge deck and piers will be partially screened by trees, and remain that way until the trees have leaves and the residential development is completed. | Maximum Modification |  | No |

| Viewpoint ID | Existing Visual Quality Class of Viewscape | Existing Conditions | Visibility of the New Bridge | Future Visual Quality Class of Viewscape with the Project | Simulated Potential Conditions | Change in Visual Quality Class? |
|--|--|--|--|---|---|---------------------------------|
| Viewpoint 9: Millennium Trail between River Woods and Highway 99 | Partial Retention |  | This location will have direct views of the bridge deck and piers. | Maximum Modification |  | Yes |
| Viewpoint 10: East of Captain's Cove Marina | Partial Retention |  | This location will have direct views of the bridge towers, deck and piers. | Maximum Modification |  | Yes |
| Viewpoint 11: Benches on Dyke Road (west of No.5 Road) | Modification |  | This location will have a slightly screened view of the new bridge towers, deck and piers. | Modification |  | No |

| Viewpoint ID | Existing Visual Quality Class of Viewscape | Existing Conditions | Visibility of the New Bridge | Future Visual Quality Class of Viewscape with the Project | Simulated Potential Conditions | Change in Visual Quality Class? |
|---|--|--|---|---|---|---------------------------------|
| Viewpoint 12: No.3 Road and Dyke Road (dog park and public pier) | Modification |  | This location will not have any views of the bridge however screened views may be visible further east on the unpaved path. | Modification |  | No |
| Viewpoint 13: Westham Island Road near the single-lane bridge | Partial Retention |  | This location will have distant views of the bridge towers, against a background of distant buildings and mountains. | Partial Retention |  | No |
| Viewpoint 14: Millennium Trail beside Captain's Cove | Modification |  | This location will have direct views of the bridge deck and piers. | Maximum Modification |  | Yes |

| Viewpoint ID | Existing Visual Quality Class of Viewscape | Existing Conditions | Visibility of the New Bridge | Future Visual Quality Class of Viewscape with the Project | Simulated Potential Conditions | Change in Visual Quality Class? |
|--|--|--|--|---|---|---------------------------------|
| Viewpoint 15: Deas Island Regional Park Lookout | Retention |  | This location will have clear views of the bridge deck, tower, and piers. | Partial Retention |  | Yes |
| Viewpoint 16: Waterstone Pier residential complex | Modification |  | This location will have views of the bridge towers, deck, and piers. | Modification |  | No |
| Viewpoint 17: Dyke and Williams Road | Partial Retention |  | This location will have partial views of the bridge towers, deck, and piers. | Partial Retention |  | No |

Interchange Upgrades

The visual assessment of interchanges being improved as part of the Project, involves a qualitative evaluation of the degree to which overall visual quality would change as a result of the Project.

Westminster Highway Interchange

Access to Highway 99 south, for westbound traffic on Westminster Highway, will be improved with a new access ramp. The access ramp will be constructed on the northwest corner of the interchange on the opposite side of Westminster Highway from the nearest residential area. The changes are entirely contained within the current right-of-way and within an area of grass and trees maintained as road verge by the Ministry of Transportation and Infrastructure. The proposed works represent an expansion in the number of lanes but no substantive change in the general nature of the infrastructure including the elevation of the existing and proposed structure.

Considering that land use adjacent to the Westminster Interchange includes limited residential development, with views typically oriented away from Highway 99, and that the nature of the existing infrastructure will not change substantially, the overall impact is considered to be low because the magnitude of the change is small and the area is already developed.

Visual Quality Classification: For this interchange, once upgrades are completed, the VQC is considered to be identical to that of the current situation and ranges from Partial Retention around Richmond Nature Park to Modified in other areas adjacent to the interchange. As noted previously, the visual sensitivity class at this location is considered to be generally low. As a result of these considerations, there is no change in the visual quality classification.

Steveston Highway Interchange

To improve the access and egress of this interchange, and accommodate all movements while avoiding the requirement for additional agricultural land, a three-level interchange may be considered.

The planned improvements in this area will result in some changes to the viewscape for adjacent receptors, including some in the residential development in close proximity to the Project. Adjacent land use is dominated by vehicle-oriented commercial and retail developments which currently experience high volumes of vehicle traffic on Steveston Highway and Number 5 Road.

While visual quality will be affected by the higher elevation of the new infrastructure, reducing existing congestion represents an improvement to visual quality in adjacent areas. The landscape adjacent to the Steveston Interchange will continue to be dominated by transportation, agricultural, commercial and residential development, as it does now. Some visual conditions will improve with reductions in congestion, others will overall remain similar.

Visual Quality Classification: Considering the proposed changes, the VQC for this interchange remains unchanged and ranges from Modification in agricultural areas (i.e., where the natural landscape is marginally present and human development is very easy to see and large in scale) to Maximum Modification elsewhere (i.e., where human development continues to dominate the landscape). Also, as noted, the visual sensitivity class at this location is considered to be generally low. As a result of these considerations, there is no change in the visual quality classification.

Highway 17A Interchange

Modifications to the existing over/underpass will involve development of a full movement interchange with some increase in height to accommodate all traffic movements while avoiding the requirement for additional agricultural land. The reference concept for the Highway 17A interchange contemplates roundabouts placed on the east and west side of Highway 99. The roundabout on the east side of Highway 99 would allow for the removal of the traffic lights on Highway 17A east of the interchange.

While the improved interchange will be higher than the current structure, the proposed works will result in improvements to visual conditions. The visual impact on the commercial property on the northwest corner of the interchange will improve with the removal of the traffic lights and reductions in congestion on Highway 99. Further, there are no residential developments in close proximity that include receptors that would experience a change in visual conditions.

Visual Quality Classification: Considering the proposed changes, the VQC for this upgraded interchange remains unchanged and is considered Modification (i.e., where the natural landscape is marginally present and human development is very easy to see and large in scale). Also, as noted the VSC at this location is considered to be generally low. As a result of these considerations, there is no change in the visual quality classification.

5.5.5 Mitigation Measures

A hierarchical approach based on avoidance of potential effects followed by minimization or reduction of unavoidable effects was used in identifying strategies to mitigate potential Project-related effects on visual quality at sensitive locations.

5.5.5.1 Avoidance

Because the Project involves replacement of the Tunnel with a bridge, and upgrades to existing interchanges to accommodate future forecasted traffic, changes in visual quality are unavoidable; however, design considerations have been incorporated into the Project to ensure that the structure is aesthetically pleasing and blends well with the local and regional landscape.

5.5.5.2 Minimization

The presence of the new bridge will add noticeable visual features to the landscape and result in changes in visual conditions of the viewsapes from certain viewpoints. Wherever possible, at those viewpoints where the greatest effects to visual quality will occur, addition of vegetation buffers could screen views and partially reduce the visual effects of having a large bridge structure in the foreground. The most directly affected locations include points along the Millennium Trail, on either side of the new bridge, and along the foreshore by Captain's Cove Marina, between the residential development and the new bridge. In designing vegetation buffers at these locations, the desire to screen views of the bridge will need to be balanced with the desire to maintain views of Deas Slough or the Fraser River and nearby mature vegetation.

The Ministry will develop and share potential options for minimizing Project-related effects with stakeholders prior to finalizing the appropriate type and extent of vegetated buffers to be installed within 150 m on either side of the bridge alignment.

Establishment of vegetation at appropriate locations to screen objects that interfere with visual quality is a best management practice that has been applied effectively in similar projects, and is expected to be effective in addressing potential effects of the Project on viewsapes from sensitive receptor locations.

As substantial structures currently exist at Steveston Highway, Westminster Highway and Highway 17A, and the assessment conducted did not identify any changes in the visual quality classifications at these locations, no mitigation is proposed to address changes in visual conditions associated with the upgraded structure. As such, changes in visual conditions, associated with highway improvements noted, are not carried forward into assessment of residual effects.

5.5.6 Residual Effects and their Significance

Residual effects are those adverse effects that remain after implementation of mitigation measures. Measures proposed to avoid or minimize Project-related effects on visual quality (primarily implementation of vegetative screening) were identified based on standard best practices and proven methodologies. Accordingly, there is a high level of confidence in the effectiveness of these measures and their ability to minimize Project-related effects on visual quality.

After the implementation of mitigation measures, there are residual effects with respect to changes in conditions predicted for the following viewpoints:

- Viewpoint 4 (Tunnel Access Road). Modification changes to Maximum Modification.
- Viewpoint 6 (Captain's Cove Marina). Modification changes to Maximum Modification.
- Viewpoint 14 (Millennium Trail beside Captain's Cove). Modification changes to Maximum Modification.

These viewpoints are located in the immediate vicinity of the new bridge (i.e., within 1 km) and will have clear views of the structure as the absorptive capacity of the landscape is lower than at distances greater than 1 km. At distances of greater than 1 km absorptive capacity is higher as the new bridge will appear smaller, and other man-made and natural structures will become prominent in the landscape (high-rise towers, industrial complexes and mountains). These other structures act to draw the eye away from, or compete with, views of the new structure. No residual effects to visual quality are predicted for viewpoints more distant to the new bridge (i.e., viewpoints 9, 10 and 15).

The new bridge will add noticeable visual features and affect viewscapes from viewpoints closest to the new bridge alignment. Overall, within the LAA, the visual effect of the new bridge is expected to result in changes in visual conditions that are moderate in magnitude, site-specific in extent, long-term in duration and, continuous, and only reversible if the bridge is removed.

The area surrounding the Project is already impacted at a moderate to high level by human development. As a result, the Project alignment has a low sensitivity, or high resilience, to additional human alterations. Given the noticeable change in the level of alteration when a tunnel is replaced with a bridge, the likelihood of the new bridge resulting in changes to visual quality is high.

Effects to viewsapes from all viewpoints are assessed together. The potential residual effect was characterized by qualitatively assessing the direction, magnitude, geographic extent, duration, frequency, and reversibility of the effect. Definitions for the ratings applied to the residual effect are presented in **Table 5.5-7**.

Context: The new bridge structure, a large angular feature, will increase the extent of human alteration in viewscape within the LAA, especially for viewers close to the bridge. The associated change in visual quality, however, is subjective and dependant on the perception and opinion of the viewer. A rating for direction (i.e., adverse, positive, or neutral) that is based on level of change has not been provided as it would not represent the preference of all viewers. Rating for the magnitude of Project-related effects was developed in the context of sensitivity of the viewscape to alteration, as measured by VSC (**Table 5.5-2**), with specific reference to visual quality experienced from sensitive receptor sites.

Table 5.5-7 Criteria Used to Characterize Residual Effects on Visual Quality

| Criteria | Description | Definition of Rating | |
|-----------|--|----------------------|---|
| Magnitude | Amount of the effect relative to natural or baseline conditions | Negligible | Effect not detectable at LAA scale. |
| | | Low | Effects detectable but will not alter visual quality ratings. |
| | | Moderate | Effects could result in a minor or moderate change in visual quality (i.e., negative change in VQC of more than one classification) for viewpoints within 1 km. |
| | | High | Effects could have a major influence on visual quality (i.e., negative change in VQC of more than two classifications) for viewpoints within 1 km. |
| Extent | Geographic extent / distribution of the residual effect | Site-Specific | Limited to directly individual sites. |
| | | Local | Effect detectable over entire LAA. |
| | | Regional | Effect detectable in area larger than the LAA. |
| Duration | Length of time over which the residual effect is expected to persist | Transient term | Limited to field investigations or <1 month during construction. |
| | | Short term | Limited to Project construction phase. |
| | | Moderate term | Will affect VC during first five years of operation, then be mitigated. |
| | | Long term | Effect is permanent. |

| Criteria | Description | Definition of Rating | |
|---------------|---|----------------------|---|
| Frequency | Nature of the occurrence of the residual effect (e.g., how often the stressor impacts the VC) | Once | Residual effect will occur once. |
| | | Rare | 1-2 times per year and intermittently. |
| | | Uncommon | 3-5 times per year and intermittently. |
| | | Frequent | More than 5 times per year or for extended periods. |
| | | Continuous | Continuous or ongoing. |
| Reversibility | Potential for the effect to be reversed or naturally return to baseline level after the disturbance has ceased (or following a period of time after the disturbance has ceased) | Reversible | Existing conditions will be restored after effect has ceased. |
| | | Irreversible | Existing conditions will not be restored after effect ceases. |
| | | Change | Effect may fluctuate between positive and adverse for the duration. |

A summary of the criteria ratings used to characterize the residual effect on visual conditions is provided in **Table 5.5-8**.

Table 5.5-8 Summary of Criteria Ratings for Change in Visual Conditions

| Criteria | Criteria Rating | Rationale for Criteria Rating |
|---------------|-----------------|--|
| Magnitude | Moderate | It will result in a noticeable change, compared to the Tunnel; however, it will be consistent with the level of alteration associated with a major highway in a populated urban area that is undergoing active growth. |
| Extent | Site-specific | The adverse effects are most evident within one kilometre of the bridge alignment because the area's flat topography and tall mature vegetation diminish the visibility of the bridge as seen from a distance. |
| Duration | Long-term | The effects will be experienced for as long as the bridge is in place. |
| Frequency | Continuous | The effect is continuous, especially for potentially sensitive viewers, like residents and recreationists, who spend more time in proximity to the Project alignment. |
| Reversibility | Irreversible | The existing visual conditions cannot be completely restored if the bridge is removed. |

5.5.6.1 Significance Definition

The residual effect of the new bridge and interchange upgrades on visual conditions will be considered significant if the magnitude of the effect is high (i.e., visual change is prominent in relation to existing natural and anthropogenic features) and the effect extends beyond the site (i.e., greater than one kilometre from the Project alignment).

The long-term plans for Richmond and Delta indicate continued growth in population and employment. The changes in visual conditions associated with ongoing growth in these communities are typically experienced as low to moderate in magnitude, with the trend being the incremental loss of natural areas and increasing extent of alteration in the landscape. The construction and operation of the bridge, which supports provincial and regional goals, will have an effect on visual resources, but not one that is greater than that typically experienced in growing municipalities with major transportation routes. The residual effect of visual impacts would be considered significant if:

- viewscales from 2/3rd of the viewpoints assessed have a negative change in VQC (i.e., negative visual quality classification change).

- viewscales from 1/3rd of the viewpoints assessed, which had high original VQC (i.e., Retention or Partial Retention), had a negative change in VQC of greater than two classifications.

This definition acknowledges that for a significant effect to occur, there must be negative changes to a multitude of viewpoints (i.e., 2/3rd of the total viewpoints changing by 1 VQC class), and some of those changes need to be substantial in magnitude and affect high-value or high sensitivity viewpoints (i.e., 1/3rd of the total with high original VQC changing by at least 2 classes).

5.5.6.2 Significance Determination

The significance determination of the Project-related residual effect on visual conditions, the likelihood of the residual effect, and the level of confidence associated with determinations of significance and likelihood are presented in **Table 5.5-9**. Likelihood characterization was based on professional judgement and the definition above. The effects were also defined as those having low, moderate, or high probability of resulting in an adverse residual effect on visual resources. Low, moderate, or high confidence reflects the level of uncertainty associated with determinations of significance and likelihood.

Table 5.5-9 Summary of Significance Determination for Residual Effects on Visual Resources

| Residual Effect | Significance (significant/not significant) | Likelihood (low/moderate/high) | Level of Confidence (low/moderate/high) |
|-----------------------------|--|--------------------------------|---|
| Change in visual conditions | Not significant | High | High |

Residual effects from the Project on changes in visual conditions are not expected to be significant on the basis that:

- Only six of the 17 viewpoints (35%) assessed had changes in VQC of the viewscape.
- Only two of 8 viewpoints (25%) with high VQC ratings had negative changes in VQC of the viewscape of greater than two classifications.

In reaching this conclusion, it is noted that the magnitude of the residual effect is moderate at the small number of viewpoints from where the new bridge structure will be noticeable, compared to the existing Tunnel. However, the extent of the residual effect is site-specific (i.e., within one kilometre of the new bridge), and most viewpoints have no change in VQC of the viewscape as a result of the Project. There was no change in VQC (no visual impact) assessed for the modified interchanges.

The likelihood of residual Project effects on visual quality is high, as the likelihood of the causal disturbance (i.e. construction and operation of the bridge) is high.

The level of confidence in this significance determination is high, based on the results of the simulated future visual conditions and the Ministry's experience with previous major infrastructure projects in the region.

The findings in this assessment are subjective as viewer perceptions and opinions on having a new bridge or upgraded interchange as part of the viewscape, and the aesthetics of the new bridge itself would vary widely.

5.5.7 Cumulative Effects and their Significance

The effects of the Project combined with the effects of other projects and activities that have been carried out are considered in existing conditions. The combination of the residual Project effects on visual quality with the effects of other certain and reasonably foreseeable projects and activities comprise the future cumulative effects on visual quality.

Spatial Boundaries

The spatial boundary of the cumulative effects assessment for visual quality is defined as the area within a six kilometre radius centered on the highest point of the new bridge deck. Beyond six kilometres, the views of the bridge and interchanges will be mostly screened by intermediate structures and vegetation, and thus are not anticipated to interact cumulatively with other projects and activities.

Other Certain and Reasonably Foreseeable Projects and Activities

A review of other current and reasonably foreseeable projects and activities (**Section 3.10.1 Identifying Past, Present or Reasonably Foreseeable Projects and/or Activities**) identified one project with new structures or components that might be visible from the locations where Project-related changes in visual quality are expected. Based on a review of EAO Project Information Centre (e-PIC), the Canadian Environmental Assessment Registry, and project websites, no other projects with anticipated visual effects that could combine with those of the Project were identified within the assessment boundary.

The replacement of B.C. Hydro and Power Authority's (B.C. Hydro) Massey Circuit transmission line, which currently passes under the Fraser River through the Tunnel, will be reconfigured to a crossing of the Fraser River outside of the Tunnel and parallel with the Project. Currently, three crossing options have been considered including:

- Alternative 1: An overhead transmission line crossing the Fraser River. Based on information currently available from B.C. Hydro (2015), this alternative would include two steel lattice towers, approximately 120 metres in height (approximately half the height of the proposed new bridge towers), would support the overhead 230-kilovolt line crossing the Fraser River. One transmission tower would be located on Deas Island and the other in Richmond, to the west of the new bridge. B.C. Hydro would place these towers in line with the proposed new bridge towers, and the conductor lines would hang at approximately the same height as the bridge deck to mitigate visual and potential avian impacts. A second, smaller steel lattice tower, approximately 75 metres in height, would also be required on Deas Island.
- Alternative 2: An underground transmission line running under the Fraser River. Based on information available from B.C. Hydro (2015), this alternative would consist of a transmission line running under the Fraser River, parallel to the new bridge, from Richmond to Deas Island. A borehole path would be created using horizontal directional drilling. Once a borehole path is drilled, conduits would be installed, through which the transmission cables would be pulled. The cables would terminate on either side of the river, at a transition infrastructure called a pothead, where they would transition from underground cables to an overhead line. A steel lattice tower, approximately 75 metres in height, would also be required on Deas Island.
- Alternative 3: A transmission line located on the new bridge. Based on information available from B.C. Hydro (2015), this alternative would include installation of the transmission line on the new bridge. This alternative requires a steel lattice tower, approximately 75 metres in height, on Deas Island and a pothead on either side of the Fraser River. The transmission cables would run from the ground in vertical shafts up the bridge, on either end of the bridge, and through a box girder within the main bridge deck.

While a decision on which alternative will be selected has not been made, B.C. Hydro has indicated that Alternative 1 appears to be the technically-leading alternative for a number of reasons, including providing a high level of safety and reliability of service.

Cumulative Interactions and Potential Cumulative Effects

For the purposes of this assessment it is assumed that the reconfigured transmission line will be the overhead transmission line crossing (Alternative 1). This assumption is considered the most conservative as it would have the greatest potential impact on visual conditions relative to other options that are being explored by B.C. Hydro. Further assumptions regarding the future reconfiguration of the transmission lines are based on B.C. Hydro's (2015) description of this alternative, and include:

- Towers for the new transmission line will be in the existing B.C. Hydro ROW and therefore close to the new bridge and existing poles where the transmission line exits the Tunnel portals.
- Towers will be in alignment with bridge piers and the transmission line will be in alignment with the bridge deck.

On this basis, the new transmission line is not considered to result in a residual effect on visual conditions. In addition, the proximity of the new bridge to the transmission line and the co-alignment of the components will result in the two blending into the viewscape, rather than appearing as separate structures. As such, the Project is not expected to interact with residual effects from B.C. Hydro's new transmission line or other projects, and no cumulative effect to visual quality is expected.

5.5.8 Follow-up Strategy

The mitigation proposed to address effects on visual quality focuses on the establishment of vegetation adjacent to the bridge abutments that are within the viewscape of nearby residential developments. Evaluation of the integrity of the vegetated buffer over one to two growing seasons, and if required, maintenance or restoration, is proposed. As the establishment of vegetated buffers is a best management practice that has been applied effectively in similar projects, no other follow-up measures are proposed.

5.5.9 References

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APPENDIX A

Overview of Potential Project Interactions with Visual Resources

Table 1 Overview of Potential Project Interactions with Visual Resources

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|------------------------|---|--|
| Pre-Construction / Site Preparation | | | |
| Site preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Acquiring property for the Project | <p>Nature of interaction: No interaction anticipated.</p> <p>Comment: Activities are not expected to affect visual resources.</p> |
| | No effect | <ul style="list-style-type: none"> • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction • Acquiring property for the Project | <p>Nature of interaction: Interactions are anticipated as a result of changes within the Highway 99 corridor.</p> <p>Comment: Activities are not anticipated to effect existing viewscales as changes are minimal in the context of the existing transportation corridor and the low-gradient landscape.</p> |
| | Potential effect | N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|---|
| Construction Phase | | | |
| New bridge construction including approaches and ramp connections | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables using land-based equipment • Installing retaining walls | <p>Nature of interaction: Interactions are anticipated as a result of changes within the Highway 99 corridor.</p> <p>Comment: Activities are not anticipated to effect existing viewsapes as changes are minimal in the context of the existing transportation corridor and the low-gradient landscape.</p> |
| | Potential effect | N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|--|---|
| Highway 99 improvements, including interchange upgrades | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Nature of interaction: Interactions are anticipated as a result of changes within the Highway 99 corridor.</p> <p>Comment: Activities are not anticipated to effect existing viewsapes as changes are minimal in the context of the existing transportation corridor and the low-gradient landscape.</p> |
| | Potential effect | N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|------------------------|---|---|
| Tunnel decommissioning | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity. | <p>Nature of interaction: No interaction anticipated.</p> <p>Comment: Activities will not be visible from sensitive locations.</p> |
| | Potential effect | N/A | N/A |
| Decommissioning of Deas Slough Bridge | No interaction | N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | <p>Nature of interaction: Interactions are anticipated as a result of changes within the Highway 99 corridor.</p> <p>Comment: Activities are not anticipated to effect existing viewsapes as changes are minimal in the context of the existing transportation corridor and the low-gradient landscape.</p> |
| | Potential effect | N/A | N/A |

| Project Phase/ Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|------------------------|---|---|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | <ul style="list-style-type: none"> Operating reconfigured Highway 99 and interchanges Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | <p>Nature of interaction: No interaction anticipated.</p> <p>Comment: Activities are not anticipated to interact with the existing viewscales since Highway 99 is already part of the viewscale.</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> N/A | N/A |
| New bridge | No interaction | <ul style="list-style-type: none"> Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | <p>Nature of interaction: No interaction anticipated.</p> <p>Comment: Activities are not anticipated to interact with the existing viewscales.</p> |
| | No effect | <ul style="list-style-type: none"> N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> Operating the new bridge | <p>Nature of interaction: Activities with the potential to cause changes to visual resources.</p> <p>Comment: Potential effects include changes in visual conditions. The bridge structure will add prominent anthropogenic features, thereby changing the viewscale aesthetics. The effect is rated as moderate because the new feature will be added to a relatively flat landscape with existing clusters/corridors of human development and activities.</p> |

"N/A" indicates that no Project works and/or activities are applicable to the category

APPENDIX B

High-resolution Photos of Existing and Simulated Future Viewscapes



Figure 1 Existing Viewscape from Viewpoint 1 (River House Restaurant and Marina)



Figure 2 Simulated Future Viewscape from Viewpoint 1 (River House Restaurant and Marina)



Figure 3 Existing Viewscape from Viewpoint 2 (River House Restaurant and Marina)



Figure 4 Simulated Future Viewscape from Viewpoint 2 (River House Restaurant and Marina)



Figure 5 Existing Viewscape from Viewpoint 3 (River Woods Neighbourhood)



Figure 6 Simulated Future Viewscape from Viewpoint 3 (River Woods Neighbourhood)



Figure 7 Existing Viewscape from Viewpoint 3B (River Woods Neighbourhood)



Figure 8 Simulated Future Viewscape from Viewpoint 3B (River Woods Neighbourhood)



Figure 9 Existing Viewscape from Viewpoint 4 (Tunnel Access Road)



Figure 10 Simulated Future Viewscape from Viewpoint 4 (Tunnel Access Road)



Figure 11 Existing Viewscape from Viewpoint 5 (Wellington Point Park)



Figure 12 Simulated Future Viewscape from Viewpoint 5 (Wellington Point Park)



Figure 13 Existing Viewscape from Viewpoint 6 (Captain's Cove Marina)



Figure 14 Existing Viewscape from Viewpoint 6 (Captain's Cove Marina)



Figure 15 Existing Viewscape from Viewpoint 7 (Admiral Way, South of Captain's Cove Marina near Woodward Landing)



Figure 16 Simulated Future Viewscape from Viewpoint 7 (Admiral Way, South of Captain's Cove Marina near Woodward Landing)



Figure 17 Existing Viewscape from Viewpoint 8 (Cove Links Golf Course)



Figure 18 Simulated Future Viewscape from Viewpoint 8 (Cove Links Golf Course)



Figure 19 Existing Viewscape from Viewpoint 9 (Millennium Trail between River Woods Neighbourhood and Highway 99)



Figure 20 Simulated Future Viewscape from Viewpoint 9 (Millennium Trail between River Woods Neighbourhood and Highway 99)



Figure 21 Existing Viewscape from Viewpoint 10 (East of Captain's Cove Marina adjacent to Proposed New Housing Development)



Figure 22 Simulated Future Viewscape from Viewpoint 10 (East of Captain's Cove Marina adjacent to Proposed New Housing Development)



Figure 23 Existing Viewscape from Viewpoint 11 (Benches on Dyke Road, West of No.5 Road)



Figure 24 Simulated Future Viewscape from Viewpoint 11 (Benches on Dyke Road, West of No.5 Road)



Figure 25 Existing Viewscape from Viewpoint 12 (No.3 Rd and Dyke Road, dog park and public pier)



Figure 26 Simulated Future Viewscape from Viewpoint 12 (No.3 Rd and Dyke Road, dog park and public pier)



Figure 27 Existing Viewscape from Viewpoint 13 (Westham Island Road near the Single-lane Bridge)



Figure 28 Simulated Future Viewscape from Viewpoint 13 (Westham Island Road near the Single-lane Bridge)



Figure 29 Existing Viewscape from Viewpoint 14 (Millennium Trail beside Captain's Cove Marina)



Figure 30 Simulated Future Viewscape from Viewpoint 14 (Millennium Trail beside Captain's Cove Marina)



Figure 31 Existing Viewscape from Viewpoint 15 (Deas Island Regional Park Lookout)



Figure 32 Simulated Future Viewscape from Viewpoint 15 (Deas Island Regional Park Lookout)



Figure 33 Existing Viewscape from Viewpoint 16 (Waterstone Pier residential complex)



Figure 34 Simulated Future Viewscape from Viewpoint 16 (Waterstone Pier residential complex)



Figure 35 Existing Viewscape from Viewpoint 17 (Dyke and Williams Road)



Figure 36 Simulated Future Viewscape from Viewpoint 17 (Dyke and Williams Road)

6.1 Heritage Resources Assessment Highlights:

- The Project is located in an area where substantial historical development has occurred, and the majority of the Project alignment is characterized as having low archaeological potential.
- No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.
- The development and implementation of an Archaeological and Heritage Resources Management Plan, which will include a chance-find procedure, will avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.
- No Project-related residual or cumulative effects on heritage resources are expected.

6.1 Heritage Resources

This section presents the results of the assessment of potential effects of the Project on heritage resources, and includes a description of existing conditions, potential Project-related effects and proposed mitigation measures, and an evaluation of residual Project-related and cumulative effects.

6.1.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on heritage resources in terms of Project setting, and defines the spatial and temporal assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

No jurisdictional, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects, or accessibility constraints or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore administrative or technical boundaries are not considered.

6.1.1.1 Assessment Context

Heritage resources, in the context of this assessment, comprise archaeological and historical heritage sites, objects, and features. In this assessment, archaeological sites are defined as those sites that pre-date AD 1846, or sites that are undated and could pre-date AD 1846. Historical heritage sites are those that originated since AD 1846.

In accordance with the B.C. *Heritage Conservation Act (HCA)*, R.S.B.C 1996, c. 187, heritage resources include, but are not limited to:

- Artifacts, features, materials, or other physical evidence of human habitation or use prior to AD 1846.

- Burial places and human remains with archaeological or historical value.
- First Nations rock paintings or First Nations rock carvings that have archaeological or historical value.
- Heritage wrecks (i.e., vessels or aircraft) or heritage objects from a heritage wreck.

The assessment of heritage resources follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Indicators used to assess the potential Project-related effects on heritage resources are based on the provincial guidelines for archaeological overview assessments (AOAs) and archaeological impact assessments (AIAs) (B.C. FLNR 1998, 2009). These indicators and the rationale for their selection are presented in **Table 6.1-1**.

Table 6.1-1 Indicators for Heritage Resources

| Indicator | Rationale for Selection |
|--|---|
| Disturbance of archaeological sites, objects, and features | <ul style="list-style-type: none"> • Disturbance may affect site integrity. |
| Disturbance of historical sites, objects, and features that are subject to protection under the <i>HCA</i> | |
| Changes in level of accessibility to archaeological sites, objects, and features | <ul style="list-style-type: none"> • Reduced accessibility may inhibit opportunities for research, preservation, or public appreciation. • Increased accessibility may expose heritage resources to vandalism or looting. |
| Changes in level of accessibility to historical sites, objects, and features that are subject to protection under the <i>HCA</i> | |

6.1.1.2 Assessment Boundaries

The assessment boundaries for heritage resources are defined below.

Spatial Boundaries

The local assessment area (LAA) and regional assessment area (RAA) for heritage resources are defined in **Table 6.1-2**, and shown on **Figure 6.1-1**. The boundaries of the LAA take into account the scale and spatial extent of potential environmental effects that are appropriate for heritage resources. The RAA is intended to provide regional context for the assessment.

Table 6.1-2 Spatial Boundary Definitions for Heritage Resources

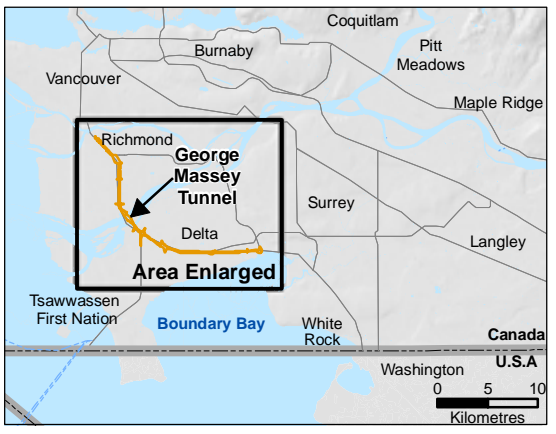
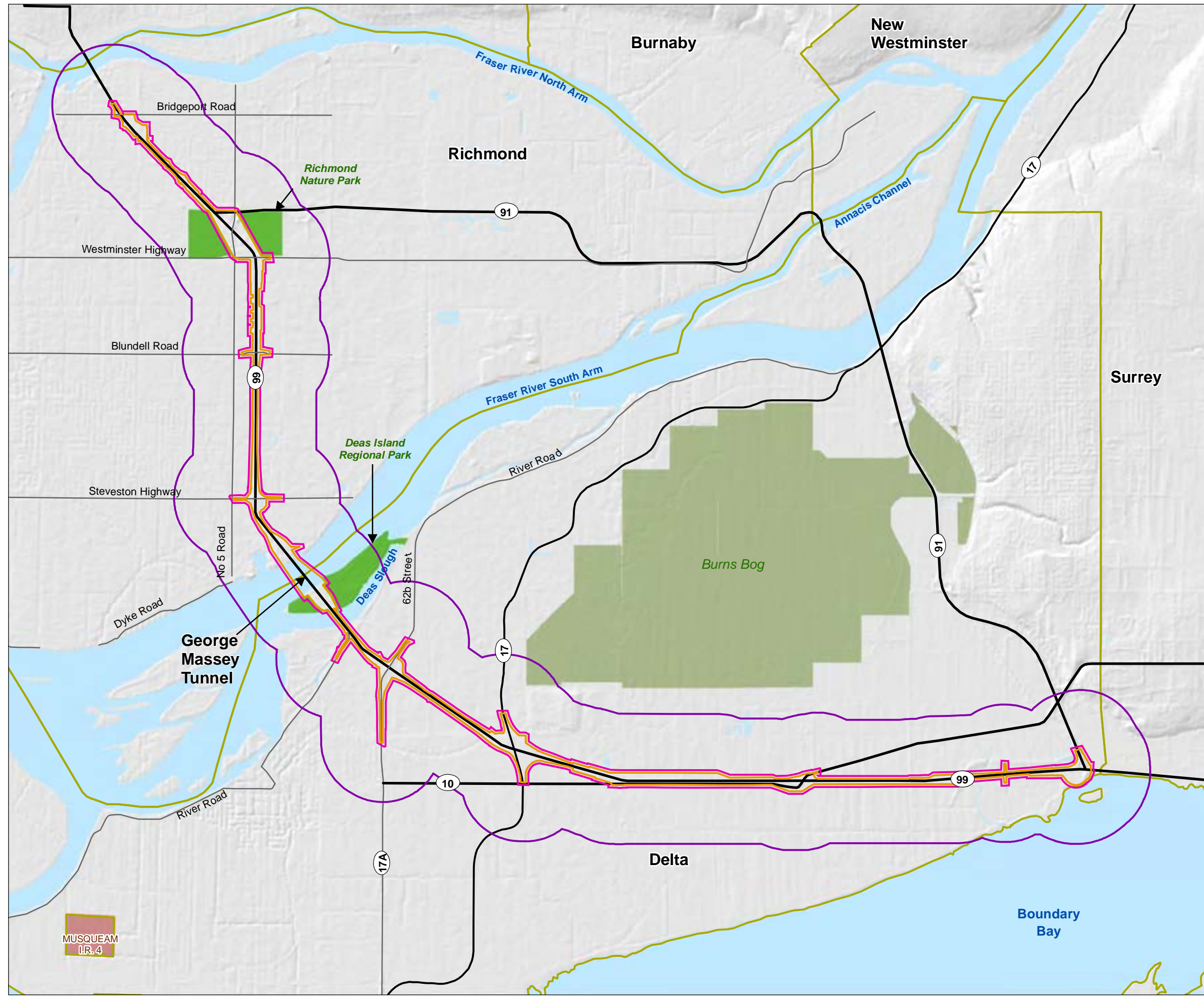
| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|---|
| Local Assessment Area (LAA) | Project alignment |
| Regional Assessment Area (RAA) | Project alignment, plus one kilometre surrounding the Project alignment |

The LAA was selected to encompass the area within which the Project is expected to interact with, and potentially have an effect on heritage resources. Given the site-specific and stationary nature of heritage resources, the Project alignment is the maximum area within which potential direct and indirect Project effects on heritage resources are reasonably expected to occur.

An area encompassing the Project alignment and a one kilometre buffer around it was selected as the RAA. An AOA of the RAA was undertaken to identify known heritage resources and archaeological potential of the Project alignment, and determine the need for and scope of further studies to assess Project-related effects on heritage resources.

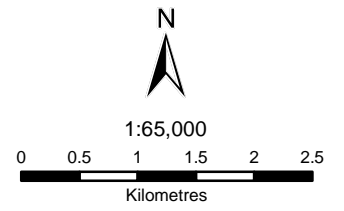
Informed by the results of the AOA, an AIA was undertaken within the LAA. In accordance with the *British Columbia Archaeological Impact Assessment Guidelines* (B.C. FLNR 1998), the effects assessment was undertaken only within the LAA, since heritage sites located outside of the LAA are not relevant to the assessment of Project effects.

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- Legend**
- Heritage Resources Local Assessment Area
 - Heritage Resources Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. HCA Permit Area, Archaeological Sites, Historical Sites received from Golder, May 2015.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| HERITAGE RESOURCES LOCAL AND REGIONAL ASSESSMENT AREAS | |
| Figure 6.1-1 | 13/05/2016 |
| | |

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on heritage resources were established based on the potential for each phase of the Project to interact with and have an effect on this VC. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect heritage resources present within the Project alignment; therefore, the following temporal boundaries were defined for the heritage resources assessment:

- Existing conditions.
- Construction phase (including decommissioning of the Tunnel).
- Operations phase (including maintenance).

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of Proposed Project**.

Administrative Boundaries

No administrative boundaries, i.e. political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on heritage resources, have been identified.

Technical Boundaries

A few areas, or portions of areas, of archaeological potential within the assessment area were inaccessible due to environmental, infrastructure, or access constraints. In this context, the need for and scope of additional archaeological assessment to confirm the absence of heritage resources within the Project alignment will be reviewed once the detailed Project design is complete.

6.1.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of heritage resources within the assessment areas. An overview of the regulatory context for management of heritage resources as relevant to the Project is also provided.

6.1.2.1 Baseline Data Collection

In 2014, the Ministry initiated desktop and field studies on heritage resources to support Project planning and assessment. Building on available information, these studies, as summarized in **Table 6.1-3**, were designed to address known data gaps.

Table 6.1-3 Desktop and Field Studies Related to Heritage Resources

| Study Name | Purpose of Study |
|---------------------------------------|---|
| Desktop literature review | <ul style="list-style-type: none"> • Determine archaeological and heritage resources potential for the local assessment area (LAA). • Identify key data gaps and areas of uncertainty within the LAA. |
| Field inventory of heritage resources | <ul style="list-style-type: none"> • Identify and evaluate heritage resources within the LAA. |

Desktop Literature Review

Information pertaining to heritage resources was gathered through an established process with regulators and interested Aboriginal Groups. The B.C. Archaeology Branch forwarded an *HCA* permit application relevant to the Project to several Aboriginal communities and organizations. Details of this process and a list of participants are provided in **Appendix A**

A review of available information pertaining to local and regional prehistory, history, built heritage, and other heritage resources was conducted for the LAA. Detailed topographic and orthographic maps were reviewed to identify areas of past and present land development, and locations that may have higher archaeological potential than surrounding terrain (e.g. streams or elevated landforms).

Readily available reports on the environment, land use by Aboriginal Groups, and archaeology of the LAA were also reviewed. Environmental data reviewed included deltaic development, watercourses, surficial geology, past sea levels, biological environments, ecological communities, and flora and faunal resources. In addition, results of selected geotechnical investigations conducted in the LAA were reviewed to evaluate the natural deposits and depth of fill. Historical aerial photographs were examined to understand historical land use and to identify areas of past disturbance. Available historical maps were consulted to identify historical shorelines, locations of minor drainages, and Aboriginal sites. Provincial and local government heritage registers were searched to identify recorded archaeological or heritage sites in the LAA. Proprietary cultural heritage resource, heritage wreck, and radiocarbon sample databases were also consulted.

Information on the location and nature of previously recorded heritage sites was obtained through a search of the Provincial Heritage Register and a review of existing archaeological, ethnographic, and historical literature relevant to the LAA.

Data reviewed from readily available public sources, including ethnographies, Aboriginal place names and land use of culturally valued landscapes, plants, and animals, as well as locations of settlements and subsistence strategies, were collected and plotted (Matthews 1955, Musqueam Indian Band 1976, Rozen 1979, McHalsie 2001, Hul'qumi'num Treaty Group 2005). To assist in making determinations pertaining to archaeological potential and traditional use within and adjacent to the LAA, information was obtained from the Stó:lō Research and Resource Management Centre (SRRMC) Traditional Use Study database (SRRMC 2014).

Where site-specific information was available, it was used to aid in the interpretation of field results and the development of mitigation measures. Information received from Aboriginal Groups was subsequently added to the summary of Aboriginal place names and land use data.

Using information derived from the literature review, the LAA was analyzed to identify areas of relative archaeological potential and select field inventory locations. Three levels of archaeological potential, as defined below, were used to classify sites within the LAA based on the predicted integrity of archaeological deposits:

- **Archaeological Potential:** These are areas that correlate with the setting of known archaeological sites in adjacent areas and that have had limited disturbance from previous land use. Such areas have the highest potential to contain intact or disturbed archaeological deposits at any depth. Examples of these locations include riparian setbacks, forested areas and bogs.
- **Compromised Archaeological Potential:** These are areas that correlate with known archaeological sites in adjacent areas, and exhibit impacts to the uppermost sediment layers due to land development. There is potential for deeper, intact archaeological deposits to be present at these locations.
- **Removed Archaeological Potential:** These are areas that correlate with known archaeological sites in adjacent areas, but have previously undergone substantial land alterations that have eliminated the likelihood of archaeological deposits at any depth.

Areas in the LAA that did not fall within one of these three classes were characterized as having low archaeological potential due to environmental constraints on human use or on site preservation. **Figure 6.1-2** and **Appendix B** show the relative archaeological potential of areas within the LAA.

Historical heritage sites were identified using provincial and local government heritage registers, and assessed according to local guidelines for built heritage. Heritage wrecks in proximity to the LAA were identified and recorded in detail consistent with the *British Columbia Shipwreck Recording Guide* (B.C. FLNR 1991).

Consultation and Input from Aboriginal Groups

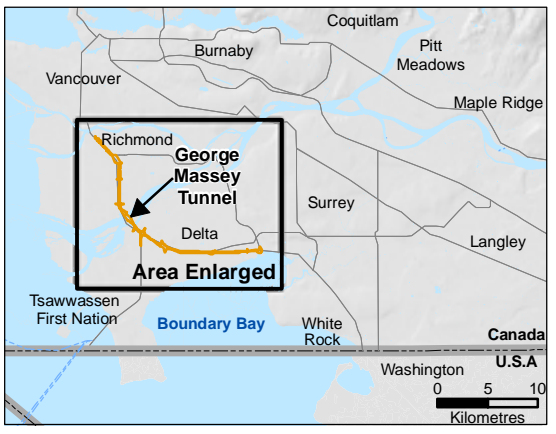
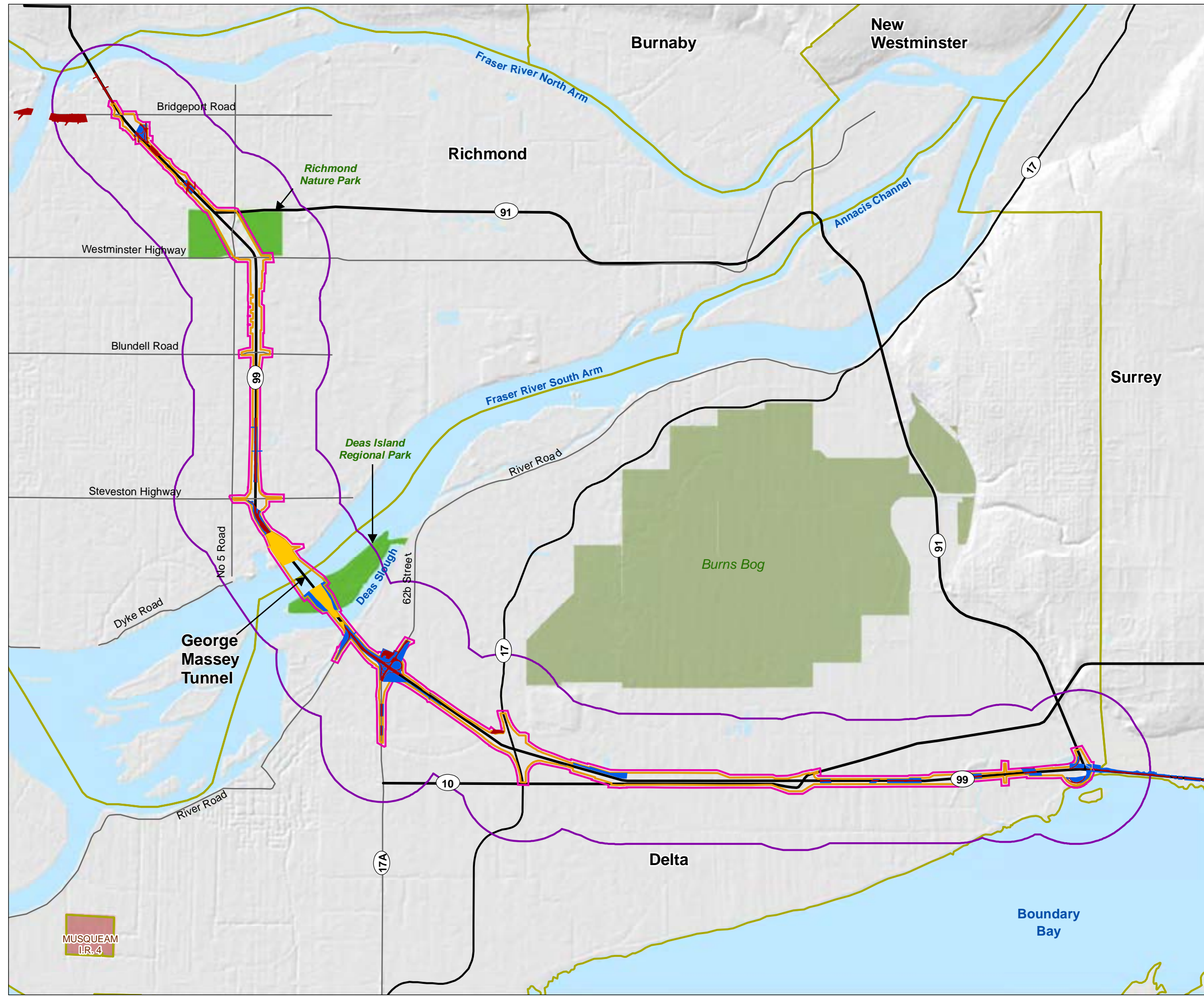
Potential impact of Project-related activities on heritage resources was identified as an area of specific interest by Aboriginal Groups during pre-Application consultation on the Project, and Aboriginal Groups have been engaged in the heritage resources assessment from early stages.

Traditional use studies in the context of the Project were undertaken by several Aboriginal Groups, and findings of the studies as well as relevant traditional knowledge shared with the Ministry during consultation informed the identification of potential archaeological or heritage sites, and supported the Project-related Heritage Resources Overview Assessment (HROA) and Heritage Resources Impact Assessment (HRIA). Draft reports on these assessments were shared with Aboriginal Groups for review and comment, and the Ministry and the Project archaeologist met with Aboriginal Groups to present the findings.

During pre-Application consultation Aboriginal Groups identified the potential for the presence of previously-unknown and unrecorded heritage sites in construction areas covered by infrastructure installed as part of the original development of the Highway 99 corridor as an area of potential interest. Potential for the presence of previously unknown heritage sites was taken into consideration in identifying potential Project-related effects on heritage resources (**Section 6.1.3 Potential Effects**) and measures to mitigate them (**Section 6.1.4 Mitigation Measures**).

Further detail on consultation activities undertaken with Aboriginal Groups is provided in **Section 10 Aboriginal Consultation**. Information provided by Aboriginal Groups on archaeological and heritage sites in and around the Project area is included in **Section 6.1.2.3 Existing Conditions**.

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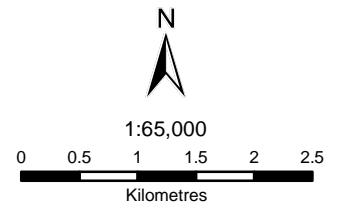
Legend

Potential

- Compromised Potential
- Potential
- Removed Potential
- Heritage Resources Local Assessment Area
- Heritage Resources Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. HCA Permit Area, Archaeological Sites, Historical Sites received from Golder, May 2015.



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AREAS OF RELATIVE ARCHAEOLOGICAL
POTENTIAL WITHIN OR ADJACENT TO THE LAA

| | |
|--------------|------------|
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|--------------|------------|

Field Inventory of Heritage Resources

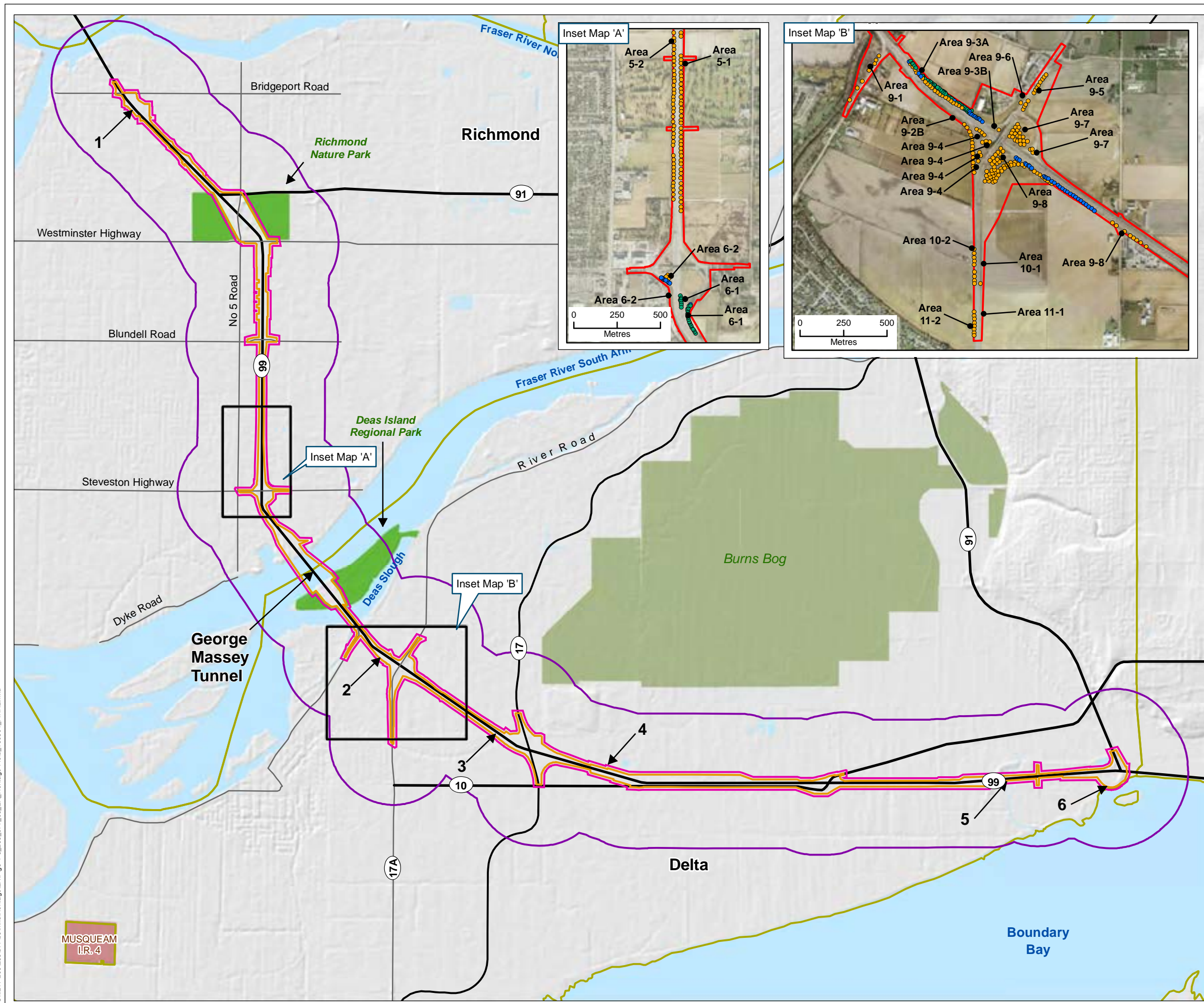
A field inventory was conducted in the LAA in September, October, and November 2014. The field inventory focused on areas identified through literature review as having the highest archaeological potential within the LAA (i.e., areas classified as having “archaeological potential” or “compromised archaeological potential” as discussed in **Section 6.1.2.2**

Regulatory Context and shown on **Figure 6.1-2**). Objectives of the field inventory were to:

- Identify, record, and assess heritage sites located within the LAA.
- Identify and evaluate possible effects of Project activities on these heritage sites.
- Recommend appropriate management actions.

The field inventory was undertaken in accordance with the *B.C. Archaeological Impact Assessment Guidelines* (B.C. FLNR 1998) and HCA permit 2014-0201. In addition, applicable permits from Aboriginal Groups were sought and obtained. Methods consisted of surface inspection and subsurface investigations for sites identified as having archaeological potential, using manual tools such as shovels and mechanical testing using power auger, backhoe, or excavator. As discussed in Appendix A, notification of the heritage resources field assessment was provided to all Schedule B Aboriginal Groups and Schedule B Aboriginal Groups were invited to participate in heritage resources field investigations.

A total of 413 subsurface tests were conducted in 16 areas in the LAA. Of these tests, 55 were excavated by hand, 90 were excavated using a power auger, and 268 were excavated using a backhoe or excavator. **Figure 6.1-3** shows the subsurface test locations.

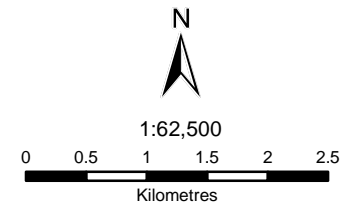


Legend

- 2** Field Reconnaissance ID
- Subsurface Test**
 - Negative Auger Test
 - Negative Backhoe Test
 - Negative Shovel Test
- ▭ HCA Permit Area
- ▭ Heritage Resources Local Assessment Area
- ▭ Heritage Resources Regional Assessment Area
- ▭ Project Alignment
- ▭ First Nation Reserve
- ▭ Municipal Boundaries
- ▭ Burns Bog Ecological Conservancy Area
- ▭ Waterbody
- ▭ Canada - U.S. Border
- ▭ Highway
- ▭ Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Subsurface Tests, HCA Permit Area, Subsurface Tests received from Golder, May 2015.



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FIELD INVESTIGATION RESULTS OVERVIEW

| | |
|--------------|------------|
| Figure 6.1-3 | 13/05/2016 |
|--------------|------------|

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6.1.2.2 Regulatory Context

The following statutes and guidance documents informed the assessment of Project-related effects on heritage resources:

- B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43
- B.C. *Heritage Conservation Act*
- Aboriginal Groups' heritage policies and memoranda of understanding

British Columbia Environmental Assessment Act

Under the B.C. *EAA*, the Environmental Assessment Office has issued guidance with respect to the assessment of potential effects on heritage resources. That guidance states that an assessment should be conducted in accordance with B.C. Archaeology Branch (Ministry of Forests, Lands, and Natural Resource Operations) standards.

British Columbia Heritage Conservation Act

In B.C., heritage sites on non-federal lands are administered by the B.C. Archaeology Branch and the B.C. Heritage Branch in accordance with the *HCA*. The B.C. Archaeology Branch is the agency responsible for administering the *HCA* and for maintaining the Provincial Heritage Register. The B.C. Heritage Branch exercises regulatory authority under the *HCA* with respect to the protection and alteration of designated (i.e., protected) heritage sites.

Section 13 of the *HCA* specifies that an individual (or corporation) must not “damage, excavate, dig in or alter, or remove any heritage object” from a heritage site, except in accordance with a permit issued by the Minister pursuant to Sections 12 and 14. The *HCA* confers automatic protection upon heritage sites that pre-date AD 1846, or undated sites that could pre-date AD 1846, regardless of whether they are recorded in the Provincial Heritage Register, whether they are located on Crown land or private property, or whether they are in a disturbed or intact context.

Section 9 (2)(c) of the *HCA* allows protection of historical sites under the B.C. *Local Government Act*, R.S.B.C., c. 323, or the *Vancouver Charter*, S.B.C 1953, c. 55. Historical sites (post AD 1846) can be protected by Ministerial Order, Designation by an Order-in-Council, or a municipal bylaw.

The requirements and procedures for heritage resource studies undertaken for development projects are described in the *British Columbia Archaeological Impact Assessment Guidelines* (B.C. FLNR 1998). Procedures for respectful handling of found human remains that are protected under the *HCA* are provided in the Found Human Remains Directive (B.C. FLNR 1999).

Heritage Policies of Aboriginal Groups and Memoranda of Understanding

Many B.C. Aboriginal Groups have developed their own heritage policies and permitting systems. In general, the scope of these policies reflects a desire to have some oversight of archaeological research in each Aboriginal Group's territory so that specific cultural protocols are observed, particularly as they relate to human remains and spiritual locations (Mason 2013). Aboriginal Groups and organizations known to have heritage policies and permitting systems that are relevant to the Project area include the Kwantlen First Nation (Seyem' Quantlen Business Group), Musqueam Indian Band, Stó:lō (Stó:lō Research and Resource Management Centre), Squamish Nation and Tsleil-Waututh Nation.

6.1.2.3 Existing Conditions

This section describes the existing conditions of heritage resources in the RAA, and a description of archaeological potential.

Archaeological and Ethnographic Background

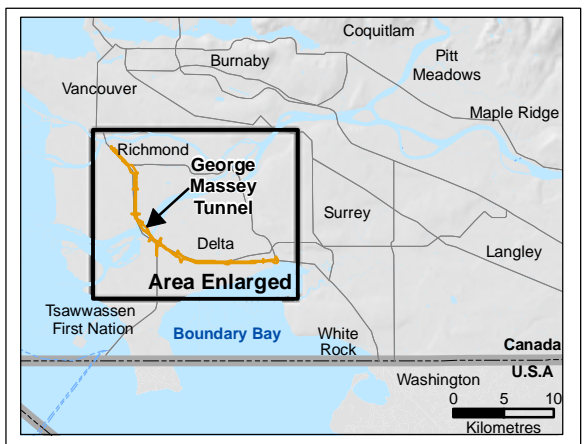
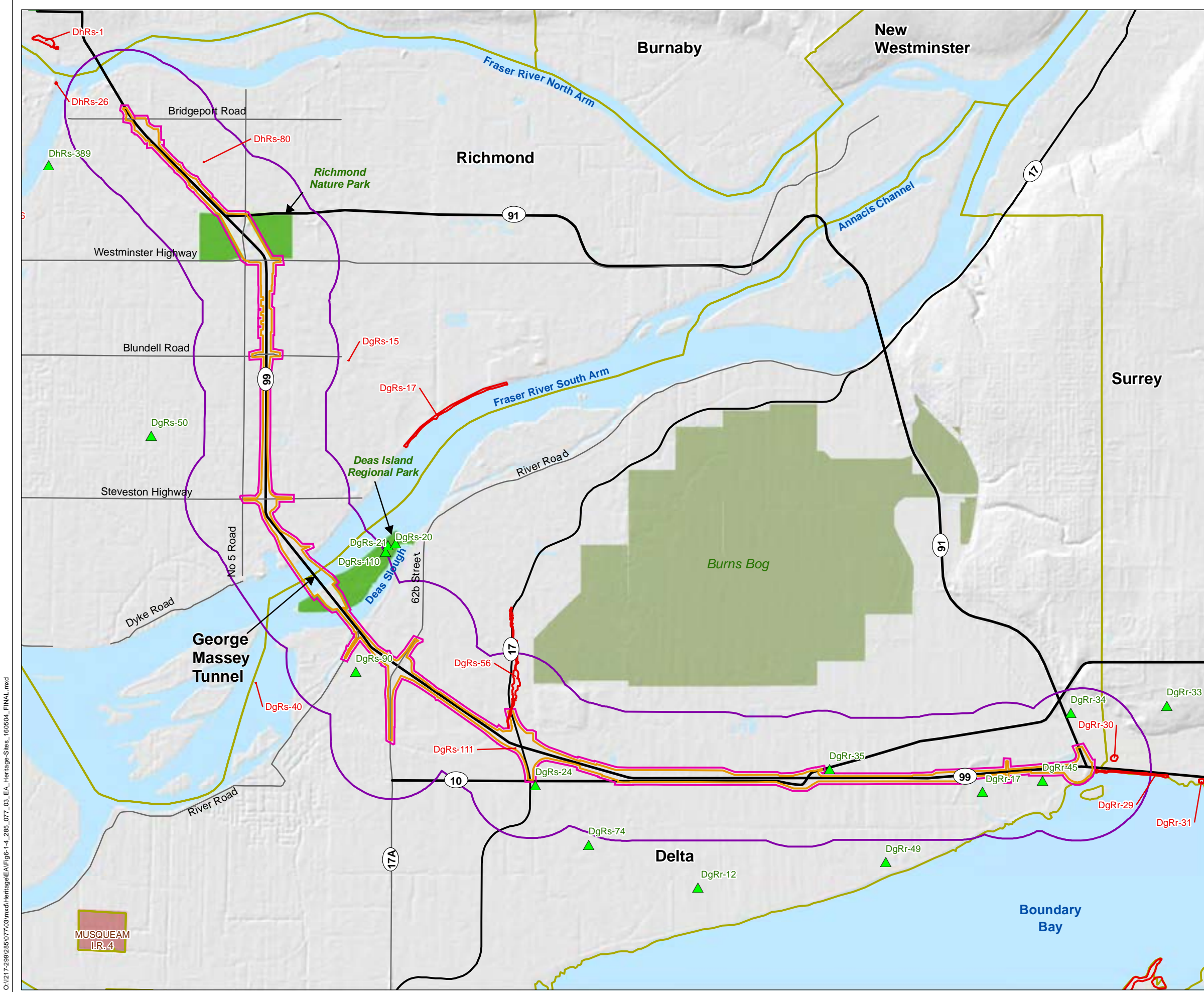
Within the Northwest Coast cultural area (Suttles 1990), the Strait of Georgia region has been the focus of considerable archaeological research (Matson and Coupland 1995, Ames and Maschner 1999). In addition to broader regional studies that have been undertaken over the last 60 years, multiple assessments carried out near the LAA have resulted in the identification of 11 archaeological sites near the LAA (**Figure 6.1-4**). Archaeological and Ethnographic Background information was also presented and discussed in the draft HROA that was shared with the Aboriginal Groups listed in Schedule B of the Section 11 Order for review and comment.

Broader regional assessments in the vicinity of the LAA showcase the cultural history and land use of the region, and provide data on expected site types that may be encountered in the LAA (e.g., Parsons 1981, Ham 1987, Eldridge and Mackie 1993, Millennia Research Ltd. 2005, Golder Associates Ltd. 2012a, b).

During consultation activities for the Project, Aboriginal Groups noted that a historical village, Tle'tinus (also Tq'ltinus and TI'uqtinus), was located within 5 km of the Project, with associated harvesting areas as well as areas used for bathing and spiritual practices. Commenters noted that this village “was a major trade centre and the elders called it little New York”, and that an area in proximity to this village site exists where one of the practices was bathing, mourning and spiritual practices. Harvesting areas were also identified to have occurred near the village site.

Aboriginal Groups also identified areas within the proposed new bridge footings and in and around Deas Slough and Deas Island Regional Park as potential archeological sites, and noted that culture-mourning rituals may have been practiced at Deas Island and/or Westham Island. The existence of a shared village site on the Highway 99 corridor by Crescent Beach where gathering and trading occurred was also noted during consultation.

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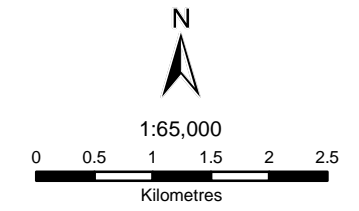


- Legend**
- ▲ Historical Sites
 - Archaeological Sites
 - Heritage Resources Local Assessment Area
 - Heritage Resources Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. HCA Permit Area, Archaeological Sites, Historical Sites received from Golder, May 2015.

Note: Named places do not necessarily refer to fixed geographical locations, but instead refer to general areas or activities. Variations in the spellings of individual place names are the product of either different translations or dialects; variations in the spellings are not exhaustive for any given place.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

HERITAGE SITES NEAR THE LAA

| | |
|--------------|------------|
| Figure 6.1-4 | 13/05/2016 |
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Heritage Inventory

Figure 6.1-2 shows the areas of archaeological potential within the LAA. The majority of the LAA is characterized as having low archaeological potential due to environmental constraints on human use or on site preservation. However, based on desktop studies and results of the archaeological potential analysis, 18 locations were considered for field inventory (**Figure 6.1-2** and **Table 6.1-4**).

Prior to commencing the field inventory, it was determined that two areas of archaeological potential (areas 9-2A and 9-3B, **Figure 6.1-2**) could not be examined due to existing environmental and infrastructure constraints. During the field inventory it was determined that portions of areas 6-1, 6-2, 9-1, 9-2A, 9-3B, 9-6, 10-1, and 11-1 (**Figure 6.1-2**) were also inaccessible due to environmental, infrastructure, or access constraints. The heritage field inventory data are considered adequate for current assessment purposes. Once the detailed design for the Project is complete, a review will be undertaken to determine the need for and scope of additional archaeological assessment to confirm the absence of heritage resources within the Project alignment.

As outlined in **Table 6.1-4**, the field inventory did not identify any archaeological or historical sites, or heritage wrecks within the LAA. Locations that were inaccessible to subsurface testing, specifically sections of areas 6-1, 6-2, 9-1, 9-2A, 9-3B, 9-6, 10-1, and 11-1, will be reviewed against the detailed Project design to confirm the need for assessment prior to, or during construction.

Subsequent to completion of the field inventory, a field reconnaissance was completed, in December 2015, to account for minor adjustments to the Project concept. The inspection focused on photographing portions of the refined Project alignment in close proximity to areas previously assessed under the HROA and HRIA as having archaeological potential (**Figure 6.1-2**). The visual inspections confirmed that there are areas considered to have archaeological potential, which would require subsurface testing prior to development. Other areas were observed to currently be composed of overfill or have existing culverts. In those areas where conventional archaeological assessment methods and techniques are limited due to access (fill or roadbeds), or areas of planned culvert replacements, archaeological monitoring during land-alterations may be adequate. A summary of the observations made during this field reconnaissance and recommendations on further

action is provided in **Table 6.1-4**. An AIA¹ may be considered at four locations (**Table 6.1-4**) prior to start of construction, depending on the nature of works proposed. Where AIAs are initiated, the Ministry will continue to involve Aboriginal Groups in the assessments. The remaining two locations will be reviewed against detailed Project plans to verify proposed development in relation to archaeological potential and complete further assessment if development is proposed within the archaeological potential zone.

¹ An Archaeological Impact Assessment is required where potential conflicts have been identified between archaeological resources and a proposed development (Ministry of Forests, Lands, and Natural Resource Operations. N.d. Archaeology: What an Archaeological Impact Assessment Entails. Available from: https://www.for.gov.bc.ca/archaeology/preservation_process/archaeological_impact_assessment.htm. Accessed May 2016.

Table 6.1-4 Heritage Inventory Summary

| Area | Results | Further Action? | Comments |
|------|--|-----------------|---|
| 5-1 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 5-2 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 6-1 | The southernmost and northernmost sections were inaccessible to subsurface testing during the field inventory due to dense thickets of blackberry bushes, or slope, fence, and trees. Access was not granted to the section of agricultural field. | Yes | Should land-altering Project developments be proposed in this section of area 6-1, subsurface deposits to be evaluated prior to or during construction. |
| | Negative results in remainder of area 6-1. | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities in the assessed section of area 6-1. |
| 6-2 | A section of area 6-2 adjacent to the Steveston Highway on-ramp to Highway 99 southbound was inaccessible to subsurface testing during the field inventory due to the presence of road shoulder, sidewalk, concrete barrier, traffic signs, above and underground utilities, steep slope, and ditch. | Yes | Should land-altering Project developments be proposed in this section of area 6-2, subsurface deposits to be evaluated prior to or during construction. |
| | Negative results in remainder of area 6-2. | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities in the assessed section of area 6-2. |

| Area | Results | Further Action? | Comments |
|------|--|-----------------|---|
| 9-1 | A section of area 9-1 was inaccessible to subsurface testing during the field inventory due to vegetation, slope, standing water, and utilities. | Yes | Should land-altering Project developments be proposed in this section of area 9-1, subsurface deposits to be evaluated prior to or during construction. |
| | Negative results in remainder of area 9-1 | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities in the assessed section of area 9-1. |
| 9-2A | Inaccessible to subsurface testing due to narrow road shoulder, concrete barrier, above and underground utilities, steep slope, and ditch. | Yes | Should land-altering Project developments be proposed, subsurface deposits to be evaluated prior to or during construction. |
| 9-2B | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 9-3A | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 9-3B | Inaccessible to subsurface testing during the field inventory due to narrow road shoulder, concrete barrier, above-ground and underground utilities, slope, ditch, and existing walking trail. | Yes | Should land-altering Project developments be proposed, subsurface deposits to be evaluated prior to or during construction. |
| 9-4 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 9-5 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |

| Area | Results | Further Action? | Comments |
|------|---|-----------------|---|
| 9-6 | A section of area 9-6 was not assessed due to the presence of the Highway 17A shoulder, bus stop/pull out, steep slope and ditch, and above-ground and underground utilities. | Yes | Should land-altering Project developments be proposed in this section of area 9-6, subsurface deposits to be evaluated prior to or during construction. |
| | Negative results in remainder of area 9-6. | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 9-7 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 9-8 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 10-1 | Inaccessible to subsurface testing during field inventory due to underground utilities, proximity to Highway 17A to the west, and slope and ditch to the east. | Yes | Should land-altering Project developments be proposed, subsurface deposits to be evaluated prior to or during construction. |
| 10-2 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |
| 11-1 | Inaccessible to subsurface testing due to underground utilities, proximity to Highway 17A to the west, and slope and ditch to the east. | Yes | Should land-altering Project developments be proposed, subsurface deposits to be evaluated prior to or during construction. |
| 11-2 | Negative | No | Archaeological Chance Find Procedures should be implemented during land-altering construction activities. |

Note: Negative = no heritage resources found.

Table 6.1-5 Heritage Field Reconnaissance

| Area | HROA Potential | Comments |
|---|---|--|
| 1 Cambie/Shell Road Loop | <ul style="list-style-type: none"> • Potential based on proximity to watercourse. • Compromised potential based on culvert, fill, and roadbed. | <ul style="list-style-type: none"> • Large culvert surrounded by raised and level grass covered fill. • If development will occur within archaeological potential zone, further assessment should be undertaken. • Archaeological monitoring during culvert removal, if applicable. |
| 2 River Road/Highway 99 within agricultural field | <ul style="list-style-type: none"> • Potential based on historic watercourse and proximity to Deas Slough. • Compromised potential based on Highway 99's built-up roadbed. | <ul style="list-style-type: none"> • Field appears to be intact with only the upper portions affected by ongoing agricultural use. • Conduct Archaeological Impact Assessment. Conduct works within conditions of HCA permit. |
| 3 Highway 17/SFPR around Crescent Slough | <ul style="list-style-type: none"> • Potential based on watercourse. • Known archaeological site. • Compromised potential based on recent development (Highway 17/SFPR). | <ul style="list-style-type: none"> • Site appears to be within areas assessed under the SFPR's AIA and overlaps mitigated site DgRs-111. • Conduct Archaeological Impact Assessment, if required. Conduct works within conditions of HCA permit. |
| 4 Highway 99 adjacent to Vancouver Landfill | <ul style="list-style-type: none"> • Potential based on margins of historic lake. • Compromised potential based on Burns Drive. | <ul style="list-style-type: none"> • Burns Drive lies between the area of potential and Highway 99. • Limit Project alignment to between Highway 99 and Burns Drive. • Conduct works within chance find protocol that will be developed as part of the Archaeological and Heritage Management Plan component of the Construction Environmental Management Plan. |

| Area | HROA Potential | Comments |
|--------------------------------|--|---|
| 5 Highway 99 and unnamed creek | <ul style="list-style-type: none"> Potential based on proximity to watercourse. | <ul style="list-style-type: none"> Highway 99 appears only slightly raised with fill from the surrounding terrain. Two large culverts run under the highway. Conduct Archaeological Impact Assessment if required. Undertake archaeological monitoring during culvert removal, if applicable. |
| 6 Highway 99/91 Loop | <ul style="list-style-type: none"> Potential based on watercourse. Proximity to known archaeological sites (DgRr-29 and 30). | <ul style="list-style-type: none"> Large amount of fill has been placed within the loop and used to construct the interchange. Conduct Archaeological Impact Assessment if required. Conduct work under a chance find protocol, if development is to occur within fill area. |

6.1.3 Potential Effects

This section discusses anticipated interactions of Project components and activities with heritage resources, and potential effects of such interactions. Information on mitigation of potential effects, including Project design measures to avoid adverse effects, is provided in **Section 6.1.4 Mitigation Measures**. Potential residual effects (i.e., effects remaining following the implementation of mitigation measures) are described in **Section 6.1.5 Residual Effects and their Significance**. A discussion of potential cumulative effects on heritage resources is presented in **Section 6.1.6 Cumulative Effects and their Significance**.

6.1.3.1 Project Interactions and Potential Effects

As shown on **Table 6.1-4**, no historical or archaeological heritage sites were identified in the LAA. Therefore, no Project interactions or potential Project-related effects are anticipated. Furthermore, a determination of the significance² of heritage resources using the criteria established in the *British Columbia Archaeological Impact Assessment Guidelines* (B.C. FLNR 1998) was not conducted.

There is potential for currently-unidentified archaeological and heritage resources, including previously-unknown and unrecorded heritage sites in construction areas covered by infrastructure installed as part of the original development of the Highway 99 corridor, to be encountered during Project activities. Measures to mitigate potential effects on such resources, including the development of a chance-find procedure as part of an Archaeological and Heritage Resources Management Plan, are discussed in **Section 6.1.4**.

6.1.4 Mitigation Measures

A hierarchical approach based on avoidance of potential effects followed by minimization or reduction of unavoidable effects was used in identifying strategies to mitigate potential Project-related effects on heritage resources.

Measures to avoid potential effects have been/will be incorporated into project considerations such as site and route selection, Project design, and construction and operation procedures, and practices. Where potential effects cannot be avoided through project considerations, standard mitigation measures, BMPs, and construction and operation environmental management plans (EMPs) will be implemented to minimize potential Project-related effects or reduce them to acceptable levels. These measures are described in general terms below.

² Heritage sites are commonly evaluated using criteria that describe heritage value in terms of their significance. This use is distinct and separate from the use of significance in the residual effects assessment.

6.1.4.1 Avoidance

Since no heritage resources were identified in the LAA, no specific mitigation measures pertaining to the preservation of existing sites are required.

6.1.4.2 Minimization

Archaeological and Heritage Resources Management Plan

An Archaeological and Heritage Resources Management Plan will be developed as part of the Construction Environmental Management Plan (**Section 12.0 Management Plans**), and will include a chance-find procedure to be implemented during construction activities that involve ground disturbance. The chance-find procedure will outline actions to be taken by construction personnel if previously-unknown and unrecorded heritage resources, including those that may be present in areas covered by infrastructure installed as part of the Highway 99 corridor development, are encountered during Project construction. It will also include a human-remains protocol to be followed should human remains be encountered during Project construction activities. The plan will be developed in accordance with existing Ministry policies and procedures, with guidance, where applicable, from the B.C. Archaeology Branch and in consultation with Aboriginal Groups. The implementation of a chance-find procedure is consistent with regulatory requirements and recognized good practices, and is expected to effectively address potential Project-related effects on previously-unidentified heritage resources.

Additional Archaeological Surveys

Certain areas with archaeological or compromised archaeological potential were partially inaccessible during the field inventory (areas 6-1, 6-2, 9-1, 9-2A, 9-3B, 9-6, 10-1 and 11-1; **Figure 6.1-2**) or identified during subsequent field reconnaissance. These areas will be reviewed against the detailed Project design to confirm the need for further assessment. If required, further assessment of these sites will be undertaken under the terms and conditions of an *HCA* permit prior to or during Project construction.

6.1.5 Residual Effects and their Significance

Residual effects are those adverse effects that remain after implementation of mitigation measures. Since no heritage resources were identified in the LAA, and any potential effect on previously-unknown heritage resources are expected to be addressed effectively through the implementation of a chance-find procedure, no Project-related residual effects on heritage resources are anticipated.

6.1.6 Cumulative Effects and their Significance

Since no Project-related effects on heritage resources are anticipated, a cumulative effects assessment is not required.

6.1.7 Follow-up Strategy

As no residual effects on heritage resources are predicted, no follow-up program is proposed.

6.1.8 References

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APPENDIX A

Heritage Conservation Act Permit Application Communications

Communications with Aboriginal Groups is a requirement of the *HCA* permit application. The following summarizes the groups included in that process.

In July 2014, the B.C. Archaeology Branch forwarded an *HCA* permit application, which encompassed the Highway 99 right-of-way and associated interchanges from Bridgeport Road to the Canada–U.S. border, to the following Aboriginal communities and organizations: Katzie First Nation, Kwantlen First Nation (Seyem' Quantlen Business Group), Musqueam Indian Band, Semiahmoo First Nation, Squamish Nation, Stó:lō Nation (SRRMC), Tsawwassen First Nation, and Tsleil-Waututh Nation. These communities were provided 30 days to review and comment on the proposed methods to be employed during the field work, analysis, and reporting stages of the archaeology program. The Ministry provided copies of the *HCA* permit application and the *HCA* permit to Cowichan Tribes, Halalt First Nation, Hwlitsum, Penelakut Tribe, Lyackson First Nation, Lake Cowichan First Nation and Stz'uminus First Nation.

In addition, the Ministry provided copies of the draft HROA to the Cowichan Tribes; Halalt First Nation; Hwlitsum; Katzie First Nation; Kwantlen First Nation; Lake Cowichan First Nation; Lyackson First Nation; Musqueam Indian Band; Penelakut Tribe; Semiahmoo First Nation; Squamish Nation; People of the River Referrals Office; Stó:lō Nation (Aitchelitz First Nation, Leq'a:mel First Nation, Matsqui First Nation, Popkum First Nation, Skawahlook First Nation, Skowkale First Nation, Shxwha:y Village, Squiala First Nation, Sumas First Nation, Tzeachten First Nation, Yakweakwioose Band); Stó:lō Tribal Council (Chawathil First Nation, Cheam Indian Band, Kwantlen First Nation, Kwaw'Kwaw'Apilt First Nation, Scowlitz First Nation, Seabird Island First Nation, Shxw'ow'hamel First Nation, Soowahlie Band); Stz'uminus First Nation; Tsawwassen First Nation; and Tsleil-Waututh Nation for review.

Notification of the heritage resources field assessment was provided to all Schedule B Aboriginal Groups identified in the Section 11 Order and to Stó:lō Nation (SRRMC). The assessment was carried out under *HCA* permit 2014-0201. Applicable First Nations permits were sought and obtained.

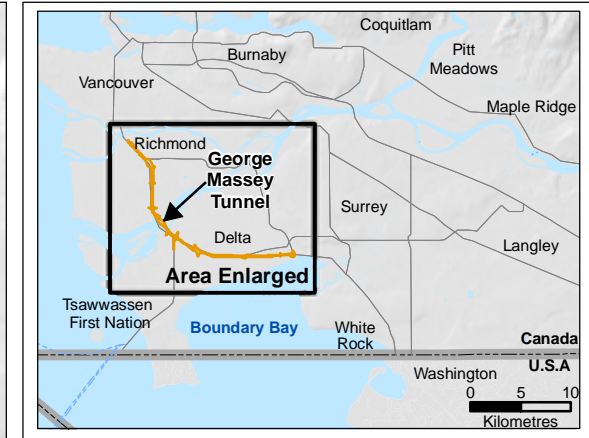
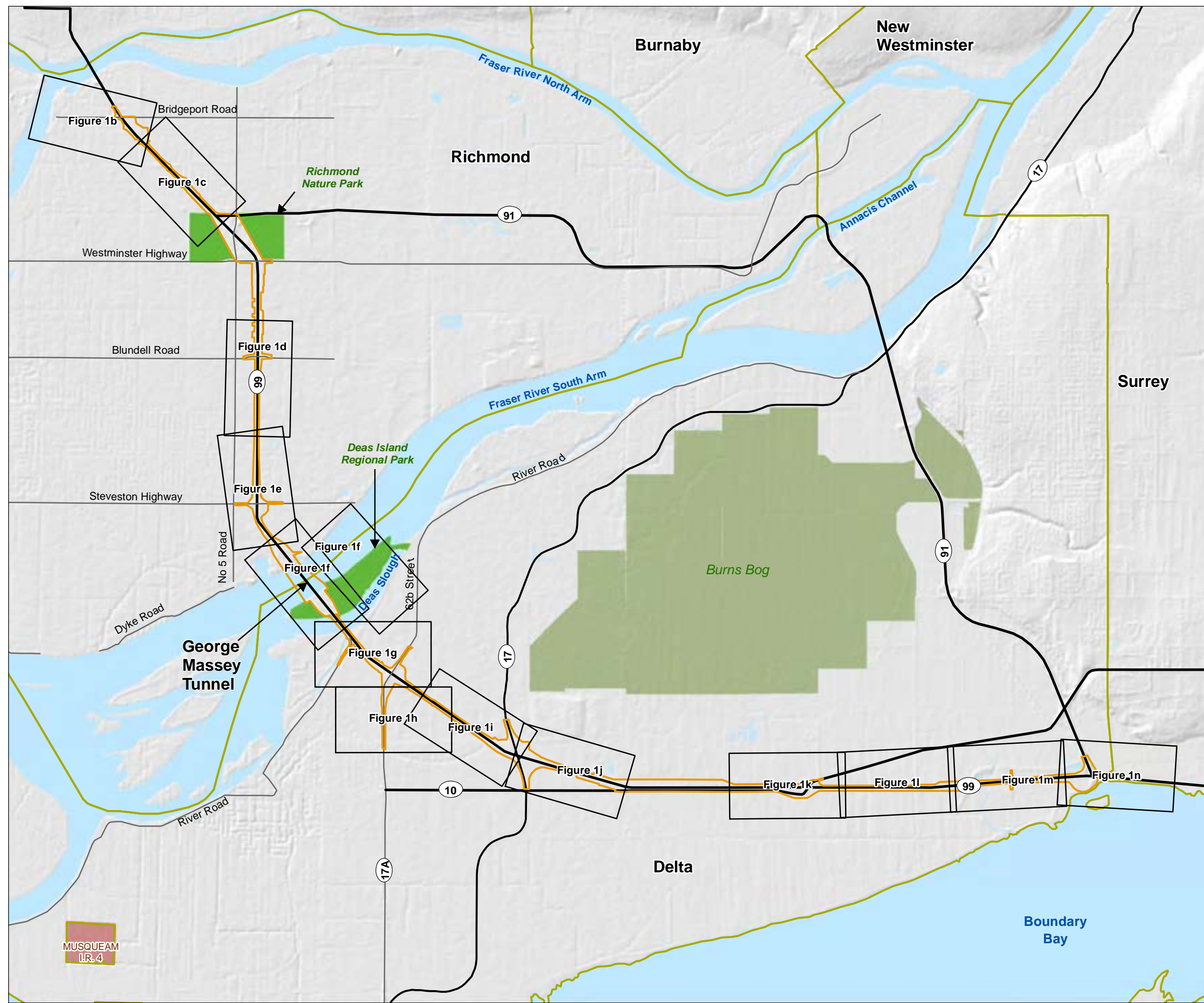
All Schedule B Aboriginal Groups were invited to participate in the heritage resources field investigation.

Representatives from the Cowichan Tribes, Katzie First Nation, Kwantlen First Nation, Lake Cowichan First Nation, Musqueam Indian Band, Penelakut Tribe, Semiahmoo First Nation, Stz'uminus First Nation, Tsawwassen First Nation, and Tsleil-Waututh Nation participated in the heritage resources field assessment.

APPENDIX B

Archaeological Potential Detailed Figures

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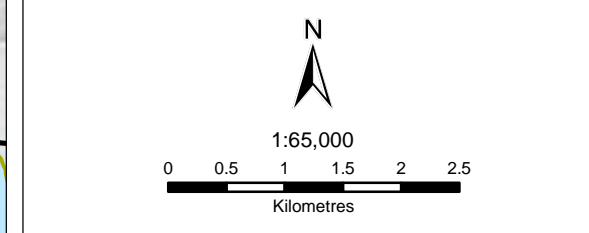


Legend

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

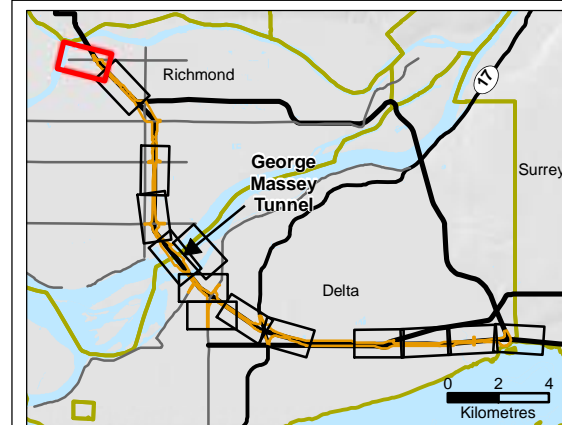
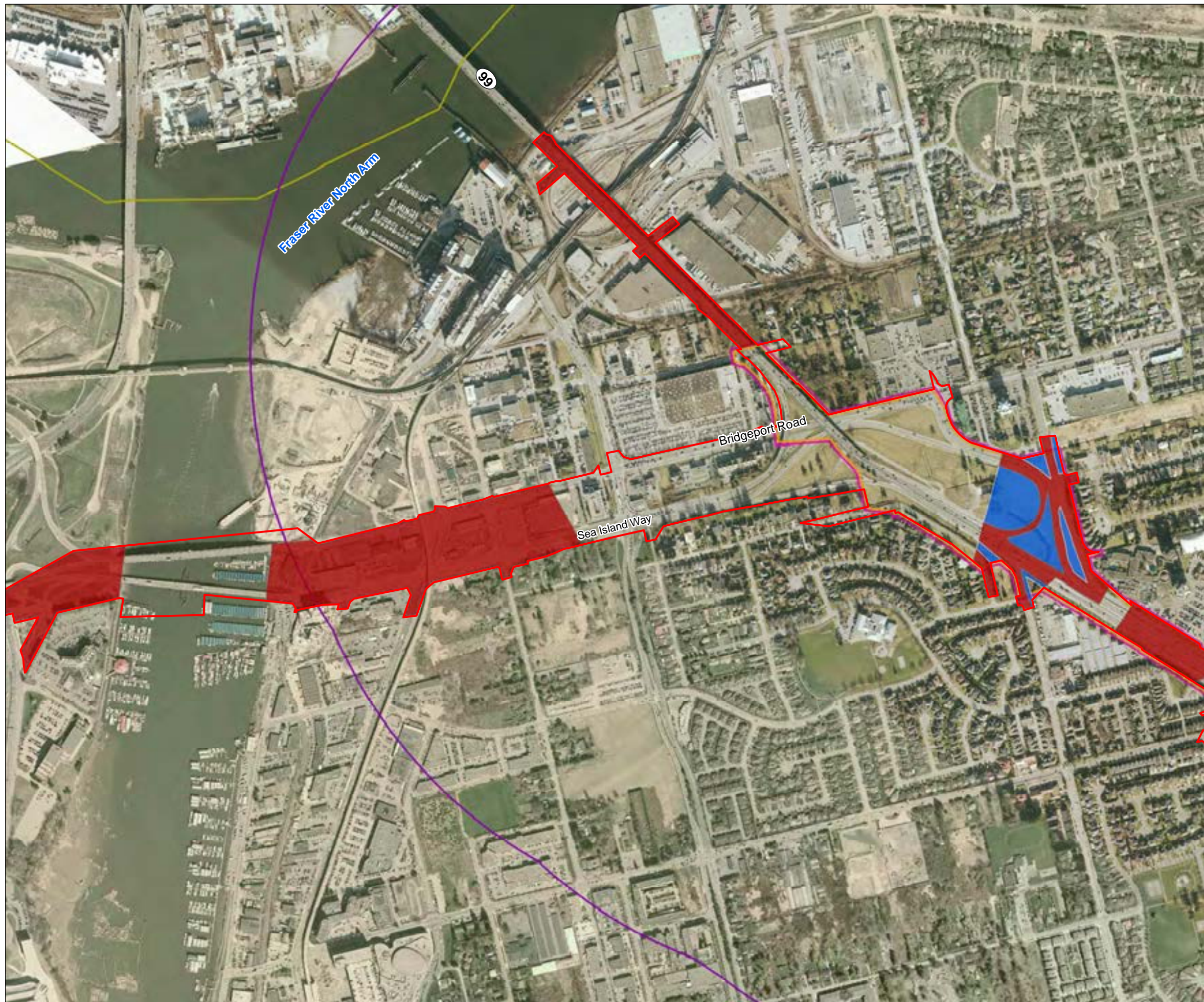
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AREAS OF RELATIVE ARCHAEOLOGICAL
POTENTIAL WITHIN OR ADJACENT
TO THE LAA OVERVIEW

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| Figure 1a | 13/05/2016 |
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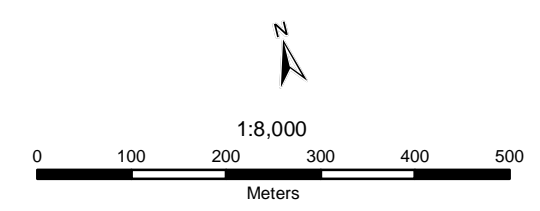


Legend

- HCA Permit Area
- Potential**
- Compromised Potential
- Potential
- Removed Potential
- Heritage Resources Local Assessment Area
- Heritage Resources Regional Assessment Area
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Canada - U.S. Border

SOURCES

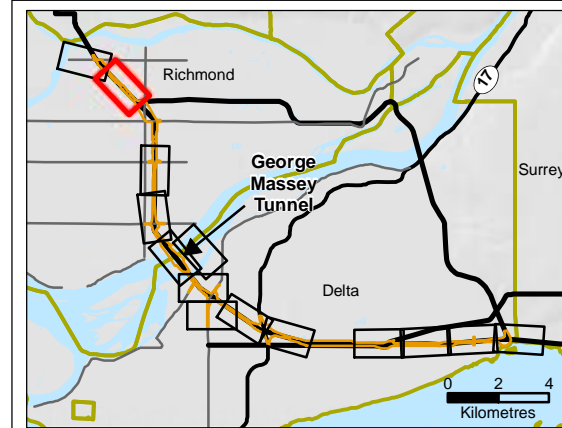
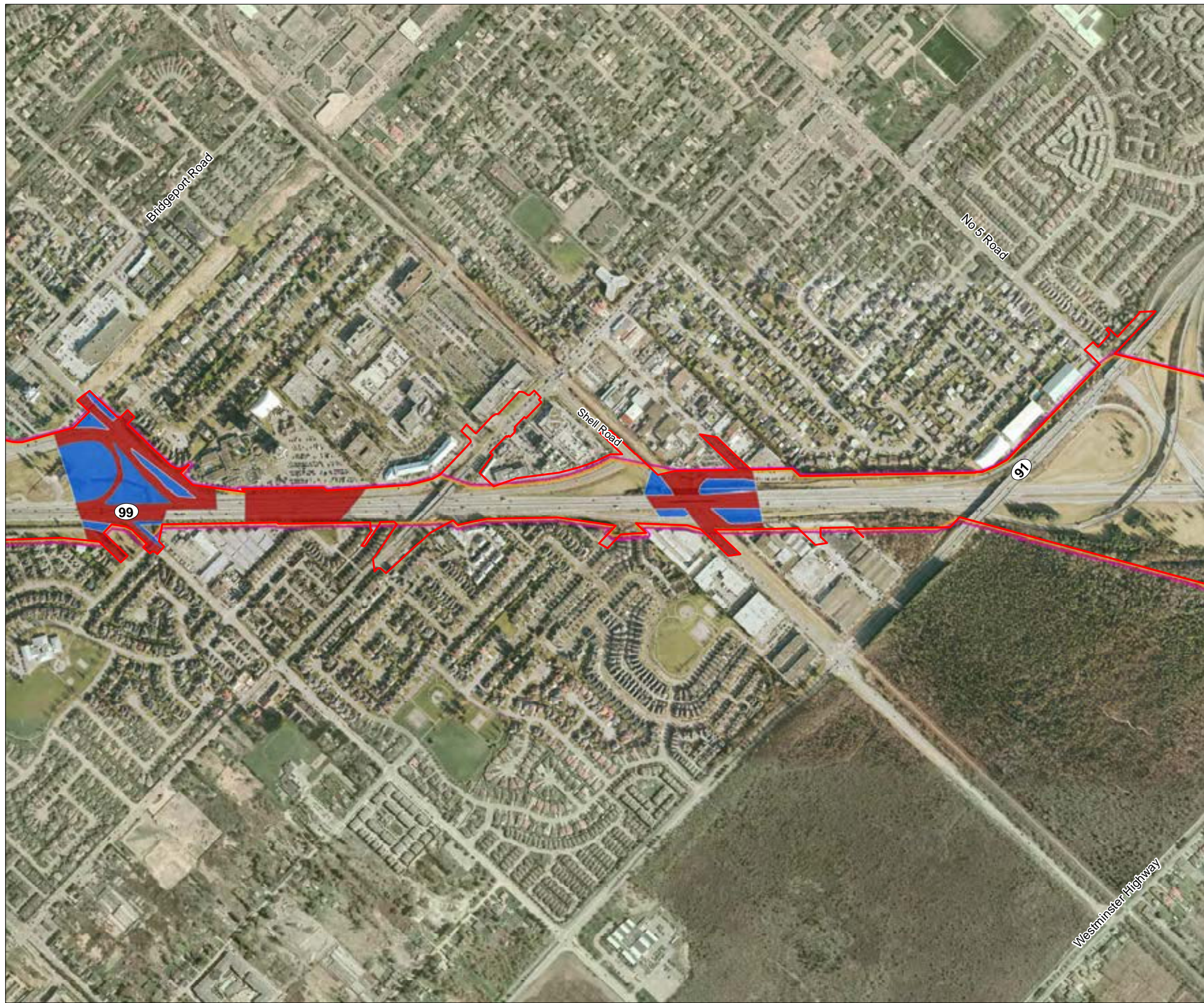
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AREAS OF RELATIVE ARCHAEOLOGICAL
POTENTIAL WITHIN OR ADJACENT TO THE LAA

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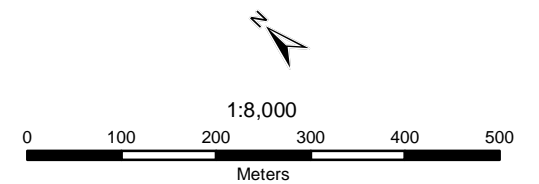


Legend

- HCA Permit Area
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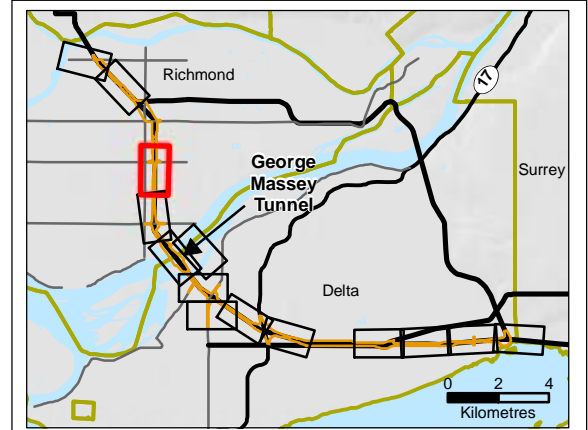
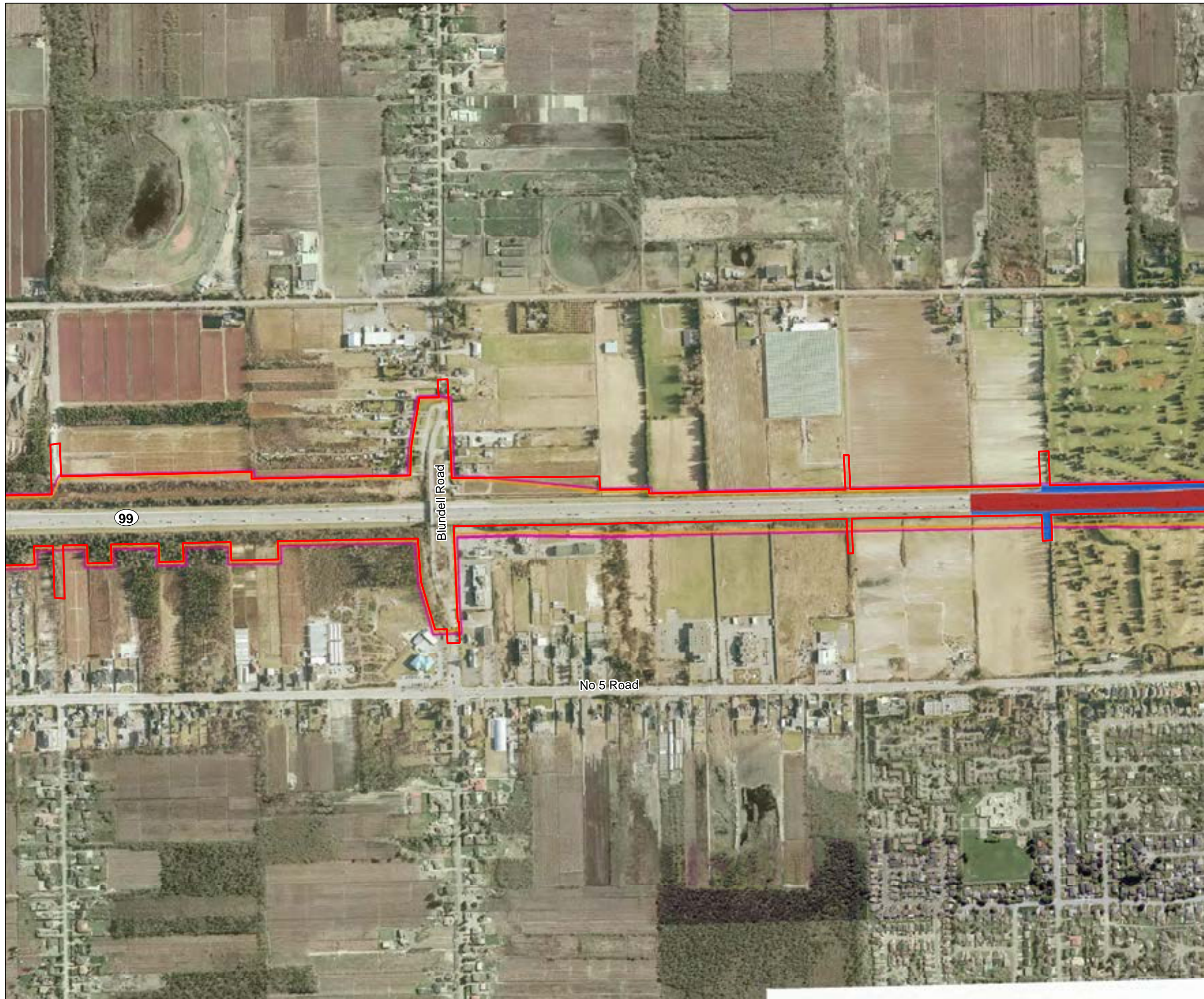


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AREAS OF RELATIVE ARCHAEOLOGICAL
POTENTIAL WITHIN OR ADJACENT TO THE LAA

Figure 1c

13/05/2016

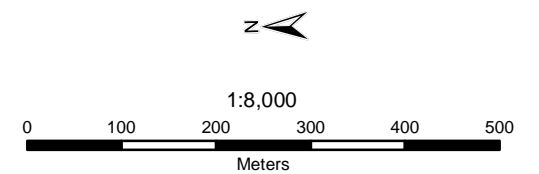


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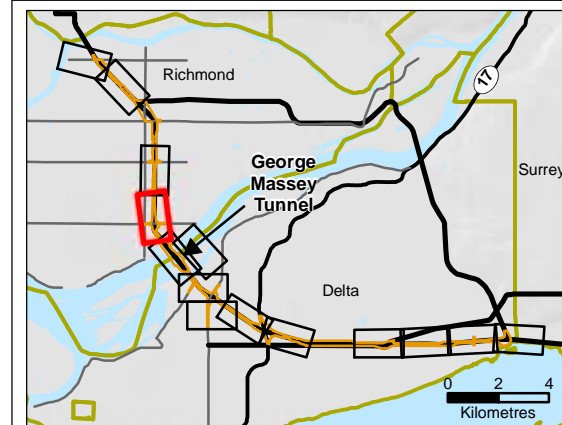
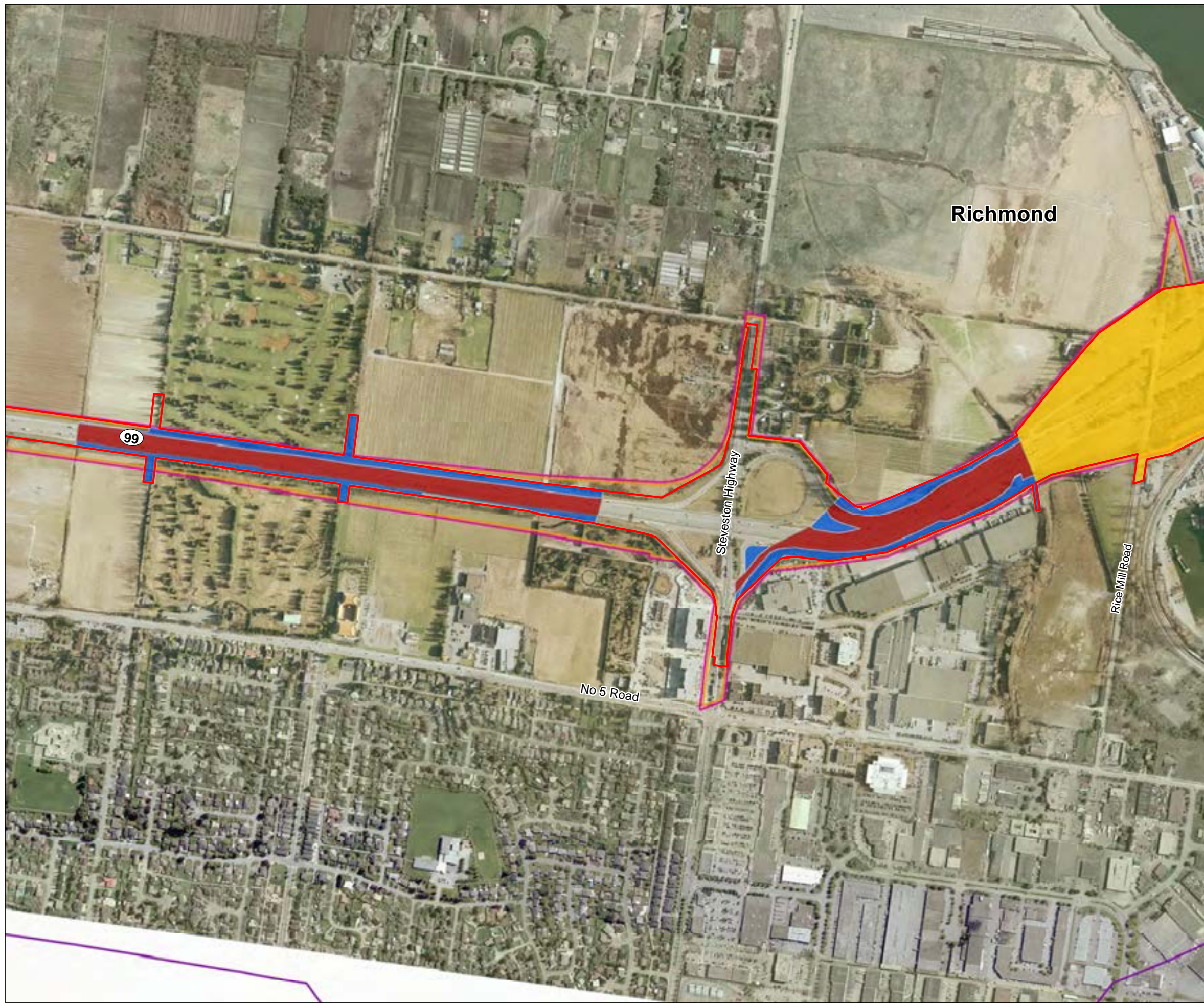
- HCA Permit Area
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SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AREAS OF RELATIVE ARCHAEOLOGICAL POTENTIAL WITHIN OR ADJACENT TO THE LAA | |
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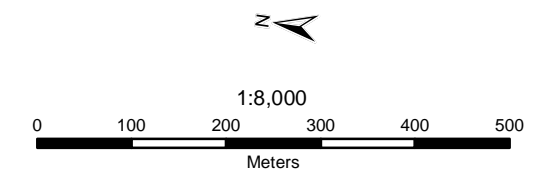


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SOURCES

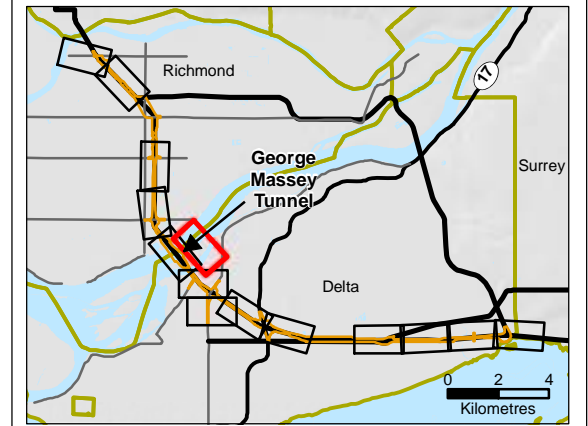
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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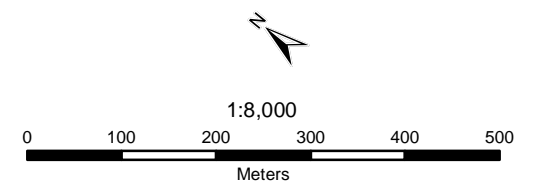


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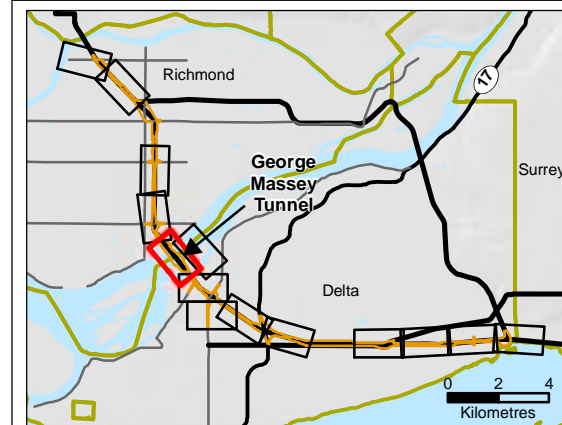
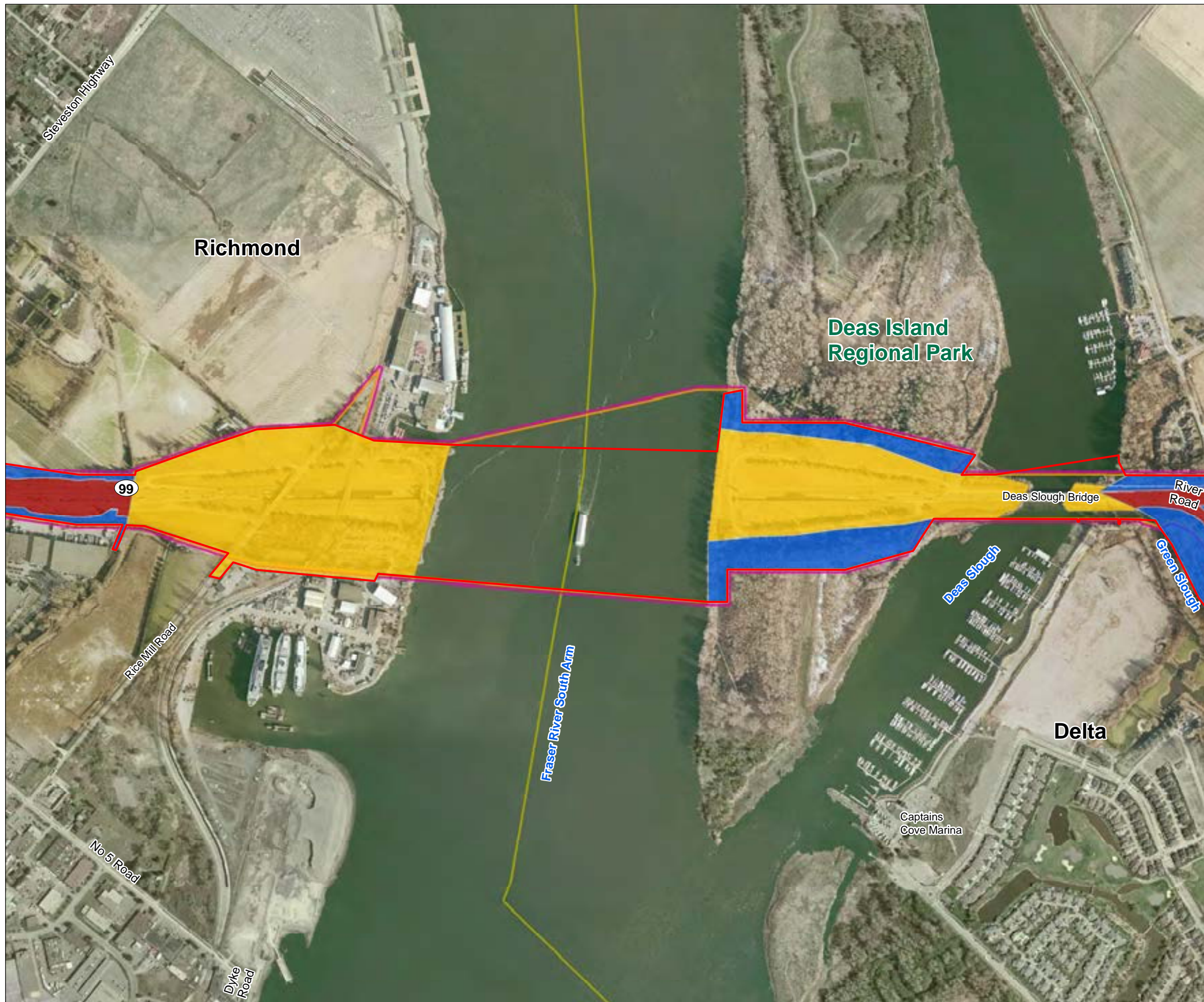
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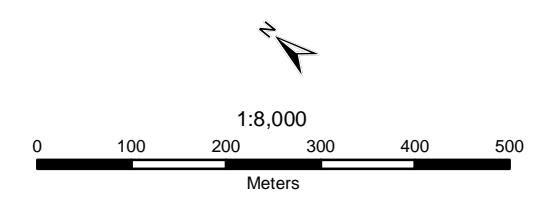


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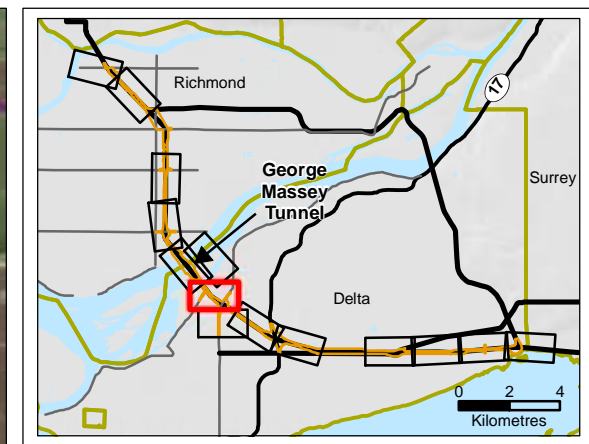
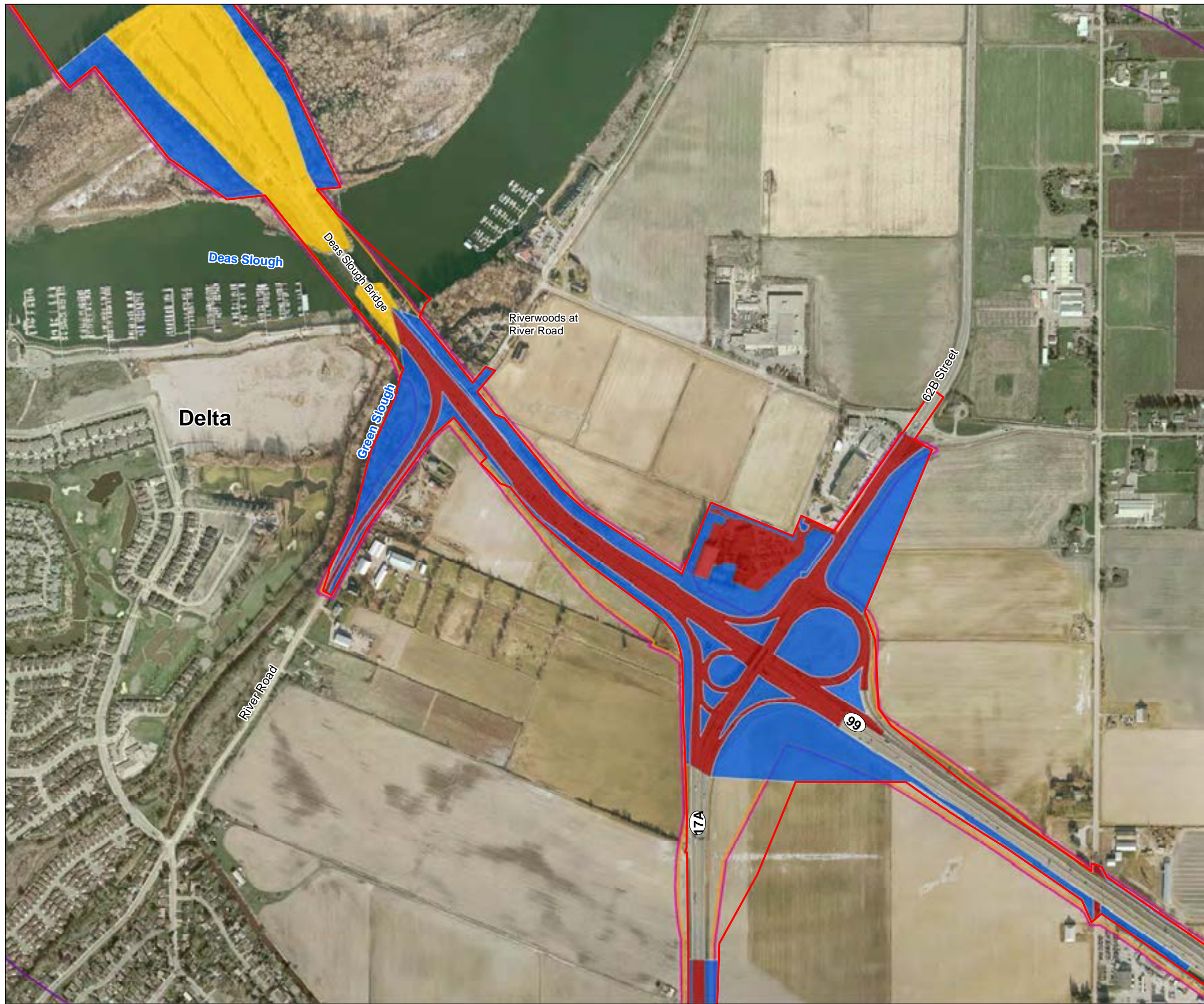
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
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AREAS OF RELATIVE ARCHAEOLOGICAL
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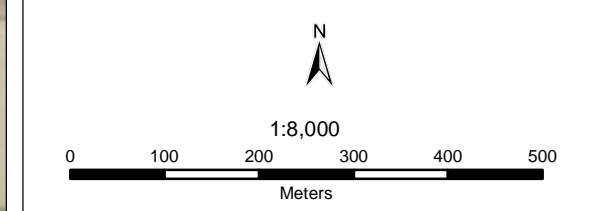


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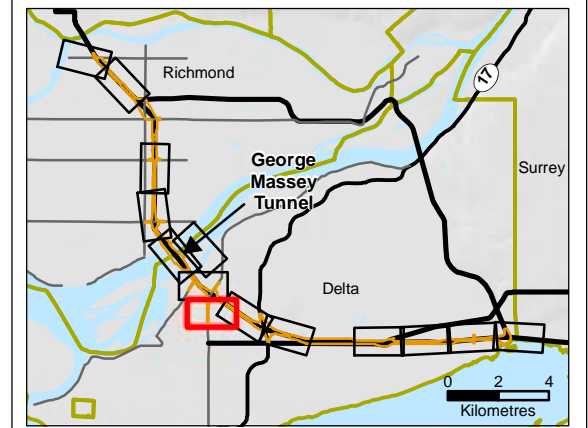
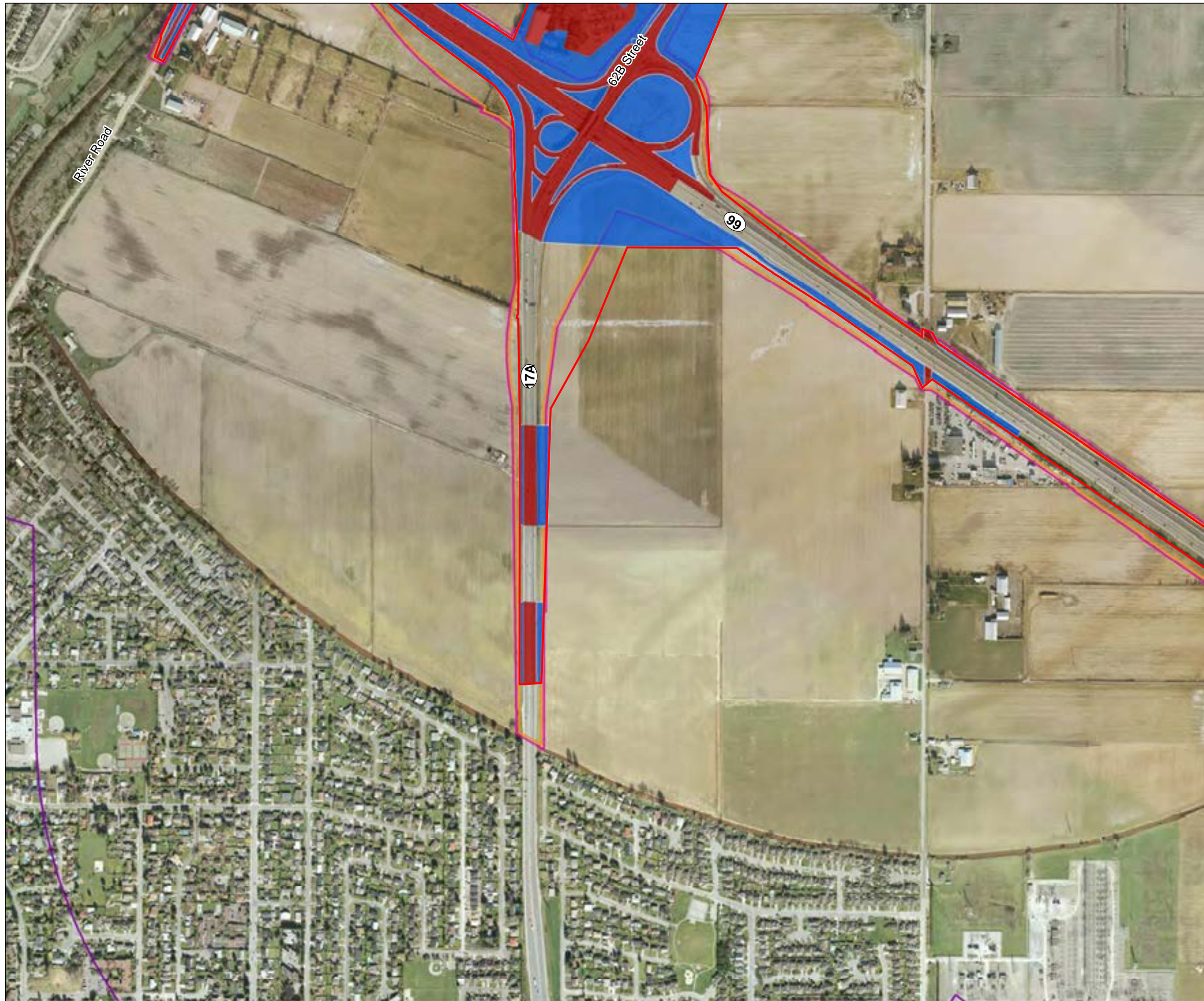
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
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AREAS OF RELATIVE ARCHAEOLOGICAL
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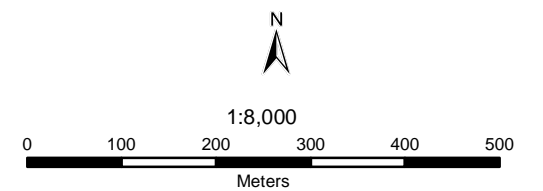


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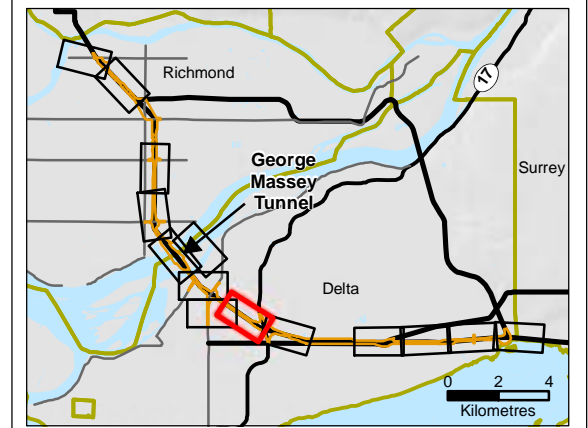
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| AREAS OF RELATIVE ARCHAEOLOGICAL POTENTIAL WITHIN OR ADJACENT TO THE LAA | |
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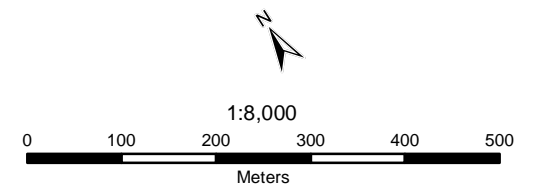


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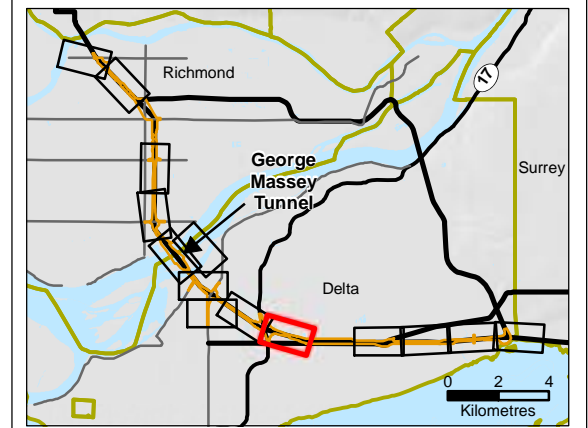
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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AREAS OF RELATIVE ARCHAEOLOGICAL POTENTIAL WITHIN OR ADJACENT TO THE LAA | |
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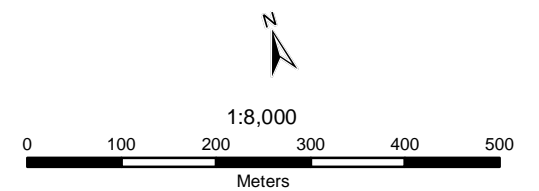


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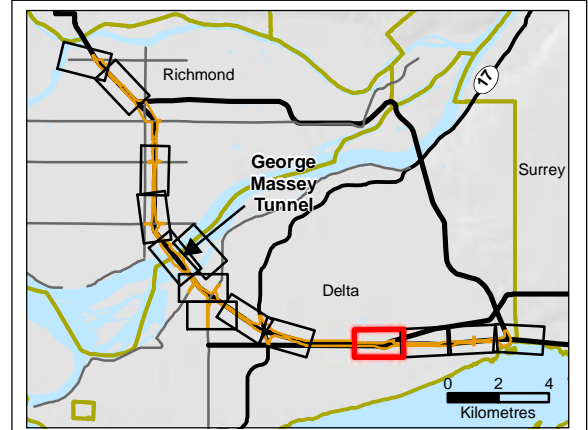
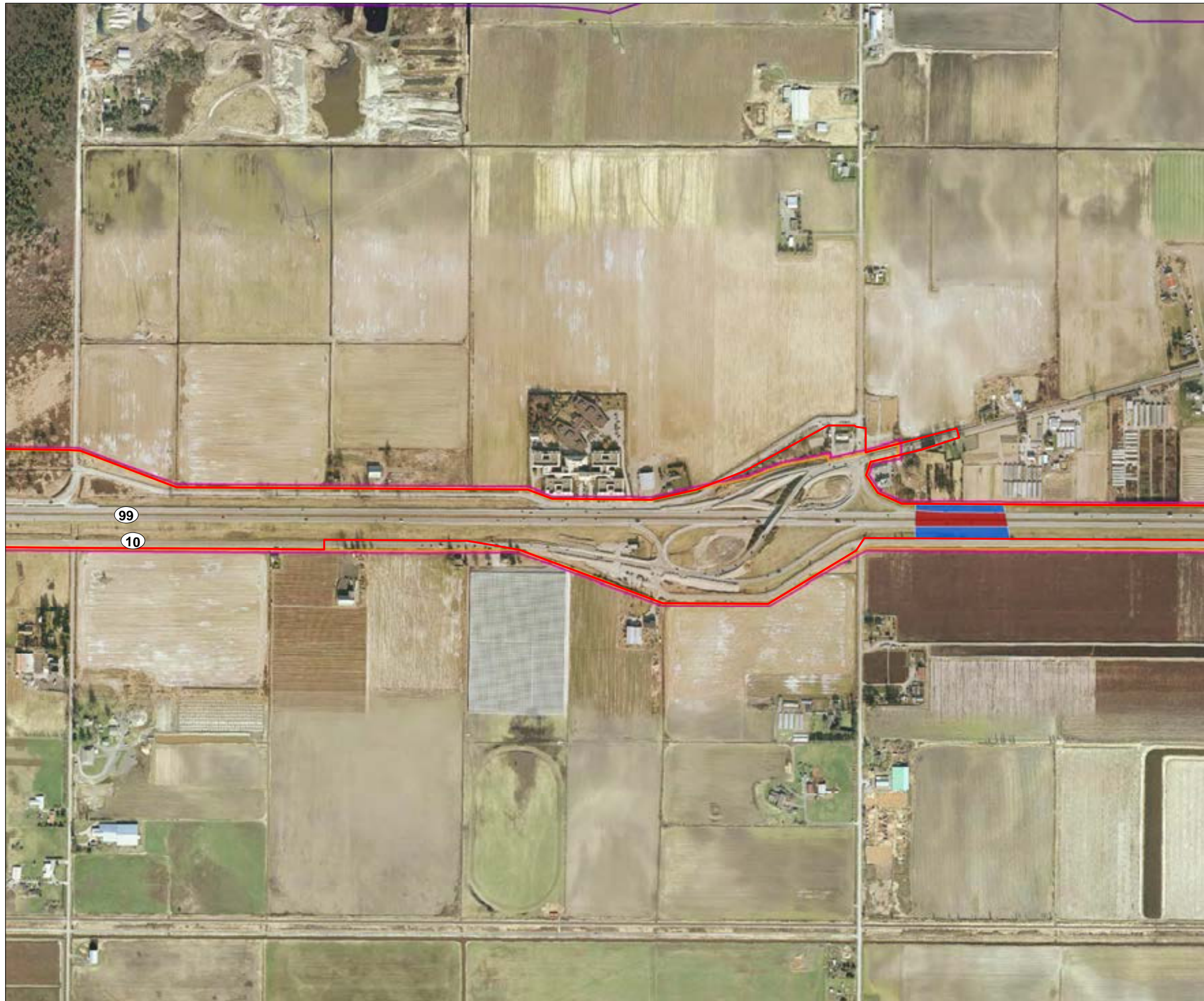
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| AREAS OF RELATIVE ARCHAEOLOGICAL POTENTIAL WITHIN OR ADJACENT TO THE LAA | |
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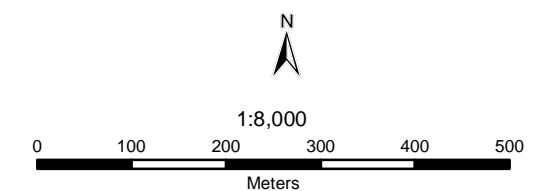


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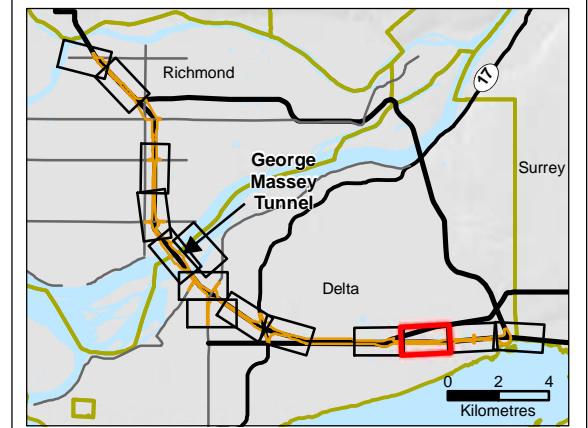
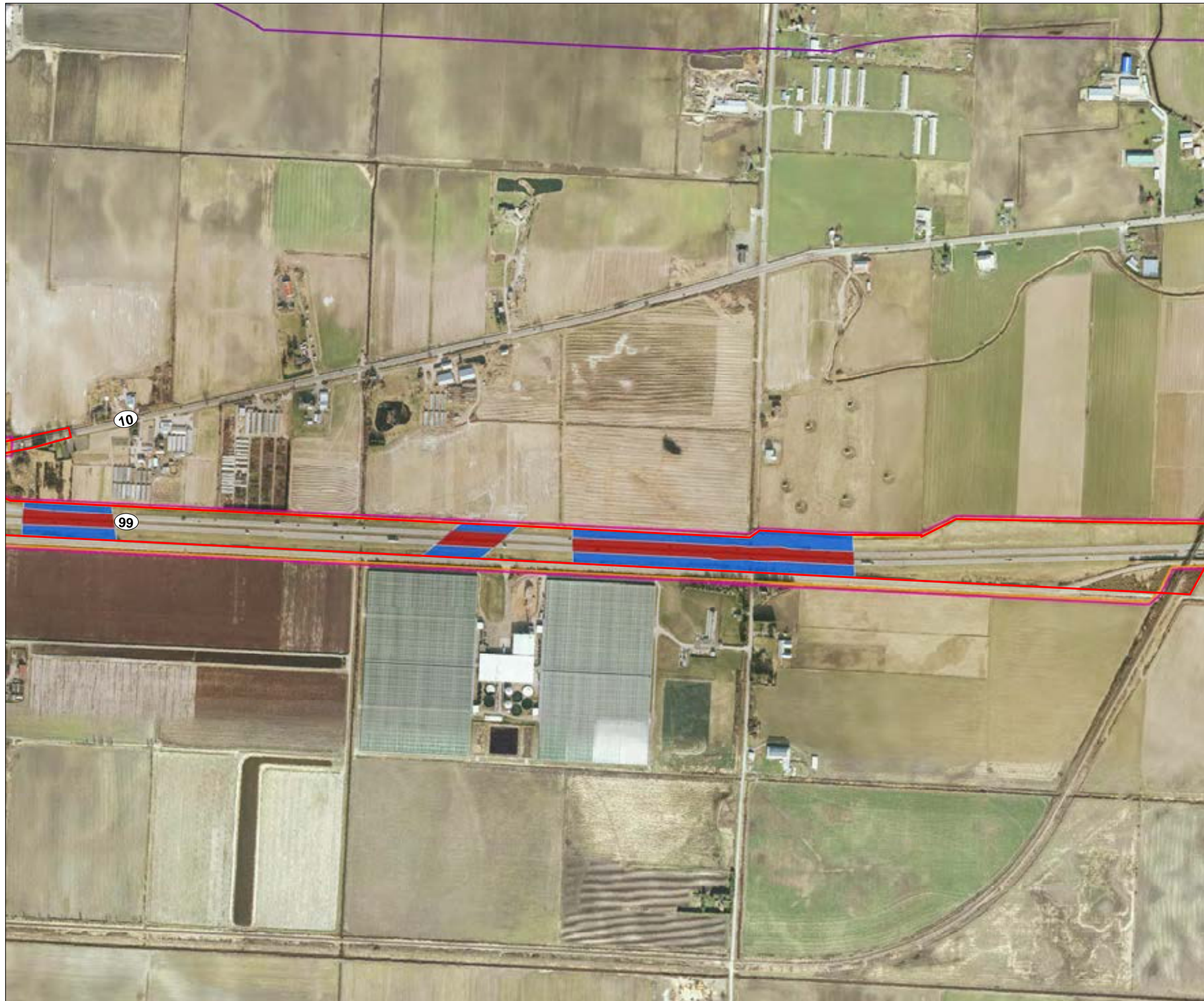
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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| AREAS OF RELATIVE ARCHAEOLOGICAL POTENTIAL WITHIN OR ADJACENT TO THE LAA | |
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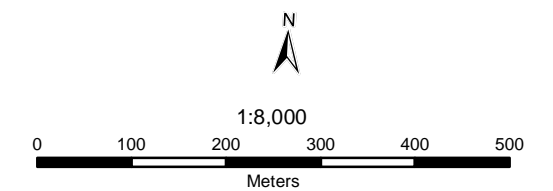


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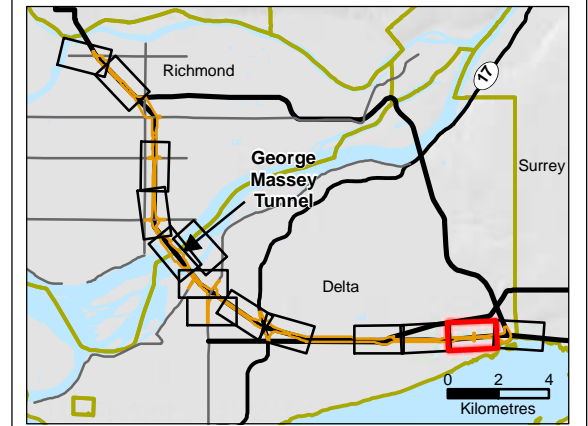
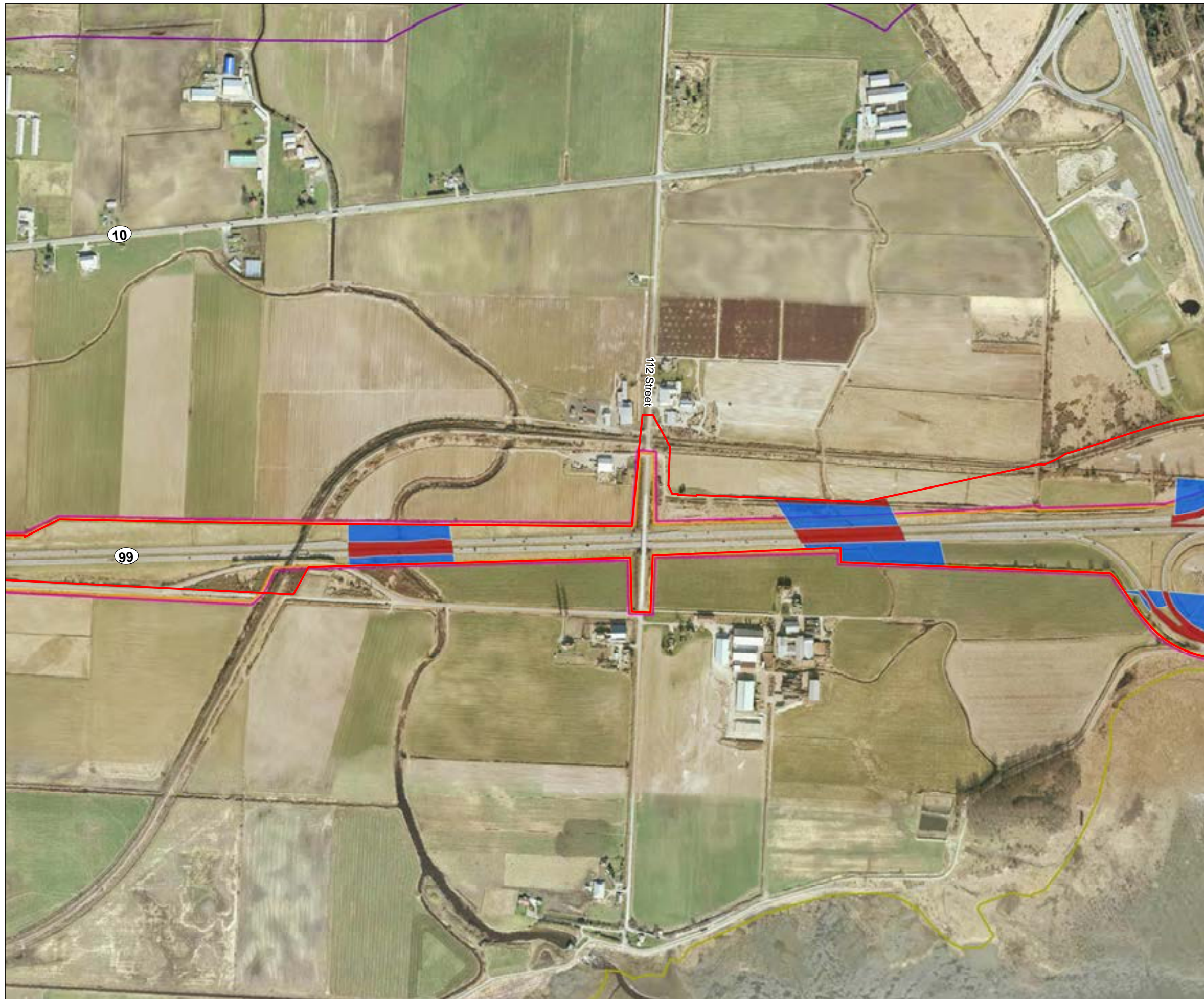
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| AREAS OF RELATIVE ARCHAEOLOGICAL POTENTIAL WITHIN OR ADJACENT TO THE LAA | |
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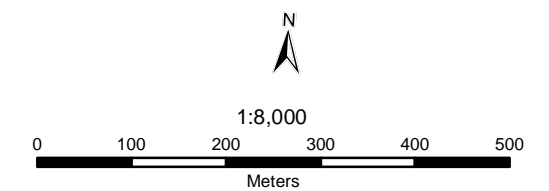


Legend

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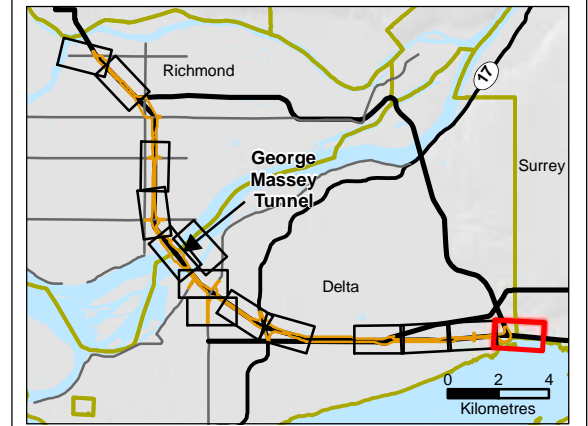
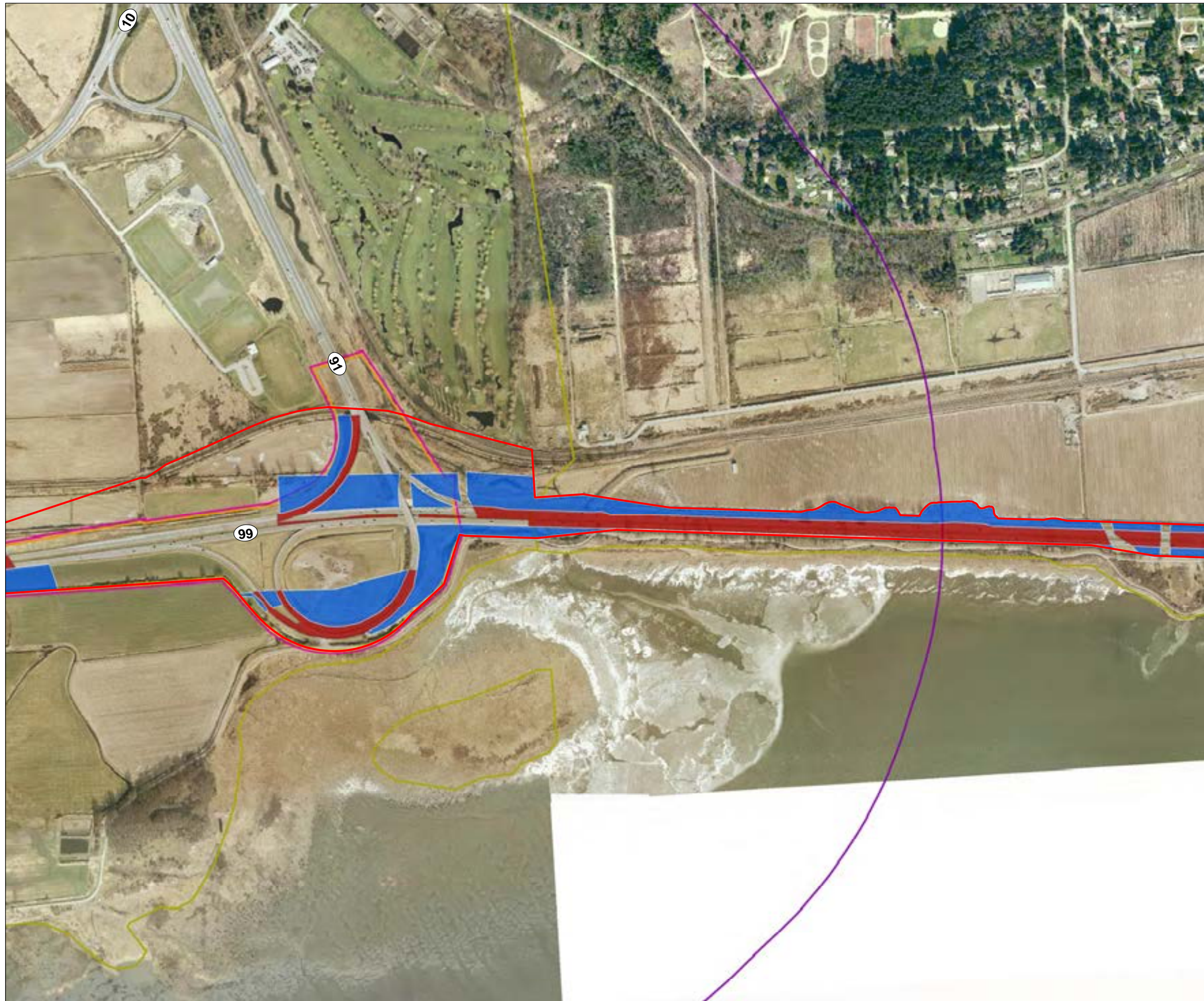


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

AREAS OF RELATIVE ARCHAEOLOGICAL
POTENTIAL WITHIN OR ADJACENT TO THE LAA

Figure 1m

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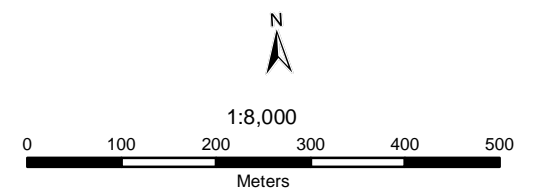


Legend

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7.0 Health Effects Assessment Highlights:

- Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health.
- Implementing mitigation measures to address traffic-related noise during Project operation will avoid increases in human health risk and in some cases will result in improvements over current conditions.
- Proven mitigation measures, effectively used during the construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement project, will be implemented to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
- The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options.
- The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased opportunities for active and public transportation, improved traffic safety, improved connectivity and access, improved emergency response, and economic development opportunities.
- Future Project-related consultation with Aboriginal Groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.
- Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations and emergency response.
- No Project-related residual or cumulative effects on human health are expected.

This section presents the results of the assessment of potential Project effects on human health and includes the rationale for selecting human health as a valued component (VC), identification of Project-related effects, proposed approaches to mitigation, and evaluation of residual Project-related and cumulative effects.

In addition, a health impact assessment (HIA) was undertaken to support ongoing Project planning and development. Information obtained through the HIA process has been used to support the assessment of the Project and recommendations emerging from the HIA have guided the development of mitigation measures throughout the Application with the goal of enhancing Project-related health benefits.

7.1 Human Health

The assessment of the health VC focuses on potential changes in human health, supported by a human health risk assessment (HHRA), and focuses on human health considerations associated with Project-related changes in the intermediate components air quality and noise.

7.1.1 Context and Boundaries

This section describes the context for assessment of Project-related effects on human health in terms of Project setting, and defines the spatial, temporal, administrative and technical assessment boundaries. Rationale for selecting the assessment boundaries as defined is also provided.

No jurisdictional, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects, accessibility constraints, or gaps in data that could limit the ability to predict the effects of the Project were identified; therefore, administrative or technical boundaries do not exist for this VC and are not discussed further.

7.1.1.1 Assessment Context

Changes in road traffic can influence local air quality and community noise levels, which can affect human health. In addition, ground-borne vibration, potentially experienced by communities and properties in close proximity to highways (and highway construction activities) may be of potential concern and source of annoyance. Additional information supporting the selection of human health as a VC is provided in **Section 3.1 Issues Scoping and Selection of Valued Components**.

7.1.1.2 Methodology

The assessment of human health follows the general methodology described in **Section 3.0 Assessment Methodology** and applied to all VCs. Building on this approach, the assessment of human health was designed to focus on health effects linked to changes in air quality and exposure to noise and vibration. In this context, the assessment of human health focuses on two sub-components as presented in **Table 7.1-1**.

Table 7.1-1 Sub-components of Human Health

| Sub-component | Rationale for Selection |
|--|--|
| Air emissions (Health effects linked to changes in air quality) | The Project involves potential changes in volume and composition of traffic along the Highway 99 corridor, which could change air emissions, and in turn, affect human health. Some airborne chemicals may deposit onto soil and plants which are subsequently ingested by animals. Human exposure to soil, plants and animals affected by airborne chemical deposition may result in human health effects. |
| Noise and vibration (Health effects linked to exposure to noise and vibration) | Project-related change in ambient noise conditions during construction and operation, and ground-borne vibration during construction may affect human health. |

Effects to human health from food quality (e.g., fish) were considered for inclusion as a VC. Bed sediments in some areas of the Fraser River South Arm contain trace elements, PAHs, and other organic contaminants at levels that may exceed Canadian Council of Ministers of the Environment (CCME) sediment quality guidelines (SedQGs). Historically, samples collected in lower flow sub-areas of the South Arm have routinely exceeded CCME SedQG for arsenic, chromium, and copper (Swain and Walton 1991, 1993, Brewer et al. 1998). These trace elements occur naturally at higher concentrations in the finer-textured (silt and clay) fractions of bed sediments, which are more common in Deas and Green Slough, but the sediments in the main channel of the Fraser River South Arm have very limited fines (generally less than 2 percent by weight) as a result of the higher bottom currents and generally do not accumulate trace element or various contaminants of human origin. Baseline sediment quality data for the Fraser River in the Project areas, as discussed in **Section 4.2 Sediment and Water Quality**, confirm that sediments within Deas Slough may contain arsenic, chromium and copper at concentrations higher than CCME SedQC. Riverbed sediment samples, however, collected from within the LAA directly adjacent to the Tunnel (except near the river banks) were coarse-grained, with very low concentrations of chemical constituents. An important conclusion is that the riverbed sediments within the main channel of the Fraser River South Arm, near the Tunnel, that are expected to be re-suspended during Tunnel removal are not contaminated based on comparisons with CCME SedQC. Given that no substances were observed to occur in sediment samples collected from the riverbed near the Tunnel at concentrations suggestive of contamination, the Project-related re-suspension of this sediment is not expected to alter the extent to which any contaminants enter living resources such as edible fish. Therefore, a human health risk assessment for this exposure and effects pathway was not deemed necessary, and not included in this assessment.

Indicators chosen for the assessment of Project-related effects on the two human health sub-components, and the rationale for their selection are presented on **Table 7.1-2**. These indicators were used to assess trends in human health within the assessment area and evaluate potential Project-related effects. The selection of indicators was guided by a variety of considerations, including categories of health indicators commonly associated with transportation projects.

Table 7.1-2 Indicators for Assessment of Human Health Sub-components

| Sub-component | Indicator | Rationale for Selection |
|---------------------------------|---|---|
| Air emissions | Acute inhalation risk quotient (chemical exposure ÷ chemical exposure limit) for air concentrations of individual chemicals and potentially interacting chemical groups over short-term averaging times. | Assesses the potential for acute health effects following short-term inhalation exposures. |
| | Chronic inhalation risk quotient for air concentrations of individual chemicals and potentially interacting chemical groups over long-term averaging times. | Assesses the potential for chronic health effects following long-term inhalation exposures. |
| | Chronic risk quotient for multi-media exposures (concentrations of chemicals in soil and plants following airborne deposition and concentrations of chemicals in animal tissue following soil and plant consumption). | Assesses the potential for chronic health effects from long-term oral and dermal exposures to chemicals in media other than air (soil, plants, and livestock). |
| Atmospheric noise and vibration | Annoyance associated with highway noise (as measured by the expected percent of community that is “highly annoyed” (%HA) as predicted from day-night noise levels (expressed as L_{dn}). | A primary indicator of the potential for adverse health effects based on the established relationship between day-night noise levels (L_{dn}) and the per cent of highly annoyed (%HA) individuals. High levels of annoyance can lead to stress and other related adverse health effects. |
| | Sleep impairment based on nighttime sound level (L_n). | Sleep disturbance and awakenings can result in adverse health effects associated with sleep impairment. Effects may include tiredness, lack of focus, among others. |
| | Ability to maintain adequate speech comprehension based on daytime sound level (expressed as L_d). | Speech interference can negatively affect normal communication. Of particular importance is the potential impact on learning effectiveness associated with high indoor noise levels in schools and daycares. |
| | Annoyance associated with ground-borne vibration, based on expected magnitude relative to the threshold of perception. | Vibration can be felt and cause rattles in indoor spaces. This can cause increased levels of annoyance in residential buildings. Increased annoyance can lead to stress related health effects. |

7.1.1.3 Assessment Boundaries

The assessment boundaries for human health are defined below.

Spatial Boundaries

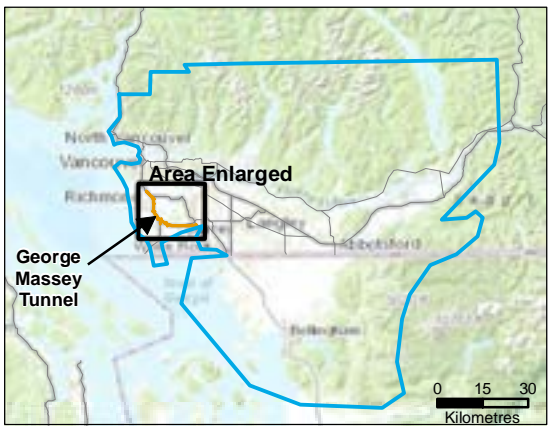
The local assessment areas (LAA) and regional assessment areas (RAA) for human health associated with air quality, and noise and vibration are summarized in **Table 7.1-3** and shown in **Figure 7.1-1**. The boundaries of the assessment area take into account the scale and spatial extent of potential effects that are appropriate for the two sub-components. Assessment of human health effects associated with air quality adopted the spatial boundaries defined in **Section 4.9 Air Quality**. Assessment of human health effects associated with noise and vibration adopted the spatial boundaries identified in **Section 4.10 Atmospheric Noise**.

Table 7.1-3 Spatial Boundary Definitions for Human Health

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local Assessment Area (LAA) | Air emissions: the Project alignment, plus a one-kilometre zone around the Project alignment. |
| | Noise: the Project alignment, plus 500 m from either side of the Project alignment, except in the vicinity of the new bridge where it extends 1,600 m from either side of the Project alignment. |
| Regional Assessment Area (RAA) | Air emissions: lower Fraser Valley airshed, bounded to the north by North Vancouver, to the east by Hope, and to the south by the Cascade Mountains in Washington |
| | Noise: Potential Project-related change in noise conditions are expected to be limited to within the LAA; therefore a RAA has not been defined. |

In general, the LAA encompasses the area within which the Project is expected to most likely interact with, and potentially have an effect on human health. The RAA for air quality provides a regional context for the assessment of Project-related effects and also encompasses the area within which the residual effects of the Project on human health may combine with the effects of other projects and activities to potentially result in cumulative effects.

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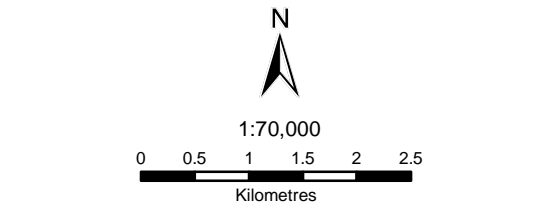


Legend

- Noise Local Assessment Area
- Air Quality Local Assessment Area
- Air Quality Regional Study Area
- Project Alignment
- First Nation Reserve
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**HUMAN HEALTH RISK ASSESSMENT
LOCAL AND REGIONAL ASSESSMENT AREAS**

| | |
|--------------|------------|
| Figure 7.1-1 | 13/05/2016 |
|--------------|------------|

Temporal Boundaries

Temporal boundaries for the assessment of Project-related effects on human health were established based on the potential for each phase of the Project to interact with and have an effect on human health. As discussed in **Section 3.1 Issues Scoping and Selection of Valued Components**, both the construction and operational phases of the Project include components and activities that could interact with and affect human health within the Project alignment; therefore, the following temporal boundaries were defined for human health assessment:

- Existing conditions
- Project construction (including Tunnel decommissioning)
- Project operation (including maintenance)

Temporal characteristics of the Project phases are discussed in **Section 1.1 Description of the Proposed Project**. Specific considerations for the temporal variability in air quality, and noise and vibration effects are presented in **Section 4.9 Air Quality** and **Section 4.10 Atmospheric Noise**, respectively.

Administrative Boundaries

No political, economic, or social constraints that could impose limitations on the assessment of potential Project-related effects on human health have been identified; therefore, no administrative boundaries are defined.

Technical Boundaries

No technical boundaries have been identified that could impose limitations on the assessment of potential Project-related effects on human health.

7.1.2 Existing Conditions

This section provides an overview of the methodology for collecting baseline data, and describes the existing conditions of human health within the assessment areas. An overview of the regulatory context for management of human health as relevant to the Project is also provided.

An appreciation of the existing conditions facilitates the identification of potential future changes associated with the Project. In describing existing conditions, it is assumed that the time period between the present and expected date of completion of the proposed work is sufficiently short that natural trends are not likely to result in appreciable changes in air quality or noise in the intervening period. In addition, it is assumed that human-caused trends that could affect either air quality, noise exposures, or other drivers of human health by the time the Project is constructed or complete, are expected to be minor.

With respect to air quality, it is generally expected that air quality in the assessment area will improve based on technological advancements in transport vehicles (e.g. based on greater percentages of electrical vehicles in use). With respect to noise, any trend is likely to be driven by changes in traffic density and road speeds, which tend to counteract each other. Trends in health status – for example, based on statistical trends in longevity or specific facets of morbidity and mortality – tend to be discernible only over longer periods, and are thus not considered explicitly here.

The existing conditions described in the following sections reflect the cumulative influences on human health of a large number and variety of past and present projects and activities, based on trends in urban development and human migrations, transportation, land use, industrialization, access to food and other basic resources, and health care capabilities and access..

7.1.2.1 Baseline Data Collection

In 2014, the Ministry initiated desktop studies to support the evaluation of Project effects on health, including a quantitative human health risk assessment of changes predicted to as a result of potential changes in air quality, and noise and vibration within the LAA. The assessment of Project-related effects on human health was based on the air quality and noise studies described in **Section 4.9 Air Quality** and **Section 4.10 Atmospheric Noise** of this Application.

Information supporting the assessment of potential effects, of project-related change in air quality and noise conditions and vibration, on human health is based on the following sources:

- Air quality:
 - Acute and chronic air concentrations and deposition rates: Levelton Consultants Ltd.(2014).
 - Baseline health status data: Statistics Canada (2008; 2013a; 2013b), Canadian Cancer Society (2013), Fraser Health Authority (2012).
 - Exposure characterization data: Health Canada (2012), and U.S. EPA (2005).
 - Exposure limit data: Agency for Toxic Substances and Disease Registry (ATSDR, 2013); British Columbia Ministry of Environment (B.C. MOE, 2013); California Office of Environmental Health Hazard Assessment (OEHHA, 2008; 2011; 2014); CCME (2012); Health Canada (2010a); International Agency for Research on Cancer (IARC 2014); Metro Vancouver (2011); Texas Commission on Environmental Quality (TCEQ 2015; 2014); United States Environmental Protection Agency (U.S. EPA 2012, 2014); Netherlands National Institute of Public Health and the Environment (RIVM 2001); WHO (2000, 2006).

- Noise and vibration:
 - Calculation of %HA: American National Standards Institute (2005), Michaud et al. (2008) and International Standards Organization (2003).
 - Assessment of ground-borne vibration: United States Federal Transit Administration (2006).
 - Speech comprehension and sleep impairment: World Health Organization (1999, 2009).

The following guidance documents on human health risk assessment were considered in the assessments of Project-related effects on human health:

- *Guidance on Human Health Risk Assessment for Environmental Impact Assessment in Alberta* (Alberta Health and Wellness 2011).
- *Useful Information for Environmental Assessments* (Health Canada 2010b).
- *Guidance for Evaluating Human Health Impacts in Environmental Assessment* (Health Canada 2011).
- *Human Health Risk Assessment Protocol for Hazardous Waste Combustion Facilities* (U.S. EPA, 2005).
- *Transit Noise and Vibration Impact Assessment* (U.S. Federal Transit Administration 2006).

7.1.2.2 Regulatory Context

Various regulatory and public agencies have oversight of air quality health issues, including the B.C. Ministry of Environment, Metro Vancouver, and the B.C. Ministry of Health, particularly as represented by the Vancouver Coastal Health and Fraser Valley Health authorities. The Canadian Council of Ministers of the Environment (CCME) has also taken a lead role in managing the effects of air pollution on Canadians, through the development and refinement of the CCME Canada-wide Standards and Canadian Ambient Air Quality Standards.

The World Health Organization (WHO), Health Canada, the Ministry, and various other agencies recognize that noise generated from transportation and other activities can result in effects on human health and interfere with daily activities (Swift, 2010).

There are no formal federal or provincial standards available to assess the health effects of community noise levels; however, there are internationally recognized standards for the evaluation of noise effects on individuals and communities that were identified for the HHRA, mainly the U.S. EPA (1974), WHO (1999), and International Standards Organization (ISO), that have been adopted in Canada (CAN/CSA ISO). These agencies generally base their guidance

on previously demonstrated connections between various metrics of shorter- to longer-term noise exposure and (i) the estimated percent of highly annoyed (%HA) residents, (ii) sleep disturbance, and (iii) interference with speech comprehension and/or learning.

7.1.2.3 Existing Conditions

Air Quality

Overview

As discussed in **Section 4.9 Air Quality**, existing air quality within the LAA was estimated based on background air quality data analysis, and traffic and emissions model outputs. Air quality findings are summarized as:

- Carbon monoxide, nitrogen dioxide, benzene, and benzo(a)pyrene exceed the most stringent Ambient Air Quality Objectives (AAQOs).
- The maximum one-hour 98th percentile of carbon monoxide concentrations does not exceed the objective and existing carbon monoxide levels exceed the one-hour AAQO less than 0.2% of the time.
- While nitrogen dioxide exceeds the most stringent AAQO, it does not exceed the federal one-hour objective.

Human Health Considerations

Exposure limits recommended by regulatory agencies, including Health Canada, the World Health Organization (WHO), and the U.S. EPA are appropriate scientific and epidemiological estimates of safe levels of chemical exposure. Comparison of predicted chemical exposures (air concentrations in $\mu\text{g}/\text{m}^3$) to corresponding exposure limits provide the major portion of interpretations for conclusions about human health implications of air quality.

Risk quotient (RQ), a ratio (exposure divided by exposure limit) that reflects the relative magnitude of predicted exposure above or below the exposure limit, is typically used to assess potential health effects of the presence of specific chemicals in ambient air. Using the RQ approach, it is concluded that no adverse health effects are expected where RQ values are equal to or below 1.0.

Risk quotients for contaminants of potential concern (COPC) under existing conditions were calculated based on ambient air concentrations estimated through background air quality data analysis, and traffic and emissions model outputs as discussed in **Section 4.9 Air Quality**.

Existing conditions are as follows:

- The majority of RQ values determined for acute and chronic inhalation exposure to individual chemicals were less than or equal to 1.0.
- All RQ values determined for farmers growing plants and raising livestock within the LAA were less than 1.0.
- The maximum acute and chronic RQ values for residential exposure to nitrogen dioxide were slightly greater than 1.0 (1.1 and 1.2).
- Acute RQ values marginally above 1.0 (from 1.3 to 1.4) estimated for agricultural, residential, and recreational receptors when combined exposure to chemicals in the respiratory irritant group was assumed (i.e., acetaldehyde, naphthalene, nitrogen dioxide, sulphur dioxide).
- The individual RQ value for nitrogen dioxide was the most significant contributor to the respiratory irritant group.
- At locations where highest chemical concentrations are expected to occur in Delta and Richmond, RQ values greater than 1.0 (from 1.2 to 1.8) were identified for acute exposures to carbon monoxide, nitrogen dioxide and particulate matter (PM_{2.5} and PM₁₀) and for combined exposure to chemicals in the eye irritant and respiratory irritant groups.
- The highest chemical concentrations in the air occur within 5 to 15 m of the road edge near either entrance to the Tunnel.

Details on exposure limits and risk characterization for existing conditions, and a discussion of these conservative assumptions are provided in **Appendix B**.

Noise and Vibration

Overview

Noise measurements were collected in 2013 and 2014 at 41 noise-sensitive locations along Highway 99 between Westminster Highway and Highway 10 interchanges to characterize the existing noise environment. These locations are considered to be representative of areas where noise levels are expected to be highest and from which predictions about exposure and effects can be drawn. The predicted noise exposures were compared to guidelines (thresholds) developed by international organizations and relevant health effect indicators including: percent highly annoyed, sleep impairment (sleep disturbance and awakenings), speech interference and annoyance due to ground-borne vibration. Details on methods pertaining to exposure to noise and vibration are provided in **Appendix C**.

Human Health Considerations

Existing (2013) noise levels, within the LAA, range from approximately 45 dBA to 75 dBA, with existing noise levels dominated by Highway 99 traffic. The noise levels are greater than the health indicator guidelines adopted for the assessment at most of the noise-sensitive receptor locations evaluated. Therefore, current noise levels may be contributing to speech interference, sleep impairment, and high annoyance in some individuals at some receptor locations.

Current ground-borne vibration levels are dominated by road traffic along Highway 99. Except for receptors very close to the highway, existing ground-borne vibration levels are considered unlikely to cause annoyance within the LAA.

7.1.3 Potential Effects

This section provides a summary of anticipated changes to air quality related to the construction and operation of the Project. It also describes the methodology used to assess potential Project-related effects.

7.1.3.1 Assessment Methods

Quantitative assessments of human health risk were conducted to assess the potential for adverse health effects as a result of Project-related changes in air quality, and noise and vibration levels. The assessment involved comparison of estimates of air contaminant and noise exposure against health-based exposure limits. The potential for human health risks are evaluated based on the outcome of these comparisons.

The expected changes in air quality, noise, and vibration levels were estimated for Project construction and operation activities relative to estimated conditions without the Project.

For Project emissions to air, health effects were evaluated by comparing air quality projections for the year 2031 with the Project, to air quality projections without the Project, as well as existing air quality conditions (2011) as described in **Section 4.9 Air Quality**.

For Project-related noise, health effects were evaluated by comparing noise exposures in the year 2030 with the Project, as well as during Project construction, to the existing (2011) conditions, as described in **Section 4.10 Atmospheric Noise**.

The magnitude of exposure to Project-related changes in air emissions and noise is highly dependent on the proximity of humans to the various Project components. Residences, school and learning settings, medical/care facilities, places of worship, parks, and agricultural lands situated near the Project alignment were identified as potentially sensitive receptor sites for the characterization of exposure.

Air Quality

The assessment of human health risks related to air quality was supported by a HHRA that involved the determination of the potential for adverse health effects as a result of Project related emissions. The HHRA process provides for comparing predicted exposures to COPCs in air and in media affected by deposition of airborne chemicals (soil, plants, and livestock) to exposure limits. No adverse health effects are expected where predicted RQ values are at or below 1.0, indicating that predicted chemical exposure is at or below the chemical exposure limit. An RQ value greater than 1.0 signals the need for further review of COPC exposure to ensure the protection of human health.

The air quality HHRA is a predictive analysis that relies on assumptions to estimate receptor exposure and chemical toxicity. These assumptions were made such that potential health risks are not underestimated and are most likely overestimated. The HHRA assumes receptors are exposed to maximum modeled air concentrations plus relatively high measured (ambient) air concentrations. When combined, these outdoor air concentrations would only be expected to occur under worst-case conditions. Potential chemical toxicity was represented by the most stringent and defensible of the exposure limits available from regulatory agencies. The air quality HHRA further assumed that chemicals with similar health endpoints would interact in an additive manner, despite the lack of information to support these interactions.

The air quality HHRA was supported by comparing future predicted changes in air quality, with and without the Project, as presented in **Section 4.9 Air Quality**. Details on the HHRA of air quality are provided in **Appendix B**.

Noise and Vibration

Potential health effects were evaluated by comparing predicted noise levels with health-based guidelines for each indicator considered including %HA, sleep impairment (sleep disturbance and awakenings), speech interference, and annoyance associated with ground-borne vibration. The following guidelines values were adopted:

- For nighttime noise, an outdoor L_n of 45 dBA was adopted as a threshold for sleep disturbance and an outdoor L_n of 55 dBA was adopted as a threshold for sleep awakenings.
- For daytime noise, outdoor L_d should not exceed 50 dBA to maintain acceptable noise levels near schools and other learning centres and outdoor L_d should not exceed 55 dBA to maintain adequate speech comprehension in outdoor spaces.

- For day/night noise (L_{dn}), the maximum increase in %HA should not exceed 6.5%, taking into consideration noise source characteristics such as impulsiveness, tonality, and frequency.
- For ground-borne vibration, not exceeding a level of 100 VdB will prevent annoyance at sensitive receptor locations such as homes.

Where predicted noise and vibration levels, taking into account Project-related contributions to noise conditions, were above the guidelines, then adverse health effects were considered possible. In such instances, as noted in **Section 4.10 Atmospheric Noise**, mitigation is proposed to address Project-related increases in noise and associated changes in human health risk. In some cases, Project-related mitigation may address existing exceedances of such guidelines and in doing so provide a benefit with respect to human health. In such cases, reductions in human health effects were identified.

The noise HHRA was supported by comparing future predicted changes in noise, with and without the Project, as presented in **Section 4.10 Atmospheric Noise**. Details on the HHRA for noise and vibration are provided in **Appendix C**.

7.1.3.2 Project Interactions

An overview of potential interactions between Project activities and human health during the construction and operation of Project components is provided in **Appendix A**. A preliminary evaluation of the potential effects of Project interactions on human health, intended to focus the assessment on those interactions of greatest importance, is presented below. Interactions rated as having no effect are not considered further in the assessment.

Construction: The types of air emissions expected during construction (e.g. from diesel powered construction equipment) are different than those associated with the existing highway traffic.

Heavy equipment noise as well as ground vibration associated with compaction, densification, and pile driving (especially in the vicinity of the new bridge footings) are expected during Project construction. Construction-related noise, including decommissioning of the Tunnel, is more likely to vary over shorter time spans, being more impulsive and transient than traffic noise, which is typically dominated by continuous noise.

Operation: During operations, the Project involves potential changes in volume and composition of traffic along the Highway 99 corridor and allows for increased access to healthier transportation options (e.g., transit, walking and cycling). These bridge and highway improvements are expected to positively influence human health.

7.1.3.3 Potential Effects

Risk to Human Health from Exposure to Air Emissions

Project Construction

Potential health risks as a result of exposure to COPC in construction emissions are expected to be avoided through the implementation of best management practices for vehicle and equipment operation. Therefore, the health effect of construction-related emissions on air quality was not evaluated. For this reason, the potential health risks from Project-related air emissions during construction are not carried forward for assessment. However, mitigation measures typically employed to reduce potential construction impacts can be identified based on knowledge gained from experience on recent transportation projects, and are presented in **Section 7.1.4**.

Project Operation (2031)

The air quality HHRA considered inhalation exposure to COPCs in air for agricultural, residential, and recreational receptors, as well as oral/dermal exposure to COPCs in soil, plants, and livestock for agricultural receptors. Air quality with the Project was defined by air concentrations determined from air dispersion modeling of Project emissions in 2031 (described in **Section 4.9 Air Quality**) plus ambient air concentrations measured in the Lower Fraser Valley in 2010.

The acute and chronic inhalation RQ values determined for agricultural, residential and recreational receptors were below 1. Acute inhalation RQ values at or below 1 were estimated at locations of maximum concentrations (i.e., immediately adjacent the roadway) for Richmond and Delta. All of the chronic oral/dermal RQ values were below 1 for agricultural receptors exposed to non-volatile chemicals in soil, plants and livestock, as a result of airborne deposition.

RQ values predicted for future conditions with and without the Project are generally below 1, and therefore no adverse health effects are identified as a result of changes to air quality from Project emissions in the LAA. The RQ values determined for the future (2031) with the Project were the lowest of all of the scenarios evaluated (i.e., compared to the future without the Project (2031) or existing (2011) conditions, indicating an overall improvement in air quality as a result of the Project. For these reasons, potential effects to human health from emissions during Project operation are not carried forward for assessment.

Details on the RQ values for individual contaminants under existing, and projected future conditions with and without the Project are provided in **Section 4.0** of **Appendix B**.

Risk to Human Health from Change to Noise or Vibration Levels

Project Construction

Noise predictions for the construction phase, as discussed in detail in **Section 4.10 Atmospheric Noise**, were based on the draft design concept and preliminary assumptions about the location and duration of noise/vibration generating activities such as pile driving. An overview of Project-related effects during construction, without mitigation, in terms of %HA, and potential for sleep disturbance and interference with speech comprehension, is provided below. Detailed results of noise-related human health risk characterization are provided in **Appendix C**.

There will be increased noise and vibration levels associated with construction activities compared with existing conditions. The noise thresholds for % HA, sleep impairment (disturbance and awakenings) and speech comprehension are likely to be exceeded at the majority of the receptor locations considered. Also, the change in predicted noise level due to construction activities will be of sufficient magnitude that they will be perceived at several sensitive receptor locations. Similarly, ground-borne vibration levels due to pile driving and compaction activities are predicted to exceed the annoyance guideline at several sensitive receptor locations. These effects will be temporary during these specific activities but will last for the duration of construction.

Project Operation (2031)

Future operation of the Project without mitigation is predicted to increase noises levels by one to four dBA at most receptor locations. Since the health indicator guidelines are already exceeded at most receptor locations, any further increase in noise levels may increase the likelihood and/or severity of effects. Any such effects are expected to be greater in areas where noise level increases are perceptible (>3 dBA) because individuals are less likely to adapt to increased noise levels, if they are perceived. The results indicate that the predicted increase in average sound level resulting from Project operation is unlikely to be perceptible by the majority of residents.

As vibration effects associated with existing traffic levels are below annoyance thresholds, increases in ground-borne vibration from levels currently experienced along Highway 99 are not expected, even with forecasted growth in traffic, as the maximum permitted truck size and speed limits are not expected to change.

Without mitigation, the following potential Project-related health effects during the operational phase for each health indicator evaluated is provided below. Further detail on potential effects of Project-related changes in noise levels is provided in **Appendix C**.

Percent highly annoyed

The predicted change in %HA during Project operation compared with existing conditions, without mitigation, is higher than the threshold of 6.5% at 5 of 31 noise-sensitive receptor sites.

Potential for Sleep Disturbance

The modelled nighttime sound level (L_n), without mitigation, is predicted to exceed the sleep disturbance threshold of 45 dBA outdoors at all but one of 29 receptor sites (97%). In comparison, the L_n under existing noise levels exceeds the sleep disturbance guideline at 19 of 21 receptor sites (90%). Overall, the increase in L_n as a result of Project operation is anticipated to be minimal (generally less than 3 dBA).

Potential for Interference with Speech

Without mitigation, the modelled daytime sound level (L_d) (or L_{dn} values for sites where no L_d values were developed) is predicted to exceed the speech comprehension guideline of 55 dBA outdoors at 34 of 38 receptor locations (89%). In comparison, the L_d under existing conditions exceeds the speech comprehension guideline at 83% of the receptor locations. The overall increase in L_d as a result of Project operation in comparison with existing conditions is anticipated to be minimal (generally less than 5 dBA).

Vibration

Project operation is not anticipated to result in a substantial change in ground-borne vibration levels experienced by sensitive human receptors.

7.1.4 Mitigation Measures

Measures that will be incorporated into Project design or implemented during construction to avoid or reduce potential effects of Project-related changes in air quality and noise on human health, and expected outcomes of implementation of those measures are outlined in the sections below.

7.1.4.1 Air Quality

A suite of best management practices and mitigation measures will be outlined in an Air Quality and Dust Control Management Plan, a component of the Construction Environmental Management Plan (CEMP) as described in **Section 12.0 Management Plans** to ensure that potential air quality and human health issues related to Project construction are addressed.

Mitigation measures in the Air Quality and Dust Control Management Plan may include:

- Procedures for the application of dust suppressants to construction areas and stockpiles to control fugitive dust and other airborne emissions.
- Routine maintenance of vessels and vehicles.
- Implementation of engine idling restrictions and selection of quieter vessels and vehicles when possible.
- Managing speeds of construction-related vehicles.

The Ministry has extensive experience in developing and implementing effective measures to address issues related to air quality during construction of large transportation infrastructure projects in urban areas in the Lower Mainland. Therefore, with the implementation of best practices and mitigation measures specified in the CEMP, no human health issues related to air quality are expected during Project construction.

7.1.4.2 Noise and Vibration

Mitigation during Project Construction

Mitigation measures that will be implemented to minimize community impacts due to temporary, unavoidable construction-related noise are identified in **Section 4.10.6 Atmospheric Noise Mitigation Measures**. These measures include equipment and activity restrictions and scheduling, noise monitoring, and community engagement and communication.

Since the atmospheric noise predictions (**Section 4.10 Atmospheric Noise**) explicitly identify areas where noise exposures may be greatest, this facilitates the consideration of site specific mitigation. A key mitigation for construction noise and vibration, therefore, will be the inclusion of measures to minimize the influence of noise and vibration at sensitive receptor locations, and includes consideration of mitigation such as installation of noise barriers at appropriate locations and schedule limitations on when specific construction activities can occur.

A key component of this mitigation, especially to minimize increases in stress and annoyance, is strong communication and dialogue with potentially affected parties so that they have a clear understanding of the expected degree of disturbance associated with noise/vibration during the construction phase. The Ministry will continue to identify potentially affected parties that frequent relevant sensitive receptor locations and engage with them as the details of Project construction evolve.

Implementation of mitigation measures, including appropriate scheduling of construction activities and community engagement and communication, are expected to minimize potential human health effects associated with noise during Project construction.

Mitigation during Project Operation

During Project operation, noise may be mitigated through application of the Ministry's 2014 Noise Policy. Specific mitigation will include noise avoidance and mitigation measures such as noise barriers and noise control at the receptor or other measures. Noise sensitive sites where mitigation consideration is warranted are summarized in **Section 4.10.6 Atmospheric Noise Mitigation Measures**.

With mitigation, the Project is anticipated to reduce noise levels (relative to without mitigation), below current (2013) levels at most receptor locations. This will not only reduce the number of individuals exposed to noise levels above the health indicator guidelines, but will further reduce the likelihood/severity of effects compared with current noise levels. A summary of the changes in for each health indicator is provided below. Further detail on Project-related changes in noise levels and human health is provided in **Appendix C**.

Percent highly annoyed

The %HA under the future with mitigation scenario will be reduced, compared with current (2013) conditions, except at four receptor locations. The predicted decrease in %HA with mitigation (relative to without mitigation) varies from approximately 2 to 20 %HA, with most residential receptors predicted to experience reductions of 10 to 20 %HA. Of the four receptors that are predicted to have an increased %HA, the increases are predicted to be less than the 6.5% guideline. Overall, there will be a significant reduction in the number of people who are highly annoyed compared with existing conditions. This represents an important net benefit for the Project.

Potential for Sleep Disturbance

The sleep disturbance threshold of L_n 45 dBA and sleep awakening threshold of L_n 55 dBA is estimated to be exceeded currently at most receptor locations. With mitigation, L_n noise levels are predicted to be reduced below existing levels depending upon the type of mitigation and receptor location. This will not only lead to an overall improvement to the nighttime noise environment but it will also reduce L_n noise levels below the sleep awakening threshold at a number of residences. This represents a net benefit for the Project.

Potential for Interference with Speech

Two outdoor receptor locations (places of worship) are predicted to currently exceed the outdoor speech comprehension threshold of L_d 55 dBA. Additionally, one school is predicted to have L_d levels higher than the 50 dBA threshold. However, mitigation is predicted to reduce outdoor daytime (L_d) sound levels, depending upon the type of mitigation and receptor location, compared with existing noise levels. This will reduce the level of speech interference at all receptor locations to levels below existing conditions. This represents a net benefit for the Project.

Vibration

Existing vibration effects associated with current traffic levels are below the annoyance thresholds and are not expected to increase even with forecasted growth in traffic in the corridor.

7.1.5 Residual Effects and their Significance

Increased levels of air pollutants and noise levels can affect human health if predicted levels are higher than the thresholds adopted for the protection of human health.

As discussed in **Section 4.9 Air Quality**, construction-related air emissions can be effectively mitigated with the application of effective best management practices that will be in place during construction. As a component to the CEMP, an Air Quality and Dust Control Management Plan will be developed, which will describe measures to control and minimize fugitive dust and other airborne emissions associated with construction equipment, demolition, and other decommissioning activities, and soil handling. In the future, operation of the proposed Project will result in an improvement in air quality relative to existing conditions and future conditions without the Project. On this basis, no Project-related residual effects on human health, associated with air contaminants, are predicted.

As discussed in **Section 4.10 Atmospheric Noise**, construction-related increases in noise levels will be addressed through the use of best practices including scheduling of specific noise intensive activities. While future noise levels are predicted to exceed health effect indicator thresholds at some receptors, this will be at receptors where such exceedances occur today and the Project is anticipated to reduce noise levels below current (2013) levels at most receptor locations. This will improve the overall sound environment and reduce any health effects to below current levels. This is considered a net benefit and no residual effects to human health are predicted.

7.1.6 Cumulative Effects and their Significance

As discussed in **Section 7.1.5**, the Project is not predicted to have residual effects on human health. Therefore, a cumulative effects assessment was not undertaken.

7.1.7 Follow-up Strategy

As no residual or cumulative effects are predicted for human health, no follow-up strategy is proposed.

7.2 Health Impact Assessment

In recent years there has been increased interest, among the public, governments, and health authorities, in the use of health impact assessments (HIAs) for assessing health considerations associated with various development projects. In general terms, an HIA is used as a planning tool and provides a framework for considering the way in which the planning and development of community infrastructure may influence health in either positive or adverse ways.

Building on this interest, Metro Vancouver has published a guidebook and toolkit for conducting HIAs of transportation and land use activities (Metro Vancouver 2015a,b). Recognizing this emerging trend, and in response to input from regional health authorities (i.e. Vancouver Coastal Health and Fraser Health) during pre-application consultation, the Ministry initiated an HIA to support the ongoing planning and development of the Project.

The following section includes:

- A description of how the HIA undertaken supports the Project planning
- Background on the HIA process including specific HIA planning tools developed by Metro Vancouver
- An overview of the methodology used to support the HIA for the Project
- A summary of the key findings of the HIA for the Project

The full HIA for the Project can be found www.masseytunnel.ca

7.2.1 Integration of HIA into Application and Project planning

The issues assessed in the HIA are subject to a different methodology than that applied to issues assessed in the Application as intermediate or valued components. Nonetheless, the analysis of health issues provided for in the HIA has supported the environmental assessment of the Project presented in the Application in a number of ways including:

- Identifying a broader range of Project-related health considerations for potential inclusion in the environmental assessment and confirming the scope of health-related intermediate and valued components assessed in the Application.
- Providing a framework, that complements the environmental assessment process, for considering health issues that may not be captured in the assessment of intermediate and valued components presented in the Application.
- Providing useful information to support future stages of Project planning by highlighting Project-related opportunities to enhance health benefits during future stages of Project design and construction.

7.2.2 HIA Background

The conceptual framework behind HIA is based on the idea that individual and community health is shaped by wider social, economic, and environmental influences and factors beyond health services and biological such as age. These factors, referred to as health determinants, influence health outcomes (i.e., rates of injury and disease) and include:

- Physical environment factors (e.g., air quality, water quality)
- Built environment factors (e.g., buildings, public spaces, roads, bike lanes)
- Livelihood factors (e.g., income, employment)
- Social and community factors (e.g., social support, family structure, access to services)
- Lifestyle factors (e.g., diet, exercise, alcohol and tobacco use)

The application of the HIA framework is supported by the established understanding of the relationship between determinants of human health noted above and health outcomes. The understanding of the relationship between determinants of health and health outcomes is supported by epidemiological studies that link changes in determinants of health to specific health outcomes.

Applying the HIA framework in the context of a specific project provides for a consideration of how the development and operation of the project can influence human health through a variety of mechanisms.

The Process Diagram included in Metro Vancouver’s HIA guidebook **Figure 7.2-1**, illustrates the conceptual framework behind HIA and how land use planning activities and the development of community infrastructure influences broader determinants of health.



Figure 7.2-1 Activity Impacts, Health Determinates, and Health-Related Outcomes (Metro Vancouver 2015a)

7.2.3 Project HIA Methodology

Considering previous planning and consultation work that had been done to support Project development, and the work done in support of the environmental assessment (Application) for the Project, it was determined that a desktop HIA would be an appropriate level of assessment. The Project's HIA followed the standard process for health impact assessment outlined in multiple reference documents: screening; scoping; assessment and analysis; development of recommendations; reporting; and monitoring and evaluation.

This HIA drew on the reported results of stakeholder engagement activities that have been undertaken about the Project over the last three years with Aboriginal Groups, the general public, and municipal, professional and community-based organizations. In addition, the scope of the HIA was directly reviewed by the Vancouver Coastal Health and the Fraser Health Authorities. Aboriginal Groups and federal, provincial and local governments associated with the Technical Working Group supporting the environmental assessment of the Project were provided an opportunity to provide feedback on the HIA process for the Project. Additional engagement with emergency responders was also undertaken to support HIA development. Comments from all of these reviewers informed the HIA approach.

Eleven health interest areas emerged from the scoping process; these are shown in **Table 7.2-1**.

Table 7.2-1 Health interest areas scoped for the HIA

| Health Issue | Potential changes during Construction | Potential changes during operations | Health outcomes (positive or adverse) that could be affected |
|--------------------------------------|--|---|---|
| Physical Environment | | | |
| 1. Exposure to Airborne Contaminants | <ul style="list-style-type: none"> • Cardiorespiratory effects, from dust and emissions due to construction and equipment | <ul style="list-style-type: none"> • Changes to health outcomes related to reduced emissions from reduced congestion-related idling • Changes in regional air quality due to traffic pattern changes | <ul style="list-style-type: none"> • Cardiorespiratory health outcomes. • Additional health outcomes associated with airborne contaminants. |
| 2. Noise | <ul style="list-style-type: none"> • Construction-related noise | <ul style="list-style-type: none"> • Road traffic noise | <ul style="list-style-type: none"> • Annoyance, sleep disturbance, speech comprehension. |
| 3. Food and Water Consumption | <ul style="list-style-type: none"> • Contamination of food sources via construction activities | <ul style="list-style-type: none"> • Changes to food (fish, agriculture) quality or acceptability • Exposure to contaminants via food/water sources • Changes to agricultural land production capability | <ul style="list-style-type: none"> • Health considerations associated with changes in air quality/water quality. |
| 4. GHG Emissions | <ul style="list-style-type: none"> • N/A | <ul style="list-style-type: none"> • Changes to emissions from a reduction in congestion-related idling • Changes to emissions from increases in traffic volumes or vehicle kilometers travelled | <ul style="list-style-type: none"> • Climate change-considerations associated with construction and operation of the Project. |

| Health Issue | Potential changes during Construction | Potential changes during operations | Health outcomes (positive or adverse) that could be affected |
|-------------------------------------|--|---|---|
| Built Environment | | | |
| 5. Active and Public Transportation | <ul style="list-style-type: none"> • Temporary blockage of some routes leading to decreased walking/cycling • Effects on access to public transportation | <ul style="list-style-type: none"> • Change in walking and cycling conditions • Changes on access to public transportation | <ul style="list-style-type: none"> • Physical activity, weight, metabolic outcomes, stress and equity. |
| 6. Traffic Safety | <ul style="list-style-type: none"> • Traffic diversions and speed changes | <ul style="list-style-type: none"> • Change in traffic safety Change in pedestrian and cyclist injuries due to increased walking/cycling | <ul style="list-style-type: none"> • Injury and fatality as well as stress and mental well-being. |
| Social and Community Factors | | | |
| 7. Connectivity and Access | <ul style="list-style-type: none"> • Social connectivity and community cohesion | <ul style="list-style-type: none"> • Changes in travel time • Changes in social connectivity and community cohesion • Changes in accessibility to services for low-access groups | <ul style="list-style-type: none"> • Stress and mental well-being as well as care and management of health conditions. |
| 8. Emergency Response | <ul style="list-style-type: none"> • Emergency response times | <ul style="list-style-type: none"> • Changes in emergency response access | <ul style="list-style-type: none"> • Health outcomes related to timely medical treatment. |
| 9. Safety and Security | <ul style="list-style-type: none"> • N/A | <ul style="list-style-type: none"> • Suicide risk • High-risk populations congregating near Bridge • Seismic stability compared with current Tunnel | <ul style="list-style-type: none"> • Injury and mental well-being |

| Health Issue | Potential changes during Construction | Potential changes during operations | Health outcomes (positive or adverse) that could be affected |
|-----------------------------|---|---|--|
| Livelihood Factors | | | |
| 10. Economic Health Effects | <ul style="list-style-type: none"> • Construction-related employment and contracts • Temporary impacts on access to local businesses • Limitations on movements of goods or services | <ul style="list-style-type: none"> • Project related economic benefits • Changes in access to employment opportunities • Changes in access to affordable housing • Health care benefits associated with reduced potential for chronic disease or injury | <ul style="list-style-type: none"> • Multiple aspects of physical and mental well-being. |
| Lifestyle Factors | | | |
| 11. Recreation and Parks | <ul style="list-style-type: none"> • Temporary impacts to parks experience | <ul style="list-style-type: none"> • Changes in connectivity to park and recreation areas • Changes to park experience | <ul style="list-style-type: none"> • Physical activity, weight, stress and mental well-being. |

The geographic boundaries for the HIA for the Project were developed on an issue-by-issue basis in order to most appropriately capture the different effects of topics ranging from air quality to recreation and parks. The temporal boundary for construction was defined as the years 2017 to 2022; and for operations, the years 2022 to 2031.

In addition to assessing the effects of the Project on the general population for each of these 11 health interest areas, the HIA also paid specific consideration to how effects might be experienced by vulnerable populations (i.e., those more likely to suffer adverse health effects) and by Aboriginal populations.

7.2.4 Existing Conditions

The City of Richmond (Richmond) is a multi-ethnic urban centre with a population of approximately 213,000. Richmond residents report incomes that are lower than the Canadian average – and 38% of its population earns less than \$40,000 annually. Overall, the municipality relies more heavily than others in the area on cars for daily commuting, rather than biking, walking, or public transit (My Health My Community 2014). While Richmond residents consider themselves to be less healthy than residents of Metro Vancouver overall, Richmond also has the highest life expectancy in all of Canada.

Delta is a population of around 100,000 people, with an average household income 30% higher than the Canadian average. Although it has a strong farming and agricultural background, the municipality is currently one of the fastest growing industrial areas in the Metro Vancouver region. In Delta, residents were more likely to rate their general health as excellent or very good in comparison to the region. However, health outcomes actually show that Delta residents have slightly higher reported rates of chronic conditions than Metro Vancouver as a whole.

Within all areas of Metro Vancouver, vulnerable populations are at elevated risk of experiencing adverse health effects. These potentially vulnerable populations include children and the elderly, those with pre-existing health conditions, and those at the lower end of the socio-economic spectrum.

In addition, Aboriginal Groups in the region comprise a distinct group that may experience health effects differently than the population at large. Project planning has involved consultation and engagement with 13 Aboriginal Groups, as noted in **Section 10.0 Aboriginal Consultation**, with potential interests in the Project.

7.2.5 Key findings

7.2.5.1 Exposure to Airborne Contaminants

The potential for health effects stemming from exposure to airborne contaminants is reviewed in **Section 7.1**. Although this issue is addressed thoroughly in the HHRA presented in **Section 7.1**, the HIA also provides for a consideration of health effects related to changes in air quality.

The HIA supports the following conclusions with respect to exposure to airborne contaminants:

- Air quality will improve in the future across the Local Assessment Area, both with and without the Project. However, improvements are greater with the Project.
- The predicted human exposure to air contaminants will be far below the thresholds that have been set for specific substances; therefore, no adverse effects are predicted.
- Vulnerable populations, including children, the elderly, and those with chronic respiratory problems, will derive the most benefit.
- During the Construction phase, there is the potential for Project-related equipment to temporarily generate diesel emissions. The Project will implement best management practices for vehicle and equipment operation to minimize exposure to these emissions.

7.2.5.2 Noise

The potential for health effects stemming from exposure to noise is reviewed in **Section 7.1**. Although this issue is addressed thoroughly in the HHRA presented in **Section 7.1**, the HIA also provides for a consideration of health effects related to changes in noise.

The HIA supports the following conclusions with respect to exposure to noise:

- During the construction phase, there will be temporary noise generated during site preparation and construction activities. A limited number of locations in Richmond and Delta may temporarily experience perceptible increases in daytime noise.
- During operations, vehicles will remain the primary source of noise. Planned mitigation for Project operations include the potential application of a combination of measures, as appropriate for specific sites, as discussed in **Section 4.10 Atmospheric Noise**.
- As a result of the application of such measures, traffic-related noise during Project operation is not expected to have an impact on human health.

7.2.5.3 Food and Water Consumption

Healthy diets help prevent disease and promote better health. For Aboriginal Groups, subsistence food sources are important for maintaining a healthy diet, and have been linked with lower rates of conditions such as obesity, diabetes, heart disease and stroke as well as supporting other aspects of culture and community (Authority 2012). Similarly, access to a safe, steady water supply is essential to support health and prevent disease.

The South Arm and the mouth of the Fraser River are important locations for subsistence and commercial fishing. Field sampling suggests that fish currently live in clean habitat, making them safe for consumption (**Section 4.2 Sediment and Water Quality**). In addition to recreational and sport users, there are several Aboriginal Groups who fish, in the area between the Port Mann Bridge and the mouth of the Fraser River, for food, ceremonial and social purposes. Aboriginal Groups have indicated that fishing is an important factor for wellness and that access to traditional foods is important for maintaining a nutritious diet, as such foods tend to be more nutrient-dense than market foods, leading to better overall health. **Section 10.1.3 Aboriginal Interests Assessment** provides information regarding the assessment of potential Project-related effects on the availability and quality of resources for the exercise of Aboriginal Interests.

The HIA supports the following conclusions with respect to food and water consumption:

- As noted in **Section 5.4 Agricultural Use**, agricultural production will not be adversely affected by the Project. As well, as noted in **Section 4.9 Air Quality**, Project-related decreases in air contaminants will help to reduce the risk of exposure to contaminants, via consumption of locally grown food, in the future.
- The Project is not expected to affect the quality or availability of fish for consumption, as protecting fish and fish habitat has been incorporated within the Project design and construction planning (**Section 4.4 Fish and Fish Habitat**).
- In the event of a spill, it is plausible that concerns could result regarding exposure to contamination and lead to avoidance among people who rely on fishing for food including Aboriginal Groups.
- The perception that Project could result in changes to the quality of fish or other marine resources can be addressed through communicating the results of Project-related environmental monitoring programs as discussed in **Section 12.0 Management Plans** of the Application, including those required to address accidents or malfunctions that may occur. This will be particularly relevant for Aboriginal Groups who rely more heavily than other populations on access to fish as an important component of their diet.
- Drinking water availability will remain secure during all stages of the Project. Construction of the bridge and decommissioning of the Tunnel are not expected to affect the Lulu Island-Delta water main, and careful monitoring and mitigation as discussed in **Section 4.1 River Hydraulics and River Morphology** will be implemented.

7.2.5.4 Greenhouse Gas (GHG) Emissions

Potential Project-related changes in air quality, are assessed in **Section 4.9 Air Quality**. The HIA builds on the results of the air quality assessment for the Project by considering potential health impacts associated with changes in GHGs.

GHG emissions such as carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O) are drivers of climate change (Environment Canada 2013). Climate change has the potential to adversely impact health through risks posed by high temperatures, extreme weather events, and changes in patterns of infection (World Health Organization 2015). Climate change can also affect the social and environmental determinants of health: clean air, safe drinking water, sufficient food and secure shelter (World Health Organization 2015). These effects are primarily experienced at a regional or global level, rather than being localized close to GHG emissions sources.

The HIA supports the following conclusions with respect to GHG emissions:

- Reducing current congestion at the Tunnel will result in reductions in GHGs that occur as a result of congestion-related idling.
- GHG emissions may further decrease during operation of the bridge if traffic volume is reduced by the uptake of active or public forms of transportation.

7.2.5.5 Active and Public Transportation

Potential Project-related changes in traffic, including a consideration of different modes of transportation such as transit, cycling and walking, are assessed in **Section 5.1 Traffic**. The HIA builds on the results of the assessment of traffic by considering potential health impacts associated with changes in access to different modes of transportation.

Both active transportation (walking and cycling) and public transportation are associated with a wide range of health benefits, such as cardiovascular fitness, mental health and reductions in obesity and chronic disease; and reductions in traffic collisions and contaminant emissions (Litman 2010, Reynolds, Winters et al. 2010).

The HIA supports the following conclusions with respect to active and public transportation:

- As concluded in **Section 5.1 Traffic**, the Project will improve both active and public transportation options once in operation and public transportation will become more efficient and accessible.
- Construction phase effects on traffic can be mitigated to prevent access and safety problems for active and public transportation.

- As noted in **Section 5.1 Traffic**, the current bike shuttle service will remain open during the construction phase.
- The addition of multi-use pathways across the new bridge and interchanges will improve options for active transportation locally and regionally and will also improve safety for users.
- Increased options for safe active and public transportation may contribute to improved health equity. Improvements to public transit can also have beneficial effects for disadvantaged or vulnerable populations.
- Monitoring of the use of the multi-use paths will be undertaken to confirm Project objectives have been met and make further operational refinements if required.
- Better public transit has been associated with increased access to medical services and healthy foods, and as a result could have positive impacts on health equity.
- Future Project consultation, as discussed in **Section 11.0 Public Consultation** and **Section 10.0 Aboriginal Consultation** will provide opportunities for local governments and other key stakeholders to provide input on the final design of multi-use paths that are part of the Project.
- As discussed in **Section 5.1 Traffic**, the Ministry will work with TransLink and local governments to ensure that current levels of active transportation and transit service is maintained through the construction period.

7.2.5.6 Traffic Safety

Potential Project-related changes in traffic, including a consideration of how the Project will address existing (traffic) safety risks, are assessed in **Section 5.1 Traffic**. The HIA builds on the results of the assessment of traffic by considering potential health impacts associated with addressing existing safety risks.

Currently, the Tunnel and the interchanges at Steveston Highway and Highway 17A have substantial safety issues. Over the five-year period of 2008-2012, 6,024 collisions occurred on Highway 99 within the Project corridor and some adjacent intersections and routes south of the Oak Street Bridge. Of these collisions, approximately 37% resulted in injury or fatality (Delcan 2015). In the span of the Tunnel itself, almost half (49%) reported collisions between 2008 and 2012 resulted in injury or fatality.

The HIA supports the following conclusions with respect to traffic safety:

- As noted in **Section 5.1 Traffic**, the Project is expected to result in a decrease in traffic accidents and associated injuries and fatalities.
- The new bridge includes several features that will reduce the high collision rates at the Tunnel including elimination of the need for the current counter-flow system and additional lane capacity that allows for safer merging movements and separation of slower moving traffic.
- Monitoring of collision incidence on the improved Highway 99 will be undertaken to confirm project objectives have been met and guide operational refinements if required.
- Planned improvements for interchanges will also result in safer merging lanes and modern standards.
- Future Project consultation, as discussed in **Section 11.0 Public Consultation**, will provide opportunities for the Ministry to work with police on planning for monitoring and enforcement of speed limits.

7.2.5.7 Accidents and Malfunctions

The effects of potential Project-related accidents and malfunctions are assessed in **Section 8.0 Accidents and Malfunctions** of the Application. The HIA builds on the results of this assessment by considering potential health impacts associated with potential accidents and malfunctions.

The HIA supports the following conclusions with respect to accidents and malfunctions:

- During construction, there is a very low possibility of an accident or malfunction that results in a release of toxic, hazardous or otherwise harmful materials into the water as discussed in **Section 8.0 Accidents and Malfunctions**. Mitigation measures recommended for addressing potential spills are provided in **Section 12.0 Management Plans**.
- In the event of a spill, it is plausible that concerns could result regarding exposure to contamination and lead to avoidance among people who rely on fishing for food including Aboriginal Groups.
- Communicating the results of Project-related environmental monitoring programs presented in **Section 12.0 Management Plans**, including those required to address accident or malfunctions that may occur, will help to inform communities about exposure risk and allow continued access to food resources such as fish.

7.2.5.8 Connectivity and Access

Socially connected communities foster social participation and strong relationships, leading to physical and social well-being, while a lack of connection can increase social disorder, conflict and inequality (Forrest 2001). Connectivity and access are also important with respect to accessing vital services, such as health care and employment opportunities.

The HIA supports the following conclusions with respect to connectivity and access and draws on information presented in **Section 1.1 Description of Proposed Project** and **Section 5.1 Traffic** of the Application:

- As noted in **Section 1.1.10 Project Benefits**, the overall impacts of the Project on connectivity and access will be positive.
- Reduced congestion in the Highway 99 corridor, as discussed in **Section 5.1 Traffic**, will improve travel times and reliability for those accessing services, school, work or other locations.
- As noted in **Section 5.1 Traffic**, the Project will support reductions in transit times for those using public transit or carpooling, making these options more attractive to commuters. This will improve equity in access to travel for disadvantaged populations.
- The Project will improve access for pedestrians and cyclists, which will lead to increases in physical activity levels.
- As discussed in **Section 1.1.10 Project Benefits**, by being designed to accommodate future forecasted growth in population and employment in communities south of the Fraser River, the Project will improve connectivity between Richmond and Delta as well as within these municipalities.
- The Project will also support improved connectivity for local farm operations.

7.2.5.9 Emergency Response

Emergency response services, including ground and air ambulance services, police services and firefighters, are all a part of responding to emergencies and provide critical medical care to individuals experiencing acute health crises.

Accidents in or near the Tunnel occur frequently and often involve simultaneous response from multiple jurisdictions. Emergency responders, including fire, ambulance and police services, have cited challenges in accessing these accidents due to congestion, a lack of shoulders and pull-outs, and a lack of cameras in the Tunnel to identify where the collision is situated. These challenges can have health implications for those travelling to seek urgent medical attention.

The HIA supports the following conclusions with respect to emergency response:

- The Project will have a positive effect on emergency response.
- The new bridge will be designed to a lifeline standard to be kept open for emergency vehicle response and post-earthquake economic recovery following a major seismic event.
- As discussed in **Section 5.1 Traffic**, the design of the Bridge will increase traffic safety by addressing congestion, improving interchanges and eliminating the need for the counter-flow which will reduce the number of events for which emergency response is needed.
- As discussed in **Section 11.0 Public Consultation** and **Section 10.0 Aboriginal Consultation**, future stages of consultation will provide opportunities for first responders, emergency response agencies and other interests to provide input on emergency response considerations during future design stages.
- The bridge is anticipated to substantially improve emergency response capabilities for local accidents. These improvements will stem from the increase in numbers of lanes; reduced traffic congestion; dedicated transit/HOV lanes; and improved safety conditions for emergency responders.
- Based on the current available evidence, improved emergency response times will likely improve health outcomes for individuals experiencing acute conditions that require urgent medical attention (Craig 2014).

7.2.5.10 Safety and Security

Within the HIA, safety and security are considered in terms of violence – either violent crime or self-inflicted violence (suicide). Both violent crime and self-inflicted violence have the potential to result in injury or death, a clear link to health. In addition, fear of violent crime has been found to adversely impact mental well-being and physical health, both directly and indirectly (Guite, Clark et al. 2006).

The HIA supports the following conclusions with respect to safety and security:

- The installation of safety fencing, as described in **Section 1.1 Project Description**, will help to reduce the incidence of suicide (Beautrais 2007, Reisch T 2007, Sinyor 2010).
- Emergency responders report that isolated areas, such as the bases of bridges, can attract high-risk populations to create temporary shelters that may be associated with elevated rates of petty crime.
- As noted, **Section 1.1, Project Description**, the Project will include lighting for the multi-use trails and applicable areas to meet functional, safety and Crime Prevention Through Environmental Design (CPTED) requirements.

- The new bridge will have a far greater ability to withstand a seismic event than the Tunnel. This greatly reduces the chance of injury and mortality from a failure compared with the Tunnel, and will improve safety into the future.
- Future engagement, as discussed in **Section 11.0 Public Consultation** and **Section 10.0 Aboriginal Consultation**, will provide opportunities to work with local governments and other key stakeholders and ensuring safety and security considerations are addressed in the design of the Project.

7.2.5.11 Economic Health Effects

Employment, income and its distribution are key determinants of health. Employed individuals and those in higher income brackets typically experience better health outcomes with respect to life expectancy, mortality, cardiovascular disease, mental health and child health status. As discussed in **Section 1.1.10 Project Benefits**, and summarized below, the impacts of the Project on economic considerations, including employment, are expected to be positive.

The HIA supports the following conclusions with respect to economic health effects:

- Overall, the Project is anticipated to have a positive effect on health in Metro Vancouver, due to positive economic contributions and effects to the local and regional economy.
- The operation of the Project will contribute to improved goods movement in the region, as well as the viability of local businesses. This will help support local economic growth and job opportunities, both of which can contribute to positive health and well-being.
- The Project will cause minor and temporary constraints to marine traffic and commercial truck traffic during construction, but these will have a negligible effect on the local and regional economies.
- Future Project consultation, as discussed in **Section 11.0 Public Consultation** and **Section 10.0 Aboriginal Consultation**, will provide for working with adjacent land owners and businesses to avoid impacts to business operations.
- Overall there will be a net gain of agricultural land that can be actively farmed as well as access improvements for local agricultural operations.
- As noted in the **Section 10.0 Aboriginal Consultation** the Ministry is currently engaged with Aboriginal Groups with respect to employment, training, and business opportunities during Project delivery.

7.2.5.12 Recreation and Parks

The consideration of recreation and parks undertaken in the HIA is informed by **Section 5.3 Land Use** which considers potential effects on parks from a land use perspective and identifies mitigation to address potential effects on land use. The assessment of land use presented in **Section 5.3** also includes a specific focus on recreational use of Deas Island Regional Park.

Access to and engagement with natural features and the environment offers numerous health benefits. Experiencing nature is associated with lower levels of stress, anxiety, depression, and chronic disease; and increased levels of concentration and cognitive functioning (Provincial Health Services Authority 2014). Parks are also associated with multiple physical, psychological and social benefits (Bedimo-Rung 2005). Parks promote physical activity, which has well-established links with positive physical and mental health outcomes. Park users may also experience psychological benefits with respect to improvements in mood, stress and anxiety. Lastly, using parks may encourage social interaction, promoting community cohesion and social capital (Bedimo-Rung 2005).

Residents of Metro Vancouver highly value outdoor recreation, and are among the most active of British Columbians. According to the 2011 *Regional Outdoor Recreation Opportunities Study* commissioned by Metro Vancouver and the Fraser Valley Regional District (FVRD), residents of Metro Vancouver used parks and open spaces year-round, with an average of 41 visits per person/year (LEES+Associates, Mustel Group et al. 2011).

The HIA supports the following conclusions with respect to recreation and parks:

- Construction activities may deter some park users from using nearby parks (such as Deas Island) as a result of construction related noise and traffic management.
- During operations, park usage may increase as existing traffic congestion is addressed and access is improved.
- As noted in **Section 5.3 Land Use**, the park experience at Deas Island Regional Park will change as a result of the Project and will include both benefits (i.e., improved air quality, restoration of shoreline, improved park connectivity, revegetation of areas under the bridge, decreased noise at Tunnel portal) as well as adverse effects (i.e., shading, overhead noise, visual conditions).
- The extent to which the overall change to the recreational experience at Deas Island Regional Park is beneficial or adverse is subjective and will be perceived differently by different users.

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APPENDIX A

Overview of Potential Project Interactions with Human Health

Table 1 Overview of Potential Project Interactions with Human Health

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|---|---|
| Pre-construction / Site Preparation | | | |
| Pre-construction / Site Preparation | No interaction | <ul style="list-style-type: none"> • Surveying • Acquiring property for the Project | Rationale: Activities do not produce air emissions, noise, or vibration. |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Clearing and grubbing of vegetation within the existing Highway 99 ROW • Restoration of Green Slough to its historic alignment • Installing temporary drainage structures and diversions • Installing temporary bridges and barging facilities • Conducting additional site investigations (i.e., a geotechnical drilling program) • Installing temporary roads, laydown areas, and site offices • Relocating utilities • Preloading for embankment and highway construction | Potential Project-related effects include: <ul style="list-style-type: none"> • Increased air emissions through the construction phase of the Project, primarily from operation of diesel or gas-powered equipment • Increased noise and vibration levels for individuals residing in close proximity to the source, or in other areas such as parks, places of worship, educational facilities, or medical facilities |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|--|---------------------|--|--|
| Construction | | | |
| New bridge including approaches and ramp connections | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Installing upland piers, including pile installation • Installing drainage structures/settling ponds • Ground improvements associated with new bridge piers • Installing piers adjacent to Deas Slough and Green Slough, including pile installation • Hoisting pre-assembled deck segments from barges in the river or land-based transport system • Constructing approach spans (concrete deck slab on steel or concrete girder) • Constructing bridge towers and installing support cables and land-based equipment • Installing retaining walls | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Increased air emissions through the construction phase of the Project, primarily from operation of diesel or gas-powered equipment • Increased noise and vibration levels for individuals residing in close proximity to the source, or in other areas such as parks, places of worship, educational facilities, or medical facilities |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---|---------------------|---|--|
| Highway 99 improvements, including interchange upgrades | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Replacement of interchanges at Westminster Highway, Steveston Highway and Highway 17A • Replacement of over/underpasses at Cambie Road, Shell Road, Highway 91 Westbound Ramp, Blundell Road, Ladner Trunk Road and 112th Street • Highway widening from Bridgeport in Richmond to Highway 91 in Delta including construction of embankments, placing and compacting fill for road base, establishing improved drainage and paving | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Increased air emissions through the construction phase of the Project, primarily from operation of diesel or gas-powered equipment • Increased noise and vibration levels for individuals residing in close proximity to the source, or in other areas such as parks, places of worship, educational facilities, or medical facilities |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|---------------------------------------|---------------------|--|--|
| Tunnel decommissioning | No interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Removing electrical/mechanical/utilities equipment from the Tunnel • Removing of four Tunnel segments and associated scour protection • Backfilling of onshore portions of Tunnel approaches • Transporting Tunnel elements for offsite disposal, and operating support vessels for that activity | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Increased air emissions through the construction phase of the Project, primarily from operation of diesel or gas-powered equipment • Increased noise and vibration levels for individuals residing in close proximity to the source, or in other areas such as parks, places of worship, educational facilities, or medical facilities |
| Decommissioning of Deas Slough Bridge | No Interaction | <ul style="list-style-type: none"> • N/A | N/A |
| | No effect | <ul style="list-style-type: none"> • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Removal of Deas Slough Bridge including substructures | <p>Potential Project-related effects include:</p> <ul style="list-style-type: none"> • Increased air emissions through the construction phase of the Project, primarily from operation of diesel or gas-powered equipment • Increased noise and vibration levels for individuals residing in close proximity to the source, or in other areas such as parks, places of worship, educational facilities, or medical facilities |

| Project Phase/Component | Interaction Ranking | Project Works and Activities that Interact with the VC | Nature of Potential Interaction |
|----------------------------------|----------------------------|---|--|
| Operation and Maintenance | | | |
| Highway 99 and interchanges | No interaction | • N/A | N/A |
| | No effect | • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Operating reconfigured Highway 99 and interchanges • Highway 99 and interchange maintenance (drainage maintenance, winter maintenance, emergency maintenance, road cleaning, etc.) | Potential Project-related effects include: <ul style="list-style-type: none"> • Changes in noise levels associated with changes in traffic patterns following Project completion for individuals residing in close proximity to the source, or frequenting other areas such as parks, places of worship, educational facilities, or medical facilities • Change in inhalation exposure to COPC in air, or ingestion/dermal exposures to COPC in soil, plants, and livestock, resulting from an increase in air emissions. |
| | Effect of high consequence | • N/A | N/A |
| New bridge | No interaction | • N/A | N/A |
| | No effect | • N/A | N/A |
| | Potential effect | <ul style="list-style-type: none"> • Operating the new bridge • Bridge maintenance (winter maintenance, emergency maintenance, structure maintenance, etc.) | Potential Project-related effects include: <ul style="list-style-type: none"> • Changes in noise levels associated with changes in traffic patterns following Project completion for individuals residing in close proximity to the source, or frequenting other areas such as parks, places of worship, educational facilities, or medical facilities |

“N/A” indicates that no Project works and/or activities are applicable to the category

APPENDIX B

Human Health Risk Assessment – Air Quality

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Attachment A Toxicity Profiles

Attachment B Predicted Air Concentrations and Risk Quotient Values – All Receptor Locations

Abbreviations and Acronyms

| Term | Definition |
|------------------------------------|---|
| $\mu\text{g}/\text{kg}/\text{day}$ | microgram per kilogram body weight per day |
| $\mu\text{g}/\text{m}^3$ | microgram per cubic metre |
| COPC | chemicals of potential concern |
| COPD | chronic obstructive pulmonary disease |
| DPM | diesel particulate matter |
| Hg | mercury |
| K_{ow} | octanol-water partition coefficient |
| MOVES | U.S. EPA Motor Vehicle Emissions Simulator |
| MPOI | maximum point of impingement |
| NH_3 | ammonia |
| NO_2 | nitrogen dioxide |
| NOAEL | no observable adverse effect level |
| OEHHA | Office of Environmental Health Hazard Assessment (California EPA) |
| PAH | polycyclic aromatic hydrocarbon |
| PM_{10} | particulate matter less than 10 microns |
| $\text{PM}_{2.5}$ | particulate matter less than 2.5 microns |
| RIVM | Netherlands National Institute of Public Health and the Environment |
| RQ | risk quotient |
| SO_2 | sulphur dioxide |
| VOC | volatile organic compound |

Glossary

| Term | Definition |
|------------------------------|--|
| acute | Short-term or less than or equal to (\leq) 24 hours. |
| carcinogen | A cancer-causing substance or agent including chemicals or contaminants. |
| cardiovascular disease | A disorder of the heart and/or blood vessels. |
| chronic | Long-term (annual average). |
| hypertension | A condition, also referred to as high blood pressure, where arteries have persistently elevated blood pressure. |
| maximum point of impingement | The locations where the highest chemical concentrations in the air are predicted to occur within the boundaries of the study area. |
| receptor | A site for which air concentrations have been modelled. Air concentrations were modelled for 51 discrete human receptor locations within the study area. These receptor locations are representative of areas where people may spend extended periods of time (daycares, places of worship, parks) or live (acreages, farms, residences, and an assisted-living facility). |
| respiratory disease | Diseases affecting any of the structures and organs that have to do with breathing, including the nasal cavities, the pharynx (or throat), the larynx, the trachea (or windpipe), the bronchi and bronchioles, the tissues of the lungs, and the respiratory muscles of the chest cage. |
| risk quotient | A value or ratio used to describe the comparison of chemical exposure to a chemical exposure limit. An RQ value less than or equal to one ($RQ \leq 1$) indicates that the total predicted exposure is at or below the recommended exposure limit. A value greater than one ($RQ > 1$) may indicate that predicted exposure is above the recommended exposure limit. |

1.0 Scope and Objectives

This technical volume provides the technical details of the Human Health Risk Assessment (HHRA) for air emissions undertaken in 2014 to support the Project assessment. The HHRA objectives, methods, and findings are described. The HHRA draws significantly from the results of the air quality studies, as described in **Section 4.9 Air Quality**. Only the details pertaining to HHRA are provided in this appendix.

The purpose of this HHRA was to evaluate the potential for adverse effects on human health as a result of Project-related changes in air emissions. The study components, major objectives, and a brief overview are provided in **Table 1** and discussed below.

A starting point for the HHRA was the review and compilation of relevant health indicator data reported in recent studies of community and regional health. These data were used to describe existing conditions of current health within the region potentially affected by the Project (i.e., the City of Richmond and Corporation of Delta) and allowed for comparisons with the health status at the regional, provincial, and federal levels.

There is no formalized approach to HHRA for environmental assessment recommended by the B.C. Environmental Assessment Office; however, guidance on HHRA for environmental impact assessments in Alberta is available from the Government of Alberta (AHW 2011). Health Canada (2010) has issued general guidance on key elements for the assessment of potential effects of a proposed project on human health. Health Canada (2012) also provides detailed risk assessment guidance for federal contaminated sites. This HHRA for air quality generally follows the approaches recommended in these guidance documents.

Consideration was given to the predicted acute (short-term or less than or equal to 24 hours) and chronic (annual average) airborne concentrations of chemicals identified in emission sources related to the Project. Potential human exposures to Project emissions were characterized based on lifestyles, land uses, or activities that could attract people to locations within the vicinity of the Project. Individuals assumed to be exposed to Project emissions include local residents, farmers, and people involved in recreational activities within the study area. All individuals were assumed to be exposed to Project emissions via inhalation of air.

Potential health risks were characterized by comparing predicted exposures to chemicals in air, to human exposure limits defined in terms of air concentrations or chemical dose. The exposure limits used to evaluate human health risks were recommended by regulatory agencies, including Health Canada, the World Health Organization (WHO), and the U.S. EPA. These exposure limits are the best scientific and epidemiological estimates of safe levels of chemical exposure (i.e., without risk of adverse health effect).

The HHRA for air emissions incorporates layers of conservative assumptions in an effort to not underestimate potential exposure to chemicals in Project emissions. Regulatory agencies also incorporate uncertainty factors to ensure that exposure limits are protective of individuals who may be more sensitive to chemical exposure. The uncertainties associated with chemical exposures and chemical effects on human health were identified and conservative assumptions were made to bias the conclusions in the direction of being fully protective of human health in the face of any uncertainties.

Table 1 Study Components and Major Objectives

| Component | Major Objective(s) | Brief Overview |
|---------------------------------------|--|---|
| Existing Conditions Health Assessment | <ul style="list-style-type: none"> Describe existing conditions with respect to health within the region that may be potentially affected by Project emissions to air (i.e., Delta and Richmond). Compare health status indicators for the study region to health status indicators at the regional, provincial, and federal levels. | <ul style="list-style-type: none"> Identify and describe health indicators affected by changes in air quality, including asthma, lung cancer and respiratory disease. Identify and describe health indicator data for the region specifically, and for provinces and Canada as a whole. |
| Acute Inhalation Assessment | <ul style="list-style-type: none"> Characterize potential acute health risks associated with direct inhalation exposure to predicted short-term air concentrations (≤ 24 hours). Discuss the contribution of Project emissions to any acute health risks. | <ul style="list-style-type: none"> Identify chemicals in Project-related emissions that could potentially produce adverse health effects following acute inhalation. Identify receptor locations for short-term exposure duration. Quantify short-term exposure based on existing air quality conditions (2011), future air quality conditions (2031), without and with the Project, and measured ambient air concentrations. Compare predicted acute air concentrations to health-based, acute inhalation exposure limits. Describe and discuss the potential for health risks under the acute inhalation exposure scenarios considered. |
| Chronic Inhalation Assessment | <ul style="list-style-type: none"> Characterize potential chronic health risks associated with direct inhalation exposure to predicted long-term air concentrations (annual average). Discuss the contribution of Project emissions to any chronic health risks. | <ul style="list-style-type: none"> Identify receptors and chemicals for which potential adverse health effects could occur with long-term exposure to annual average air concentrations. Quantify long-term exposure based on existing air quality conditions (2011), future air quality conditions (2031), without and with the Project, and measured ambient air concentrations. Compare predicted chronic air concentrations to health-based chronic inhalation exposure limits. Describe and discuss the potential for health risks under the chronic inhalation exposure scenarios considered. |

2.0 Existing Health Data

2.1 Overview

The intent of the review of existing health data was to provide general information regarding the current health of individuals in communities potentially affected by the Project in the context of the health status for larger regions within B.C. and Canada. Existing studies were identified for communities in the study area (i.e., municipalities of Richmond and Delta), and elsewhere in B.C., other provinces and territories, and Canada as a whole. These studies were produced by the Fraser Health Authority, B.C. Ministry of Health, Statistics Canada, and Health Canada. Key health indicator data available for communities in the study area were compared to data available for populations at provincial, territorial, and federal levels.

Health indicators that could potentially be affected by changes in air quality were selected for evaluation. These indicators include cancer (all forms, including lung cancer), asthma, chronic obstructive pulmonary disease (COPD) including chronic bronchitis and emphysema, hypertension, cardiovascular disease including ischemic heart disease and congestive heart failure, and general respiratory systems disease. The prevalence of smoking in the populations under evaluation was also considered. The following criteria were used to measure the incidence of disease and mortality within a population:

- Age-standardized incidence rate (ASIR) – representing the incidence rate (i.e., per 100,000 individuals) for a specified condition, standardized to the age structure of the Canadian population to account for changes in age distribution over time.
- Age-standardized mortality rate (ASMR) – representing the rate of mortality resulting from a specified condition, standardized to the age structure of the Canadian population to account for changes in age distribution over time.
- Prevalence – representing the percentage of the population affected by a specified condition.

2.2 Health Data Comparison

Available health data from Statistics Canada (2013a, 2008) and the Canadian Cancer Society (2013) for B.C., other provinces and territories, and Canada as a whole were compared. Data from the Fraser Health Authority (2012) were used to compare the health status reported for individuals in the Corporation of Delta to those in the greater Fraser Health Authority region and in B.C. Data from Statistics Canada (2013a) were used to compare the health status of individuals in the City of Richmond (Richmond) to those in B.C.

The data for B.C. suggest lower disease incidence/mortality rates compared to Canada and other individual provinces and territories. Corporation of Delta (Delta) residents rank well on a number of health status indicators (i.e., lower incidence of or mortality from lung cancer, cardiovascular disease, respiratory disease, and COPD) compared to the Fraser Health Authority region and B.C. A notable exception is a higher prevalence of asthma and smoking. Richmond reports consistently lower age-standardized mortality rates, prevalence of disease (i.e., asthma), and smoking compared to B.C.

2.2.1 Canada, British Columbia, and other Provinces and Territories

Health indicator data available for lung cancer, cardiovascular disease, asthma, COPD, hypertension, and smoking prevalence are summarized in **Table 2**. Overall, the data for B.C. compare favourably (i.e., lower disease incidence/mortality rates) to the data for Canada and other provinces and territories.

The age-standardized 2012 incidence and mortality rates for lung cancer in B.C. (Canadian Cancer Society 2013) were below Canadian rates and ranked at or below the rates reported for all provinces and territories, with the exception of the Yukon (ASIR for males) and Ontario (ASMR for females).

The 2008 mortality rate for major cardiovascular disease (Statistics Canada 2008) and the prevalence of asthma and COPD in 2012 (Statistics Canada 2013b) were marginally higher in females from B.C. compared to Canada and some other provinces and territories. For males in B.C., the 2008 mortality rate for major cardiovascular disease and the 2012 prevalence of asthma and COPD were below the rates reported for Canada and the majority of other provinces and territories.

The hypertension incidence in B.C. males and females in 2012 was below the incidence rate reported for Canada and many other provinces and territories. The prevalence of smoking for both sexes in B.C. was below national, provincial, and territorial rates for 2012 (Statistics Canada 2013b).

Table 2 Health Status Data for Canada, British Columbia, and other Provinces and Territories

| Health Indicator | Canada | B.C. | AB | SK | MB | ON | QC | N.B. | N.S. | P.E.I. | NL | Y.T. | N.T. | NU |
|---|--------|-------|-------|-------|-------|-------|-------|-------|-------|--------|-------|-------|-------|-------|
| Age-Standardized Incidence Rates per 100,000 people – 2012^a | | | | | | | | | | | | | | |
| Lung Cancer | | | | | | | | | | | | | | |
| Males | 69 | 47 | 52 | 56 | 57 | 57 | 92 | 74 | 69 | 82 | 65 | 46 | 67 | 170 |
| Females | 48 | 40 | 44 | 48 | 50 | 43 | 56 | 45 | 56 | 45 | 38 | 65 | 60 | 152 |
| Age-Standardized Mortality Rates per 100,000 people | | | | | | | | | | | | | | |
| Lung Cancer - 2012 ^a | | | | | | | | | | | | | | |
| Males | 54 | 42 | 47 | 49 | 55 | 48 | 71 | 71 | 58 | 45 | 74 | 64 | 50 | 185 |
| Females | 36 | 33 | 33 | 37 | 37 | 32 | 43 | 42 | 41 | 48 | 38 | 54 | 49 | 156 |
| Major Cardiovascular Disease – 2008 ^b | | | | | | | | | | | | | | |
| Males | 187.1 | 180.1 | 206.6 | 224.6 | 231.1 | 184.5 | 167.1 | 189.2 | 210.2 | 225.1 | 250.9 | 252.0 | 247.4 | 296.5 |
| Females | 115.4 | 120.2 | 132.3 | 129.4 | 122.0 | 112.9 | 102.5 | 125 | 126.7 | 120.4 | 170.6 | 119.0 | 92.0 | 38.4 |
| Prevalence of Disease (% of population) – 2012^c | | | | | | | | | | | | | | |
| Asthma (age 12+ years) | | | | | | | | | | | | | | |
| Males | 6.8 | 5.8 | 7.1 | 7.5 | 6.3 | 6.7 | 7.1 | 8.1 | 8.0 | 5.5 | 6.7 | 9.3 | 4.9 | n/a |
| Females | 9.4 | 9.8 | 8.5 | 12.2 | 8.6 | 9.2 | 9.4 | 10.5 | 11 | 10 | 8.6 | 10.1 | 8.9 | n/a |
| Chronic obstructive pulmonary disease (COPD) (age 35+ years) | | | | | | | | | | | | | | |
| Males | 3.8 | 3.3 | 3.1 | 4.0 | 3.6 | 3.4 | 4.2 | 5.8 | 5.8 | 6.2 | 6.3 | n/a | n/a | n/a |
| Females | 4.6 | 4.9 | 4.0 | 5.7 | 5.2 | 4.4 | 4.8 | 5.8 | 4.6 | 5.2 | 3.1 | 4.9 | n/a | n/a |
| Hypertension (age 12+ years) | | | | | | | | | | | | | | |
| Males | 17.1 | 16.0 | 15.8 | 19.5 | 17.4 | 17.2 | 16.5 | 22.8 | 21.2 | 23.9 | 23.6 | 19.4 | 8.6 | 12.9 |
| Females | 17.6 | 16.6 | 16.6 | 17.9 | 16.1 | 17.1 | 18.4 | 23.8 | 23.9 | 17.5 | 21.6 | 8.9 | 10.7 | 13.2 |
| Prevalence of Smoking (% of population) – 2012^c | | | | | | | | | | | | | | |
| Smoking (age 12+ yrs) | | | | | | | | | | | | | | |
| Males | 23.1 | 15.6 | 25.4 | 19.4 | 21.1 | 21.9 | 27.4 | 27.4 | 26.6 | 24 | 30.8 | 30.8 | 37.4 | 58.2 |
| Females | 17.5 | 13.3 | 17.7 | 20.5 | 19.0 | 16.2 | 20.3 | 20.1 | 21.0 | 19.9 | 21.6 | 27.9 | 34.1 | 50 |

Notes: ^a Canadian Cancer Society (2013) ^b Statistics Canada (2008) ^c Statistics Canada (2013b)

2.2.2 British Columbia, the Fraser Health Authority Region, and Delta

Selected health indicators for B.C., the Fraser Health Authority region, and the Corporation of Delta are summarized in **Table 3**. The Fraser Health Authority region includes 36 per cent of the B.C. population as of 2012, and includes the communities of Delta, Langley, Surrey, White Rock, Abbotsford, Mission, Chilliwack, Hope, Agassiz/Harrison, Burnaby, Coquitlam, Maple Ridge, and New Westminster (B.C. Stats Socioeconomic Profiles 2012).

Overall, Delta residents ranked well on a number of health status indicators (i.e., lower incidence of or mortality from lung cancer, cardiovascular disease, respiratory disease, and COPD), compared to the Fraser region and B.C. A notable exception was the higher prevalence of asthma in Delta compared to the Fraser Health Authority region and B.C. Residents of Delta also had the highest smoking prevalence when compared to the Fraser Health Authority region and province of B.C. (Health & Business Analytics, Fraser Health Authority 2012).

Table 3 Health Status Data for British Columbia, the Fraser Health Authority Region, and Delta

| Health Indicator ¹ | B.C. | Fraser Health | Delta |
|---|------|---------------|-------|
| Age-Standardized Incidence Rates per 100,000 people – 2008 | | | |
| Lung Cancer (age 20+ years) | | | |
| Males | 77.1 | 76.8 | 60.6 |
| Females | 61.7 | 61.9 | 55.8 |
| Age-Standardized Mortality Rates per 10,000 people – 2006-2010 | | | |
| Cardiovascular disease | 10 | 10.4 | 9.9 |
| Respiratory disease | 5.0 | 5.3 | 4.6 |
| Prevalence of Disease (% of population) – 2010/2011 | | | |
| Asthma (age 5 to 54 years) | 9.9 | 10.6 | 11.5 |
| Cardiovascular disease | 3.1 | 3.3 | 3.3 |
| Hypertension (age 20+ years) | 18.5 | 19.7 | 19.8 |
| COPD (age 45+ years) | 5.4 | 5.1 | 4.3 |
| Prevalence of Smoking (% of population) – 2009 | | | |
| Smoking (age 12+ years) | 16 | 13.2 | 19.8 |

Note: ¹ Health & Business Analytics, Fraser Health Authority (2012)

2.2.3 British Columbia and Richmond

Selected health indicators available for B.C. and Richmond are summarized in **Table 4**. Richmond has consistently lower age-standardized mortality rates and prevalence of disease (i.e., asthma) compared to B.C. Prevalence of smoking in Richmond is also below that of B.C.

Table 4 Health Status Data for Richmond and British Columbia

| Health Indicator | Richmond | British Columbia |
|--|----------|------------------|
| Age-Standardized Mortality Rates per 100,000 people – 2005/2007 | | |
| Lung cancer | | |
| Males | 37.2 | 46.9 |
| Females | 27.6 | 35.0 |
| Respiratory diseases | | |
| Males | 47 | 56.5 |
| Females | 28.5 | 37.4 |
| Ischemic heart diseases | | |
| Males | 82.1 | 99.7 |
| Females | 39 | 51 |
| Cerebrovascular diseases | | |
| Males | 35.1 | 37.0 |
| Females | 25.3 | 32.9 |
| Prevalence of Smoking (% of population smoking daily) – 2011/2012 | | |
| Smoking (age 12+ years) | | |
| Males | 6.9 | 11.9 |
| Females | 9.3 | 10.3 |
| Prevalence of Disease (% of population) – 2005 to 2012 | | |
| Asthma (age 12+ years) | 6.0 | 7.9 |

Note: Retrieved from Statistics Canada (2013a).

3.0 Methods

The evaluation of human health risks associated with Project-related air emissions was carried out using methods recommended by the U.S. EPA (2005), the Government of Alberta (AHW, 2011), and Health Canada (2010; 2012), and followed the key steps illustrated in **Figure 1**.

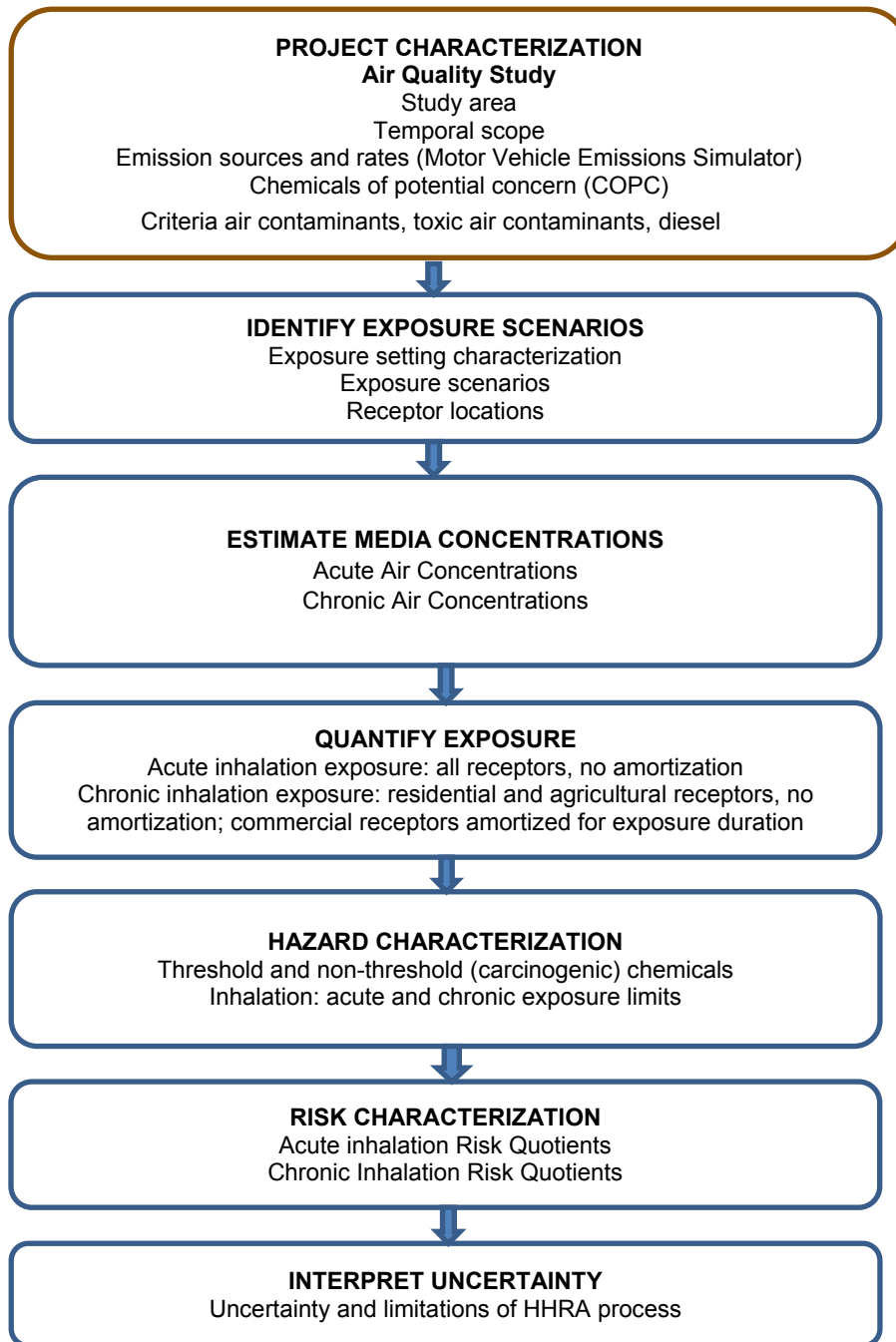


Figure 1 Human Health Risk Assessment Process (adapted from U.S. EPA 2005)

3.1 Project Characterization

3.1.1 Temporal Scope

The HHRA for air emissions accounts for temporal variability in air quality as a result of Project emissions. The HHRA for air emissions study reflects the methods and temporal scope described in **Section 4.9 Air Quality**, and evaluated potential human health risks associated with the existing (2011) conditions (including measured ambient air quality data from 2010), the future (2031) without the Project, and with the Project.

The HHRA focused on the potential health effects resulting from a change in future air quality conditions by comparing risk estimates for existing conditions to risk estimates for future conditions, without and with the Project. In addition, air concentrations as a result of emissions from the Project alone, represented by the difference between the future (2031) with the Project and the future without the Project, were considered for the assessment of incremental cancer risks associated with Project emissions (AHW 2011).

3.1.2 Project Emissions

The primary emission sources for the Project were considered to be vehicles travelling the Highway 99 corridor. The suspension of particulate matter (road dust) from the friction of tires on pavement was also considered. Vehicle emissions from traffic are influenced by the traffic pattern, volume, and vehicle fleet composition, as well as vehicle speed, fuel efficiency, and distance travelled, all of which were considered as part of **Section 4.9 Air Quality**. Vehicle emission estimates were calculated using the U.S. EPA (2012) Motor Vehicle Emissions Simulator (MOVES) computer modelling program, which generated emissions factors for highway motor vehicles and motorcycles fuelled by gasoline, diesel or compressed natural gas.

3.1.3 Chemicals of Potential Concern

All prioritized airborne contaminants associated with Project emissions were selected as chemicals of potential concern (COPC) for the evaluation of human health risks. The exceptions were parameters related to climate change or ground-level ozone formation, for which toxicity-based exposure guidelines were not available; i.e., greenhouse gases expressed as carbon dioxide equivalents, climate forcing particulate matter, volatile organic compounds (VOCs) expressed as a group, and the nitrogen oxides group, expressed as NO_x.

The COPC selected for the evaluation of human health risks are as follows:

- Sulphur dioxide (SO₂)
- Nitrogen dioxide (NO₂)
- Ammonia (NH₃)
- Carbon monoxide (CO)
- Particulate matter (PM₁₀ and PM_{2.5})
- Diesel particulate matter (DPM)
- Acetaldehyde
- Acrolein
- Benzene
- Benzo[a]pyrene (B[a]P)
- 1,3-butadiene
- Naphthalene
- Formaldehyde

The compounds considered in the HHRA for air emission include those that have been identified by the U.S. EPA (U.S. EPA 2007) as the most significant contributors to health risks as a result of breathing air toxins from mobile transportation sources (gasoline and diesel combustion engines) in outdoor air, including benzene, 1,3-butadiene, formaldehyde, acrolein, naphthalene, polycyclic organic matter, and diesel particulate matter. Acetaldehyde was added to the list of COPC based on its inclusion in the 2001 EPA priority mobile source air toxics list (California DOT 2014). Project emissions of polycyclic aromatic hydrocarbons (PAH) were represented by benzo[a]pyrene.

Although ozone is not directly emitted by vehicles, other chemicals and chemical groups in vehicle emissions could affect ozone formation as chemical precursors and catalysts in photochemical reactions (i.e., nitrogen oxides and VOCs). The study to support **Section 4.9 Air Quality** included an evaluation of the effect of Project emissions on ground-level ozone concentrations and concluded that the change in ozone concentrations would be negligible). Ozone was therefore not included as a COPC in the HHRA for air emissions.

The majority of COPCs are gaseous chemicals (NH₃, CO, NO₂, and SO₂), volatile organic compounds, or fine particulate matter (PM_{2.5}, PM₁₀ and DPM). These chemicals primarily occur in air and are not considered a health concern via exposures other than direct inhalation of air. However, some chemicals with limited volatility have the potential to deposit from air onto soil,

water and plants and may be subsequently accumulated in plant and animal tissue. Exposure limits for these chemicals have been developed based on systemic effects in humans that may occur following ingestion and dermal exposures.

Chemicals with sufficiently limited volatility to become deposited and accumulated in plant or animal tissues were identified based on the following physical-chemical properties (US EPA 2003):

- molecular weight \geq 200 grams/mole;
- Henry's Law Constant \leq 0.00001 atmosphere- m^3 /mole;
- vapour pressure \leq 0.001 mm Hg, and
- Log K_{ow} $>$ 3.5.

The only COPC that met all of these conditions was benzo[a]pyrene. Formaldehyde met the conditions for limited volatility but would not accumulate in plant or animal tissues (**Table 5**).

Table 5 Physical Chemical Properties of COPC Considered for Multi-media Assessment

| COPC | Volatility | | | Bioaccumulation | Reference |
|----------------|-------------------------------|--|--------------------------------------|-----------------|-------------|
| | Molecular Weight (grams/mole) | Henry's Law Constant (atmosphere- m^3 /mole) | Vapour Pressure (mm Hg) ¹ | Log Kow | |
| Acetaldehyde | 44.05 | 0.0000789 | 904.4 | 0.61 | US EPA 2005 |
| Formaldehyde | 30.03 | 0.000000336 | 5236.4 | 0.35 | US EPA 2005 |
| Acrolein | 56.06 | 0.00012 | 269.8 | -0.01 | US EPA 2005 |
| Benzene | 78.06 | 0.0056 | 95 | 2.1 | US EPA 2005 |
| Butadiene | 54.09 | 0.074 | 2110 | 1.99 | ATSDR 2012 |
| Benzo[a]pyrene | 252.32 | 0.0000011 | 5.50E-9 | 6 | US EPA 2005 |
| Naphthalene | 128.18 | 0.00048 | 0.08512 | 3.3 | US EPA 2005 |

¹Assuming 1 atmosphere = 760 mm Hg

Bold – meets criteria for limited volatility or bioaccumulation

3.2 Air Dispersion Modelling

Air dispersion modelling was conducted by WSP to predict air concentrations at discrete receptor locations where humans could be exposed to Project emissions. The air concentration data provided by WSP is summarised in **Attachment A**. Further details on emission sources and the air quality dispersion modelling approach are provided in **Section 4.9 Air Quality**. As described by in this section, conservative assumptions have been made in the assessment of air emissions and dispersion modelling, such that the predicted existing and future air concentrations of COPC have likely been overestimated rather than underestimated.

3.2.1 Exposure Setting

The study area to support the assessment encompassed a one-kilometre zone along Highway 99 footprint from Bridgeport Road in Richmond to Ladner Trunk Road in Delta, within which it is assumed that Project emissions will be dispersed and where measurable changes to air quality could occur. Current land uses overlapping the proposed Project components include agricultural, commercial, residential, and recreational. Land uses were assumed to remain the same in the future.

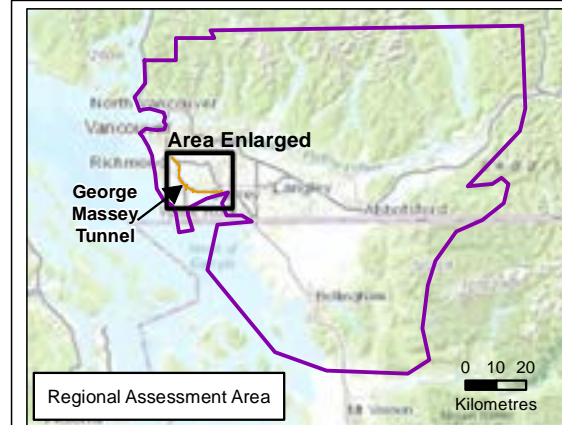
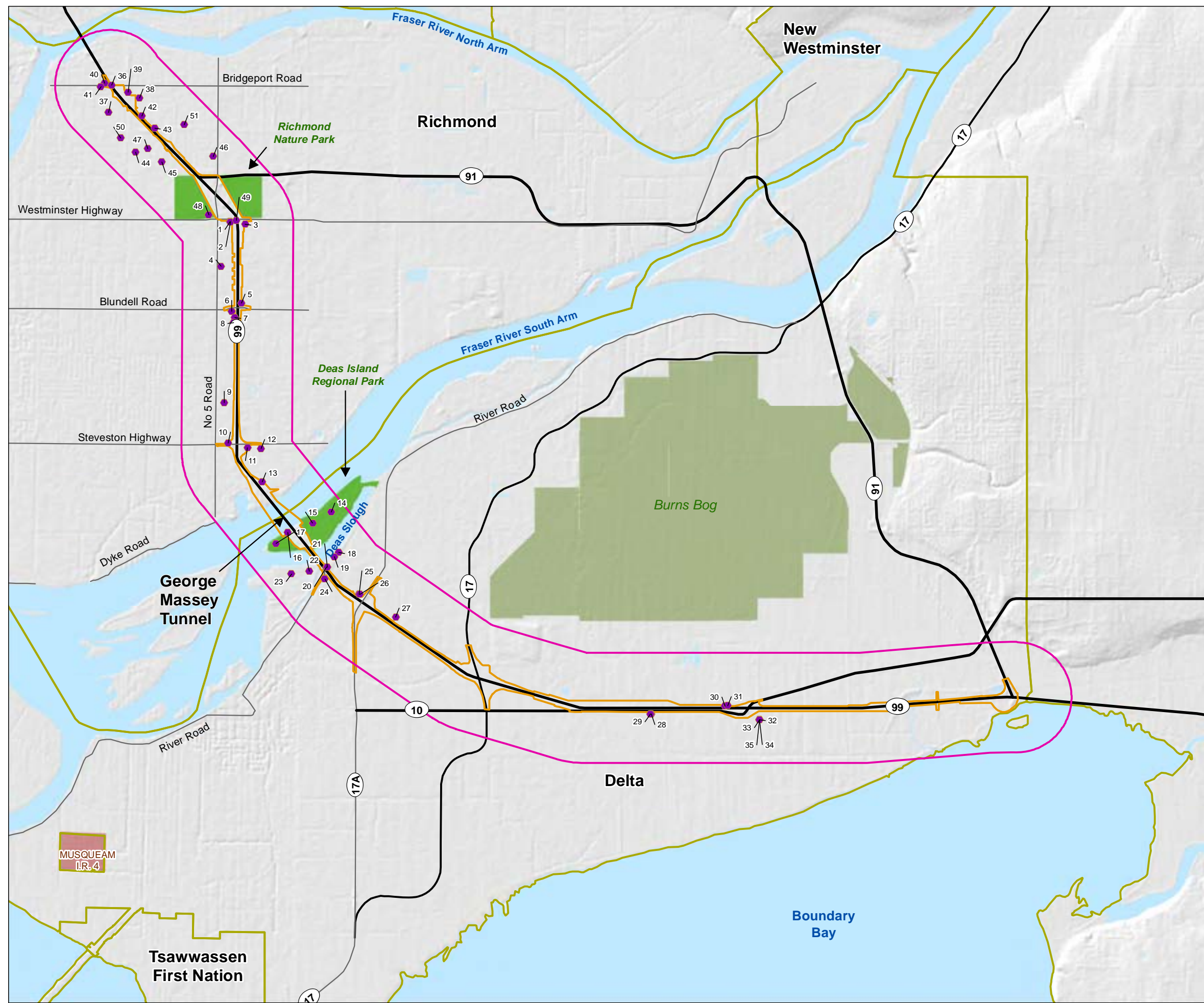
3.2.2 Receptor Locations

Air concentrations were modelled at 51 discrete human receptor locations within the study area. These receptor locations are representative of areas where people may spend extended periods of time (daycares, places of worship, parks), live (acreages, farms, residences, and an assisted-living facility) or work (commercial buildings). The land use for each of the 51 receptor locations is identified in **Table 6**. The receptors locations considered within Delta and Richmond are illustrated in **Figure 2**.

Table 6 Land Use for Receptor Locations Considered in the HHRA for Air Quality

| Agricultural Receptors | Commercial Receptor | Recreational Receptors | Residential Receptor |
|--|-----------------------------------|--|---|
| 1, 2, 3, 4, 5, 11, 12, 13 24, 27, 28, 29 32, 33, 34, 35 49 | 36, 38, 39, 40, 41, 42, 43, 46 | 14, 15, 16, 17 22 44, 45, 48 51 | 6, 7, 8, 9, 10, 18, 19, 20, 21 23, 25, 26 30, 31, 37 47 50 |

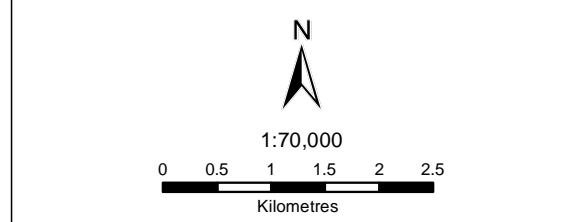
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- Legend**
- Air Quality Receptor Location
 - Air Quality Local Assessment Area
 - Air Quality Regional Assessment Area
 - Project Alignment
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

HHRA AIR QUALITY RECEPTOR LOCATIONS

| | |
|----------|------------|
| Figure 2 | 02/05/2016 |
|----------|------------|

In addition to the 51 discrete receptor locations, maximum points of impingement (MPOI) identified within the boundaries of Richmond and Delta were conservatively included for an assessment of acute, worst-case exposures. These MPOI represent the locations where the highest chemical concentrations in the air are predicted to occur. The highest air concentrations were predicted within five to 15 metres of the road in areas where there are a high number of vehicles. Under the existing conditions, and future conditions without the Project, this occurs at either entrance to the Tunnel.

3.3 Exposure Concentrations

3.3.1 Air

Ambient air quality was based on measured data available from air quality monitoring stations in the Lower Mainland operated by Metro Vancouver. These data were considered representative of baseline air quality in the Project Area. Ground-level air concentrations were predicted based on air dispersion modelling of existing (2011) emissions and future (2031) emissions, with and without the Project. Ambient and predicted air concentrations were available for acute (24 hours or less) and chronic (annual average) averaging periods, allowing for the assessment of the effects of short-term and long-term inhalation exposures.

Exposures to threshold (non-carcinogenic) COPC were estimated by adding upper estimates of ambient air concentrations with modelled air concentrations. For carcinogenic COPC, the incremental change in air concentration as a result of the Project (i.e., Future conditions with Project minus Future conditions without the Project) was considered in the estimate of incremental lifetime cancer risk, consistent with guidance by Health Canada and other agencies.

The ambient air data assumed for each exposure scenario and the predicted air concentrations (acute and chronic) for all receptor locations under existing (2011) and future (2031) conditions with and without Project are provided in **Attachment A**.

3.3.2 Media other than Air

Formaldehyde and B[a]P were identified as chemicals having the potential to deposit from air onto soil, water and plants. For the purpose of the HHRA, WSP conducted a modelling assessment of maximum predicted annual concentrations of formaldehyde and B[a]P on agricultural land (at least 20 m away from the roadway) in both Delta and Richmond. The predicted air concentrations for future emissions with the Project were compared to air concentrations for future emissions without the Project and baseline conditions. In all cases, the future scenario with the Project resulted in lower air concentrations (**Table 7**). Since the Project

results in a decrease in annual air concentrations of formaldehyde and B[a]P on agricultural land in Delta and Richmond, it would not result in additional exposures to these chemicals via media other than air. Therefore, the HHRA restricted the assessment of potential health risks associated with Project emissions to chemicals in air.

Table 7 Maximum Predicted Annual Concentrations (µg/m³) for B[a]P and Formaldehyde

| Location | Chemical | 2011 | Future with Project (2031) | Future without Project (2031) |
|----------|--------------|----------|----------------------------|-------------------------------|
| Delta | B[a]P | 1.71E-02 | 1.01E-02 | 5.75E-03 |
| | formaldehyde | 5.18E-01 | 4.01E-01 | 1.64E-01 |
| Richmond | B[a]P | 1.71E-02 | 1.09E-02 | 6.43E-03 |
| | formaldehyde | 5.82E-01 | 4.35E-01 | 1.83E-01 |

3.4 Quantifying Exposure

3.4.1 Inhalation Exposure Assessment

The HHRA for air emissions considered acute and chronic inhalation exposures to airborne concentrations of COPC predicted for existing (2011) conditions, and future (2031) conditions without and with the Project. Airborne concentrations predicted for the Project alone (future scenario with the Project minus future scenario without the Project) were considered for the assessment of chronic inhalation exposure to carcinogenic COPC.

For acute exposures, ambient air concentrations were added to the maximum predicted air concentrations resulting from vehicle emissions (existing and both future scenarios). Similar assumptions were made for chronic exposures to non-carcinogens, where relatively high (i.e., mean 24-hour concentrations) were assumed to represent annual (yearly) ambient air concentrations under the existing and future exposure scenarios. Therefore, it was conservatively assumed that (i) existing-scenario emissions do not contribute to measured ambient air concentrations, and (ii) there would be no improvements in ambient air quality under the future scenarios.

Acute inhalation exposures were assessed at the discrete receptor locations for agricultural, commercial, recreational and residential receptors, as well as at the predicted acute MPOI in Richmond and Delta. Acute or short-term exposures to Project COPC were assumed to range in duration from 10 minutes to 24 hours, depending on the length of the exposure period upon which the COPC toxicity reference value was derived.

Chronic exposures were assessed at the discrete receptor locations for residents, farmers and commercial workers, where long-term exposures would be expected. Chronic exposures of residents and farmers were based on predicted annual average air concentrations, and were assumed to occur 24 hours per day, 365 days per year, over a lifetime. Commercial receptors were assumed to be exposed for 8 hours per day, 5 days per week for 52 weeks per year, over a lifetime.

The predicted air concentration data (acute and chronic) for all receptor locations under existing (2011) and future (2031) conditions with and without Project, as well as for the alone, are provided in **Attachment A**. The ambient air data considered for acute and chronic inhalation exposures are also provided in this appendix.

3.5 Hazard Characterization

Hazard characterization is the process by which potential adverse health effects from exposure to a chemical are determined. The outcome of the hazard characterization process is the identification of an exposure level at or below which adverse health effects are unlikely to occur, i.e., an exposure limit, for each of the COPC in Project-related air emissions.

The relationship between chemical exposure and adverse response is characterized by a dose-response assessment, the outcome of which is a dose-response curve that provides a graphic illustration of the exposure levels at which adverse effects occur. An increase in exposure dose will generally result in an increase in response. The shape of the dose-response relationship is chemical-specific and endpoint-specific (i.e., specific to the response under evaluation).

A non-linear dose-response relationship suggests there is a threshold for toxicity, below which adverse health effects are not expected to occur. Non-linear dose-response relationships are observed for non-carcinogenic chemicals. Exposure limits for non-carcinogens are based on the identification of this threshold, for example, a no observable adverse effect level (NOAEL). Uncertainty factors are applied to a NOAEL to incorporate additional safety for the response of sensitive individuals and, where a threshold level is identified from an animal study, for the extrapolation of the observed effect in animals to humans, including adjustments for differences in exposure duration and exposure dose. Therefore, an exposure limit does not represent a threshold above which adverse health effects are expected to occur but rather incorporates a margin of safety so that the exposure limit is set well below any observed adverse effect level.

A linear dose-response relationship suggests there may be no threshold for adverse effects (i.e., exposure to any amount of chemical is assumed to result in a response). Linear dose-response relationships are assumed for carcinogenic chemicals and therefore the exposure limits developed for carcinogens are cancer-risk-specific and based on predictions of excess lifetime cancer risk. Public health agencies establish risk management levels for carcinogens based on an acceptable increase in lifetime cancer risk. Permissible lifetime cancer risk levels range from one in 10,000 to one in 1,000,000. Health Canada (2012) has determined that a cancer risk less than or equal to one in 100,000 is essentially negligible. Exposure limits for carcinogens were therefore derived such that the lifetime risk of cancer development as a result of carcinogen exposure would be essentially negligible (below one in 100,000 above existing cancer risk levels).

In the case of particulate matter (PM_{10} and $PM_{2.5}$), which represents a mixture of varying physical, biological, and chemical characteristics, the health effects evidence to date does not allow for identification of a threshold level below which adverse health effects are not observed. Population-based (epidemiological) studies have associated acute and chronic exposure to PM, particularly $PM_{2.5}$, with increased hospitalizations, respiratory and cardiac events, and mortality. Similar studies have provided evidence of health improvement with the reduction of airborne particulate concentrations. The exposure limits recommended for PM are intended to reduce health effects to a minimum (WHO 2013, 2014).

Exposure limits recommended by toxicologists and epidemiologists from a range of provincial, federal, and international regulatory agencies were reviewed for the identification of the most appropriate exposure limit for each COPC. These agencies include the following:

- Agency for Toxic Substances and Disease Registry (ATSDR)
- American Conference of Governmental Industrial Hygienists (ACGIH)
- B.C. Ministry of Environment (B.C. MOE)
- California Office of Environmental Health Hazard Assessment (OEHHA)
- Canadian Council of Ministers of the Environment (CCME)
- Health Canada
- Texas Commission on Environmental Quality (TCEQ)
- U.S. EPA
- World Health Organization (WHO)
- Netherlands National Institute of Public Health and the Environment (RIVM)

Exposure limits specific to acute and chronic inhalation exposure scenarios were reviewed for each COPC identified in Project-related emissions. The following attributes were reviewed and summarized for each chemical and available exposure limit:

- Key toxicology (animal) or epidemiology (human) study
- Primary effect or chemical mode of action
- Point of departure or starting point for subsequent extrapolations and analyses (lowest effect dose that is adequately supported by dose-response data)
- Dosimetric adjustments for animal to human exposures
- Uncertainty factors

In general, the most stringent exposure limit was used to determine the potential hazards associated with exposure to COPC in Project emissions to air, taking into consideration that derivation of the limit was adequately documented and scientifically defensible. The adopted exposure limits all include uncertainty factors that further reduced the presumed acceptable exposure limit for the protection of individuals who may be more sensitive to chemical exposure. The acute and chronic inhalation exposure limits are summarised below. Further details on each of the exposure limits identified for the HHRA are provided in **Attachment B**.

3.5.1 Acute Inhalation Exposure Limits

A summary of the exposure limits selected for the assessment of acute inhalation exposures to Project-related COPC is provided in **Table 8**. The averaging time, primary effect following acute inhalation exposure and the agency responsible for developing the selected exposure limit are also provided.

Table 8 Summary of Acute Inhalation Exposure Limits

| Chemical / Substance | Averaging Time | Acute Inhalation Exposure Limit ($\mu\text{g}/\text{m}^3$) | Health Endpoint | Agency |
|----------------------|----------------|--|--|-----------------|
| CO | 1 hr | 15,000 | Hypoxia | Health Canada |
| | 8 hr | 6,000 | | |
| NO ₂ | 1 hr | 188 | Respiratory irritation | U.S. EPA |
| SO ₂ | 10 min | 500 | <ul style="list-style-type: none"> • Change in pulmonary function • Respiratory irritation | WHO U.S. EPA |
| | 1 hr | 200 | | |
| PM _{2.5} | 24 hr | 25 | Increase in population mortality or morbidity | WHO |
| PM ₁₀ | 24 hr | 50 | Increase in population mortality or morbidity | WHO |
| Ammonia | 1 hr | 590 | Eye and respiratory irritation | TCEQ |
| Acetaldehyde | 1 hr | 470 | Respiratory irritation | OEHHA |
| Acrolein | 1 hr | 2.5 | Eye irritation | OEHHA |
| Benzene | 1 hr | 580 | Immunological | TCEQ |
| 1,3-butadiene | 1 hr | 660 | Developmental | OEHHA |
| | 24 hr | 15 | | U.S. EPA |
| Formaldehyde | 1 hr | 50 | Eye and nasal irritation | ATSDR |
| Naphthalene | 1 hr | 2,000 | Eye and respiratory irritation | ACGIH |

3.5.2 Chronic Inhalation Exposure Limits

The exposure limits selected for the assessment of chronic inhalation exposures to Project-related COPC are provided in **Table 9**, as well as the primary effect following chronic inhalation exposure, and the agency responsible for developing the selected exposure limit. The averaging time for all substances is annual.

Table 9 Summary of Chronic Inhalation Exposure Limits – Annual Averaging Time

| Chemical/ Substance | Chronic Inhalation Exposure Limit ($\mu\text{g}/\text{m}^3$) | Health Endpoint | Agency |
|-------------------------------|---|---|-----------------------------|
| NO ₂ | 40 | Respiratory illness in sensitive individuals | WHO |
| SO ₂ | 25 | Not described | B.C. MOE |
| PM _{2.5} | 6 | Increase in population morbidity or mortality | B.C. MOE Metro Vancouver |
| PM ₁₀ | 20 | Increase in population morbidity or mortality | WHO |
| DPM | 5 | Pulmonary inflammation | U.S. EPA |
| | 0.03 | Lung cancer | OEHHA |
| Ammonia | 200 | Pulmonary function | OEHHA |
| Acetaldehyde | 390 | Nasal irritation | Health Canada |
| | 3.7 | Nasal tumours | OEHHA |
| Acrolein | 2.7 | Nasal irritation | TCEQ |
| Benzene | 9.8 | Immunological/ hematological | ATSDR |
| | 1.3 | Leukemia | U.S. EPA |
| Benzo(a)pyrene (PAH group) | 0.00012 | Lung cancer | WHO |
| 1,3-butadiene | 2 | Ovarian atrophy | U.S. EPA |
| | 0.3 | Leukemia | |
| Formaldehyde | 9 | Eye, nasal, respiratory irritation | OEHHA |
| | 2 | Nasal tumors | Health Canada |
| Naphthalene | 3 | Nasal irritation | U.S. EPA |

Where an agency recommends non-cancer and cancer exposure limits for the same chemical, both endpoints were included in the assessment. The exposure limit for a non-cancer endpoint is generally higher (i.e., less conservative) compared to an exposure limit based on a cancer endpoint, however, it was important to consider the non-carcinogenic effects of all COPC for the evaluation of multiple chemical exposures, as described below.

3.5.3 Multiple Chemical Exposure

Chemical exposures do not occur in isolation of one another; therefore, when evaluating exposure to a group of chemicals it is important to consider the potential risks as a result of interactions between the chemicals. Possible chemical interactions include the following:

- Additive – combined effect of greater than or equal to two chemicals is equal to the sum of the individual effects)
- Antagonistic – effect of one chemical blocks or reduces the effect of another
- Synergistic – combined effect of greater than or equal to two chemicals is greater than the sum of the individual effects
- Potentiate – effect of one chemical significantly increases the effect of another (AHW 2011)

The scientific knowledge about interactive effects of exposure to multiple chemicals is very limited, especially considering the range of possible effects resulting from multiple combinations of chemicals at various exposure concentrations. Some headway has been made in the case of a few closely related groups of chemicals, for example, toxic potency equivalence factors have been derived for carcinogenic PAHs and polychlorinated dibenzo-p-dioxins and furans for the purpose of assessing the group using a single toxicity metric (U.S. EPA 1989, Health Canada 2012). The ATSDR (2004) and U.S. EPA (1999, 2000, 2007) also provide guidance to regulatory scientists for the assessment of chemical mixtures. In the absence of guidance specific to the interactions of the COPC considered in the HHRA for air emissions, the following Health Canada (2012) recommendations were assumed for the evaluation of chemical mixtures:

- Non-carcinogens – An additive interaction should be assumed for non-carcinogenic chemicals with similar target tissues and mechanisms of action. No interactions should be assumed between non-carcinogenic chemicals with unique and dissimilar mechanisms of action.
- Carcinogens – An additive interaction should be assumed for carcinogenic chemicals determined to have similar target tissues and mechanisms of action. No interaction should be assumed between carcinogenic chemicals with unique and dissimilar mechanisms of action, target organs, and/or forms of cancer.

For the purpose of the HHRA for air emissions, the interaction between chemicals with similar health endpoints (i.e., target tissues) was assumed to be additive, even though a similar mechanism of action on target tissues may not be clearly defined.

A summary of the chemical mixtures and health endpoints considered for acute inhalation and chronic inhalation exposures is provided in **Table 10**, based on the exposure limits and endpoints identified in **Table 8** and **Table 9**. Chemicals with clearly defined unique mechanisms of action or unique health endpoints were assessed individually.

Table 10 Chemical Mixtures

| Exposure Duration | Health Endpoint of Chemical Mixtures | COPC in Chemical Mixtures |
|--------------------|--------------------------------------|--|
| Acute Inhalation | Eye irritation | Acrolein Ammonia Formaldehyde Naphthalene |
| | Respiratory irritation | Acetaldehyde Naphthalene Nitrogen dioxide Sulphur dioxide |
| Chronic Inhalation | Nasal irritation | Acetaldehyde Acrolein Formaldehyde Naphthalene |
| | Nasal tumours | Acetaldehyde Formaldehyde Naphthalene |
| | Lung tumours | Diesel particulate matter Benzo[a]pyrene |
| | Leukemia | Benzene 1,3-butadiene |

3.6 Risk Characterization Method

Risk characterization involved the comparison of predicted receptor exposure to the exposure limit for each chemical identified in Project emissions. In the case of acute and chronic inhalation exposure to chemicals in air, receptor exposures were described as air concentrations (i.e., $\mu\text{g chemical}/\text{m}^3$ air). Acute exposure concentrations were compared to exposure limits defined in terms of acceptable air concentrations over an acute exposure duration (10 minutes, 1-hour, or 24 hours). Chronic exposure concentrations were directly compared to acceptable exposure limits for chronic exposure duration (i.e., 24 hours per day, 52 weeks a year over a lifetime). For commercial receptors, chronic exposure was assumed to occur 8 hours/day, 7 days/week for 42 weeks of the year.

A risk quotient (RQ) describes the comparison of chemical exposure to a chemical exposure limit and is used to determine if predicted exposures exceed recommended exposure limits. The RQ is inherently uncertain since it is based on predictions and assumptions in the case of both the exposure and toxicity estimates. Throughout the risk assessment process, conservative assumptions are made to address uncertainty and every attempt is made not to underestimate potential human health risks. The exposure assessment in particular is based on point estimates of predicted (modelled) air concentrations, which assume worst-case air emission and dispersion conditions. Inherent in the estimates of exposure, and subsequently health risk, is the assumption that an individual will inhale predicted outdoor air concentrations for time periods that extend beyond the duration most Canadians (but perhaps not Vancouverites) spend outdoors.

These conservative assumptions preclude the use of RQ values as measurements of health risk. Rather, the RQ value is useful as a screening tool to determine whether, having evaluated a worst-case scenario, assumptions of chemical exposure or the toxicity can be refined to a more realistic scenario. The health risk assessment can also be used to assist with identifying when and where risk management may be required.

3.6.1 Risk Quotients for Threshold Chemicals

For non-carcinogenic chemicals, inhalation exposure was defined by the sum of ambient (measured) air concentrations plus predicted air concentrations for the existing (2011), and both future (2031) emissions scenarios. Predicted exposures were compared to a threshold exposure limit expressed as reference concentration. The following is an example of an RQ equation for a threshold chemical under existing conditions:

$$\text{RQ} = \frac{\text{Ambient air concentration plus existing (2011) emissions } (\mu\text{g}/\text{m}^3)}{\text{Reference Concentration } (\mu\text{g}/\text{m}^3)}$$

An RQ value of less than or equal to one ($\text{RQ} \leq 1$) indicates that the total predicted exposure (considering various emission sources plus ambient levels) is at or below the recommended safe exposure limit for a non-carcinogen (AHW 2011). Considering the inherent conservatism in the risk assessment process, an RQ value greater than unity or one (i.e., >1) does not indicate that adverse health effects are expected to occur but rather, triggers the need for additional evaluation and discussion of the significance of the estimated risk within the context of the exposure and toxicity assumptions made in the HHRA (AHW 2011).

Although used as a predictor of risk, the RQ value for threshold (non-carcinogenic) chemicals does not reflect the magnitude of potential adverse health effect (or lack thereof), nor does it provide information on the specific probability that an adverse effect will occur. This type of information would require a more detailed investigation into the underlying dose-response curve for the exposure limit, or statistical analyses of exposure and toxicity.

3.6.2 Risk Quotients for Non-threshold Chemicals

For carcinogenic chemicals, inhalation exposure was defined by Project-only air concentrations (i.e., future with the Project minus future without Project). This allowed for an estimate of the incremental lifetime cancer risks specific to Project emissions. The RQ value for carcinogens compared the predicted Project-only air concentration to a risk-specific concentration as follows:

$$\text{RQ} = \frac{\text{Project-only Air Concentration } (\mu\text{g}/\text{m}^3)}{\text{Risk-Specific Concentration } (\mu\text{g}/\text{m}^3)}$$

An RQ value of less than or equal to one ($\text{RQ} \leq 1$) indicates that the incremental increase in lifetime cancer risk as a result of exposure to Project emissions is negligible (i.e., at or below one in 100,000). A risk-specific concentration for carcinogens is a measure of carcinogenic risk since it represents the slope factor of the dose-response curve. Therefore, RQ values for non-threshold carcinogens can be used to determine the potential magnitude of effect.

3.6.3 Chemical Mixtures

Individual RQs for chemicals assumed to interact additively were summed to determine the cumulative risks associated with multiple chemical exposures. For example, the RQ for chemicals determined to be respiratory irritants following acute (one-hour) exposures was determined as follows:

$$\text{Acute RQ}_{\text{respiratory irritants}} = \sum \text{acute RQ}_{\text{ammonia}} + \text{acute RQ}_{\text{acetaldehyde}} + \text{RQ}_{\text{naphthalene}} + \text{RQ}_{\text{NO}_2} + \text{RQ}_{\text{SO}_2}$$

4.0 Results

The result of the HHRA for air emissions is the characterization of risk (i.e., RQ) associated with receptor exposure to Project-related emissions. The maximum RQ values determined for acute and chronic inhalation exposures are provided in the sections below. RQ values determined for all 51 receptor locations identified in **Figure 2** are provided in **Attachment A**. The predicted RQ values are reported by exposure duration (acute versus chronic) for each receptor type (i.e., agricultural, residential, recreational and commercial) and at the MPOs for Richmond and Delta.

4.1 Acute Inhalation

4.1.1 Agricultural Receptors

The maximum acute inhalation RQ values determined for agricultural receptors are summarized in **Table 11**. All of the RQ values predicted for the future (2031) with Project conditions were <1 and lower than the RQ values predicted for existing (2011) and future (2031) without Project conditions.

Table 11 Acute Inhalation Risk Quotients – Agricultural Receptors

| Chemical / Substance | Averaging Time | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------------|----------------|-----------------|-------------------------------|----------------------------|
| Carbon monoxide | 1 hr | 0.6 | 0.5 | 0.3 |
| | 8 hr | 0.6 | 0.6 | 0.4 |
| Nitrogen dioxide | 1 hr | 0.8 | 0.7 | 0.7 |
| Sulphur dioxide | 10 min | 0.1 | 0.1 | 0.04 |
| | 1 hr | 0.1 | 0.1 | 0.1 |
| Ammonia | 1 hr | 0.1 | 0.04 | 0.03 |
| PM ₁₀ | 24 hr | 1 | 1.2 | 0.7 |
| PM _{2.5} | 24 hr | 0.8 | 0.8 | 0.5 |
| Acetaldehyde | 1 hr | 0.02 | 0.02 | 0.01 |
| Acrolein | 1 hr | 0.2 | 0.1 | 0.1 |
| Benzene | 1 hr | 0.03 | 0.02 | 0.01 |
| 1,3-butadiene | 1 hr | 0.003 | 0.002 | 0.001 |
| | 24 hr | 0.1 | 0.04 | 0.03 |
| Formaldehyde | 1 hr | 0.3 | 0.2 | 0.1 |
| Naphthalene | 1 hr | 0.001 | 0.001 | 0.001 |
| Eye Irritants ¹ | 1 hr | 0.5 | 0.4 | 0.3 |
| Respiratory irritants ² | 1 hr | 0.9 | 0.9 | 0.8 |

Notes: ¹ Combined one-hour RQ values for ammonia, acrolein, formaldehyde, and naphthalene.

² Combined one-hour RQ values for ammonia, acetaldehyde, naphthalene, nitrogen dioxide, and sulphur dioxide.

4.1.2 Residential Receptors

The maximum acute inhalation RQ values determined for residential receptors are summarized in **Table 12**. All of the RQ values predicted for the future (2031) with Project conditions were <1 and lower than the RQ values predicted for existing (2011) and future (2031) without Project conditions.

Table 12 Acute Inhalation Risk Quotients – Residential Receptors

| Chemical / Substance | Averaging Time | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------------|----------------|-----------------|-------------------------------|----------------------------|
| Carbon monoxide | 1 hr | 0.5 | 0.4 | 0.5 |
| | 8 hr | 0.5 | 0.4 | 0.4 |
| Nitrogen dioxide | 1 hr | 0.8 | 0.7 | 0.7 |
| Sulphur dioxide | 10 min | 0.1 | 0.1 | 0.05 |
| | 1 hr | 0.1 | 0.1 | 0.1 |
| Ammonia | 1 hr | 0.1 | 0.1 | 0.03 |
| PM ₁₀ | 24 hr | 0.9 | 0.9 | 0.8 |
| PM _{2.5} | 24 hr | 0.7 | 0.7 | 0.6 |
| Acetaldehyde | 1 hr | 0.02 | 0.02 | 0.02 |
| Acrolein | 1 hr | 0.3 | 0.2 | 0.1 |
| Benzene | 1 hr | 0.03 | 0.02 | 0.02 |
| 1,3-butadiene | 1 hr | 0.003 | 0.002 | 0.002 |
| | 24 hr | 0.04 | 0.04 | 0.04 |
| Formaldehyde | 1 hr | 0.3 | 0.2 | 0.1 |
| Naphthalene | 1 hr | 0.001 | 0.001 | 0.001 |
| Eye irritants ¹ | 1 hr | 0.6 | 0.5 | 0.3 |
| Respiratory irritants ² | 1 hr | 0.9 | 0.9 | 0.8 |

¹ Combined one-hour RQ values for ammonia, acrolein, formaldehyde, and naphthalene

² Combined one-hour RQ values for ammonia, acetaldehyde, naphthalene, nitrogen dioxide, and sulphur dioxide

4.1.3 Recreational Receptors

The maximum acute inhalation RQ values determined for recreational receptors are summarized in **Table 13**. All of the RQ values predicted for the future (2031) with Project conditions were <1 and lower than (or equal to in the case of PM₁₀) the RQ values predicted for existing (2011) or future (2031) without Project conditions.

Table 13 Acute Inhalation Risk Quotients – Recreational Receptors

| Chemical / Substance | Averaging Time | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------------|----------------|-----------------|-------------------------------|----------------------------|
| Carbon monoxide | 1 hr | 0.4 | 0.4 | 0.4 |
| | 8 hr | 0.4 | 0.4 | 0.3 |
| Nitrogen dioxide | 1 hr | 0.8 | 0.7 | 0.7 |
| Sulphur dioxide | 10 min | 0.1 | 0.1 | 0.04 |
| | 1 hr | 0.1 | 0.1 | 0.1 |
| Ammonia | 1 hr | 0.1 | 0.05 | 0.03 |
| PM ₁₀ | 24 hr | 0.7 | 0.7 | 0.7 |
| PM _{2.5} | 24 hr | 0.6 | 0.6 | 0.5 |
| Acetaldehyde | 1 hr | 0.02 | 0.02 | 0.02 |
| Acrolein | 1 hr | 0.2 | 0.2 | 0.1 |
| Benzene | 1 hr | 0.03 | 0.02 | 0.01 |
| 1,3-butadiene | 1 hr | 0.003 | 0.002 | 0.001 |
| | 24 hr | 0.04 | 0.03 | 0.03 |
| Formaldehyde | 1 hr | 0.3 | 0.2 | 0.1 |
| Naphthalene | 1 hr | 0.001 | 0.001 | 0.001 |
| Eye irritants ¹ | 1 hr | 0.5 | 0.4 | 0.3 |
| Respiratory irritants ² | 1 hr | 0.9 | 0.9 | 0.8 |

Notes: ¹ Combined one-hour RQ values for ammonia, acrolein, formaldehyde, and naphthalene.

² Combined one-hour RQ values for ammonia, acetaldehyde, naphthalene, nitrogen dioxide, and sulphur dioxide.

4.1.4 Commercial Receptors

The maximum acute inhalation RQ values determined for commercial receptors are summarized in **Table 13**. All of the RQ values predicted for the future (2031) with Project conditions were <1 and lower than (or similar to in the case of CO and PM) the RQ values predicted for existing (2011) or future (2031) without Project conditions.

Table 14 Acute Inhalation Risk Quotients – Commercial Receptors

| Chemical / Substance | Averaging Time | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------------|----------------|-----------------|-------------------------------|----------------------------|
| Carbon monoxide | 1 hr | 0.07 | 0.06 | 0.06 |
| | 8 hr | 0.08 | 0.08 | 0.08 |
| Nitrogen dioxide | 1 hr | 0.2 | 0.16 | 0.2 |
| Sulphur dioxide | 10 min | 0.01 | 0.01 | 0.01 |
| | 1 hr | 0.01 | 0.01 | 0.01 |
| Ammonia | 1 hr | 0.01 | 0.005 | 0.005 |
| PM ₁₀ | 24 hr | 0.2 | 0.17 | 0.17 |
| PM _{2.5} | 24 hr | 0.1 | 0.13 | 0.1 |
| Acetaldehyde | 1 hr | 0.00 | 0.003 | 0.003 |
| Acrolein | 1 hr | 0.03 | 0.02 | 0.02 |
| Benzene | 1 hr | 0.004 | 0.002 | 0.002 |
| 1,3-butadiene | 1 hr | 0.0004 | 0.0003 | 0.0003 |
| | 24 hr | 0.01 | 0.01 | 0.01 |
| Formaldehyde | 1 hr | 0.04 | 0.04 | 0.03 |
| Naphthalene | 1 hr | 0.0001 | 0.0001 | 0.0001 |
| Eye irritants ¹ | 1 hr | 0.08 | 0.06 | 0.06 |
| Respiratory irritants ² | 1 hr | 0.19 | 0.18 | 0.2 |

Notes: ¹ Combined one-hour RQ values for ammonia, acrolein, formaldehyde, and naphthalene.

² Combined one-hour RQ values for ammonia, acetaldehyde, naphthalene, nitrogen dioxide, and sulphur dioxide.

4.1.5 Maximum Point of Impingement in Delta

The highest acute inhalation RQ values determined at the MPOI in Delta are summarized in **Table 15**. The Delta MPOI represents the location where the greatest impact on acute air quality conditions could occur in the Corporation of Delta as a result of predicted existing (2011) and future (2031) emissions both without and with the Project.

For the majority of chemicals, RQ values at the Delta MPOI were ≤ 1 . The lowest RQ values were determined for predicted future (2031) conditions with the Project compared to existing (2011) conditions or future (2031) conditions without the Project. Under the predicted existing (2011) conditions, RQ values of 2 were determined for PM₁₀, and combined exposure to eye irritants. Under the future (2031) conditions without the Project, an RQ value of 2 was determined for PM₁₀.

Table 15 Acute Inhalation Risk Quotients – Delta Maximum Point of Impingement

| Chemical / Substance | Averaging Time | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------------|----------------|-----------------|-------------------------------|----------------------------|
| Carbon monoxide | 1 hr | 1 | 1 | 0.8 |
| | 8 hr | 1 | 0.9 | 0.6 |
| Nitrogen dioxide | 1 hr | 0.8 | 0.8 | 0.7 |
| Sulphur dioxide | 10 min | 0.1 | 0.1 | 0.06 |
| | 1 hr | 0.2 | 0.2 | 0.09 |
| Ammonia | 1 hr | 0.2 | 0.2 | 0.06 |
| PM ₁₀ | 24 hr | 2 | 2 | 1 |
| PM _{2.5} | 24 hr | 1 | 1 | 0.8 |
| Acetaldehyde | 1 hr | 0.05 | 0.03 | 0.01 |
| Acrolein | 1 hr | 0.7 | 0.4 | 0.08 |
| Benzene | 1 hr | 0.1 | 0.06 | 0.03 |
| 1,3-butadiene | 1 hr | 0.01 | 0.005 | 0.003 |
| | 24 hr | 0.08 | 0.05 | 0.04 |
| Formaldehyde | 1 hr | 0.7 | 0.5 | 0.1 |
| Naphthalene | 1 hr | 0.003 | 0.002 | 0.001 |
| Eye irritants ¹ | 1 hr | 2 | 1 | 0.3 |
| Respiratory irritants ² | 1 hr | 1 | 1 | 0.9 |

Notes: Values in **bold**: RQ >1

¹ Combined one-hour RQ values for ammonia, acrolein, formaldehyde, and naphthalene

² Combined one-hour RQ values for ammonia, acetaldehyde, naphthalene, nitrogen dioxide, and sulphur dioxide

4.1.6 Maximum Point of Impingement in Richmond

The highest acute inhalation RQ values determined at the MPOI in Richmond are summarized in **Table 16**. The Richmond MPOI represents the location where the greatest impact on air quality could occur in the City of Richmond as a result of predicted existing (2011) and future (2031) emissions conditions both without and with the Project.

For the majority of chemicals, RQ values were ≤ 1 at the Richmond MPOI, with the lowest RQ values determined for predicted future (2031) conditions with the Project. Similar to the results for Delta, RQ values of 2 were determined for PM₁₀, and combined exposure to eye irritants under existing condition and an RQ value of 2 was determined for PM₁₀ under future without Project conditions.

Table 16 Acute Inhalation Risk Quotients – Richmond Maximum Point of Impingement

| Chemical / Substance | Averaging Time | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------------|----------------|-----------------|-------------------------------|----------------------------|
| Carbon monoxide | 1 h | 1 | 1 | 0.8 |
| | 8 h | 0.9 | 0.8 | 0.6 |
| Nitrogen dioxide | 1 h | 0.8 | 0.8 | 0.7 |
| Sulphur dioxide | 10 min | 0.1 | 0.1 | 0.06 |
| | 1 h | 0.2 | 0.2 | 0.09 |
| Ammonia | 1 h | 0.2 | 0.2 | 0.06 |
| PM ₁₀ | 24 h | 2 | 2 | 1 |
| PM _{2.5} | 24 h | 1 | 1 | 0.8 |
| Acrolein | 1 h | 0.05 | 0.03 | 0.01 |
| Benzene | 1 h | 0.7 | 0.4 | 0.08 |
| 1,3-butadiene | 1 h | 0.1 | 0.06 | 0.03 |
| | 24 h | 0.01 | 0.005 | 0.003 |
| Acetaldehyde | 1 h | 0.07 | 0.05 | 0.04 |
| Formaldehyde | 1 h | 0.6 | 0.5 | 0.1 |
| Naphthalene | 1 h | 0.003 | 0.002 | 0.001 |
| Eye irritants ¹ | 1 h | 2 | 1 | 0.3 |
| Respiratory irritants ² | 1 h | 1 | 1 | 0.9 |

Notes: ¹ Combined one-hour RQ values for ammonia, acrolein, formaldehyde, and naphthalene

² Combined one-hour RQ values for ammonia, acetaldehyde, naphthalene, nitrogen dioxide, and sulphur dioxide

4.2 Chronic Inhalation: Non-carcinogenic Effects

The risk characterization results for chronic inhalation exposure are summarized in the sections and tables below for agricultural, residential and commercial receptor locations. Long-term exposures at recreational or MPOI locations are not expected to occur since there are no residences or permanent structures at these locations.

4.2.1 Agricultural Receptors – Non-carcinogenic Chemicals of Potential Concern

The maximum chronic inhalation RQ values for non-carcinogenic effects for agricultural receptors are provided in **Table 17**. For the majority of chemicals, RQ values were ≤ 1 , with the lowest values determined for predicted future (2031) conditions with the Project. An RQ value of 2 was determined for chronic exposure to NO₂ under existing conditions.

Table 17 Chronic Inhalation Risk Quotients for Non-carcinogenic Effects – Agricultural Receptors

| Chemical / Substance | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------|-----------------|-------------------------------|----------------------------|
| NO ₂ | 2 | 1 | 0.5 |
| SO ₂ | 0.1 | 0.1 | 0.1 |
| Ammonia | 0.0 | 0.01 | 0.004 |
| DPM | 0.3 | 0.1 | 0.1 |
| PM ₁₀ | 1 | 1 | 0.7 |
| PM _{2.5} | 1 | 1 | 0.7 |
| Acetaldehyde | 0.01 | 0.005 | 0.005 |
| Acrolein | 0.03 | 0.03 | 0.02 |
| Benzene | 0.2 | 0.1 | 0.1 |
| 1,3-butadiene | 0.1 | 0.1 | 0.05 |
| Formaldehyde | 0.3 | 0.2 | 0.2 |
| Naphthalene | 0.1 | 0.1 | 0.1 |
| Nasal irritants ¹ | 0.4 | 0.4 | 0.3 |

Notes: Values in **bold**: RQ >1

¹ Combined annual RQ values for acetaldehyde, acrolein, formaldehyde, and naphthalene

4.2.2 Residential Receptors – Non-carcinogenic Chemicals of Potential Concern

The maximum chronic inhalation RQ values for non-carcinogenic effects for residential receptors are provided in **Table 18**. All of the RQ values predicted for the future (2031) with Project conditions were ≤ 1 and lower than the RQ values predicted for existing (2011) or future (2031) without Project conditions.

Table 18 Chronic Inhalation Risk Quotients for Non-carcinogenic Effects – Residential Receptors

| Chemical | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------|-----------------|-------------------------------|----------------------------|
| NO ₂ | 1 | 0.7 | 0.6 |
| SO ₂ | 0.1 | 0.1 | 0.1 |
| Ammonia | 0.01 | 0.01 | 0.01 |
| DPM | 0.2 | 0.1 | 0.1 |
| PM ₁₀ | 0.9 | 0.9 | 0.8 |
| PM _{2.5} | 0.9 | 0.9 | 0.8 |
| Acetaldehyde | 0.005 | 0.005 | 0.005 |
| Acrolein | 0.03 | 0.03 | 0.02 |
| Benzene | 0.1 | 0.1 | 0.1 |
| 1,3-butadiene | 0.1 | 0.1 | 0.1 |
| Formaldehyde | 0.2 | 0.2 | 0.2 |
| Naphthalene | 0.1 | 0.1 | 0.1 |
| Nasal irritants ¹ | 0.4 | 0.4 | 0.3 |

Notes: ¹ Combined annual RQ values for acetaldehyde, acrolein, formaldehyde, and naphthalene

4.2.3 Commercial Receptors – Non-carcinogenic Chemicals of Potential Concern

The maximum chronic inhalation RQ values for non-carcinogenic effects for residential receptors are provided in **Table 19**. All of the RQ values predicted for the future (2031) with Project conditions were <1 and lower than (or similar to in the case of CO and PM) the RQ values predicted for existing (2011) or future (2031) without Project conditions.

Table 19 Chronic Inhalation Risk Quotients for Non-carcinogenic Effects – Residential Receptors

| Chemical | Existing (2011) | Future (2031) without Project | Future (2031) with Project |
|------------------------------|-----------------|-------------------------------|----------------------------|
| NO ₂ | 0.2 | 0.1 | 0.1 |
| SO ₂ | 0.02 | 0.02 | 0.02 |
| Ammonia | 0.001 | 0.001 | 0.001 |
| DPM | 0.04 | 0.03 | 0.03 |
| PM ₁₀ | 0.2 | 0.17 | 0.2 |
| PM _{2.5} | 0.2 | 0.17 | 0.2 |
| Acetaldehyde | 0.001 | 0.001 | 0.001 |
| Acrolein | 0.01 | 0.01 | 0.01 |
| Benzene | 0.02 | 0.02 | 0.02 |
| 1,3-butadiene | 0.01 | 0.01 | 0.01 |
| Formaldehyde | 0.05 | 0.05 | 0.05 |
| Naphthalene | 0.02 | 0.02 | 0.02 |
| Nasal irritants ¹ | 0.08 | 0.08 | 0.08 |

Notes: ¹ Combined annual RQ values for acetaldehyde, acrolein, formaldehyde, and naphthalene

4.3 Chronic Inhalation – Carcinogenic Effects

The risk characterization results for carcinogenic effects following chronic inhalation exposure to COPC defined as carcinogens were characterised for agricultural, residential and commercial receptors in **Table 20**. All of the maximum RQ values were well below 1.

Table 20 Chronic Inhalation Risk Quotients for Carcinogenic Effects

| Chemical | Agricultural Receptors | Residential Receptors | Commercial Receptors |
|----------------------------|------------------------|-----------------------|----------------------|
| Acetaldehyde | 0.003 | 0.006 | 0.00005 |
| Benzene | 0.03 | 0.05 | 0.0004 |
| DPM | 0.07 | 0.2 | 0.0008 |
| Benzo[a]pyrene | 0.04 | 0.08 | 0.0007 |
| 1,3-butadiene | 0.01 | 0.02 | 0.0002 |
| Formaldehyde | 0.006 | 0.01 | 0.0001 |
| Naphthalene | 0.04 | 0.08 | 0.0007 |
| Leukemia ¹ | 0.1 | 0.2 | 0.002 |
| Lung tumours ² | 0.009 | 0.02 | 0.0002 |
| Nasal tumours ³ | 0.003 | 0.006 | 0.00005 |

Notes: ¹ Combined annual RQ values for 1,3-butadiene and benzene

² Combined annual RQ values for benzo[a]pyrene and DPM

³ Combined annual RQ values for acetaldehyde, formaldehyde, and naphthalene

5.0 Discussion

An analysis of the uncertainties associated with the quantification of health risks, the assumptions made to reduce these uncertainties, and the potential effect of these assumptions on the quantification of risk was conducted for the HHRA for air emissions. The results indicate that predicted exposures to chemicals in air emissions are at or below exposure limits associated with adverse health risks for the majority of the chemicals, exposure scenarios, and receptor locations considered. Notably, the lowest RQ values were determined for predicted future (2031) conditions with the Project, which indicates that the lowest risks to human health were associated with the emissions scenario where the Project is completed.

5.1 Uncertainty Analysis

The goal of the HHRA for air emissions was to evaluate the potential for adverse effects on human health as a result of changes in air quality that were attributable to the Project. This was a predictive analysis and relied on assumptions to estimate receptor exposure, including use of modelled air concentrations, assumptions of chemical fate and transport, and use of generic receptor characteristics to describe lifestyles and behaviours that affect exposure potential. Uncertainty associated with various assumptions about chemical toxicity was reduced by the use of exposure limits recommended by authoritative regulatory agencies, generally following substantial scientific and peer review. The exposure limits identified for the HHRA were the most stringent and defensible of those available from regulatory agencies. The key uncertainties associated with predicting human health risks and the conservative assumptions made to minimize those uncertainties are summarized in **Table 21**.

Table 21 Key Uncertainties and Assumptions in the Human Health Risk Assessment for Air Quality

| Uncertainty | Assumption | Effect |
|---|---|---|
| Project emission estimates and dispersion of emissions under various meteorological conditions. | Exposure to the maximum predicted air concentrations based on air dispersion modelling of emissions. | Exposure and potential health risks likely overestimated. |
| Highest predicted air concentration may not occur at a discrete receptor location. | Inclusion of the MPOI within Delta and Richmond, despite the unlikelihood that receptors would spend time at these locations. | Exposure and potential health risks likely overestimated. |
| Exposure concentrations. | <ul style="list-style-type: none"> • Acute exposure concentrations were based on <i>predicted</i> (modelled) plus maximum <i>measured</i> ambient 98th percentile 24-hour concentrations. It is likely that emission sources (vehicle exhaust) contributing to measured acute air concentrations, were included in modelled acute air concentrations (i.e., double counted). • Chronic exposure concentrations included the highest measured mean 24-hour concentrations (a conservative estimate of annual air concentrations). It is likely that emission sources for ambient and modelled concentrations were likely double counted. • Existing ambient air concentrations were assumed to continue under future exposure scenarios, despite the prediction that improvements in vehicle technology will improve future ambient air quality. | Exposure and potential health risks likely overestimated. |
| Exposure duration. | No attenuation of exposure assumed for agricultural and residential receptors; e.g., continuous exposure to outdoor air 24 hours/day, seven days/week, 52 weeks/year. | Exposure and potential health risks likely overestimated. |

| Uncertainty | Assumption | Effect |
|--|---|--|
| Chemical toxicity | <p>Evaluation of a range of exposure limits from several regulatory agencies and selection of the most defensible and protective limit for non-carcinogenic effects.</p> <p>The limits selected include safety factors that are applied to the observed effect/response levels lowered to account for sensitive individuals (e.g., those with compromised respiratory systems).</p> | <p>Chemical toxicity and potential health risks associated with non-carcinogens are not likely to be underestimated.</p> |
| | <p>Evaluation of a range of exposure limits from several regulatory agencies and selection of the most defensible and protective limit for carcinogenic effects.</p> <p>The limits selected are based on an incremental increase in lifetime lung cancer risk of one in 100,000, considered by Health Canada to be a negligible increase in cancer risk.</p> | <p>Cancer risks are not likely to be underestimated.</p> |
| <p>Potential interaction between chemicals that share a similar health effect endpoint</p> | <p>An additive interaction was assumed for chemicals with similar health endpoints, despite lack of scientific evidence for additive effects.</p> | <p>Chemical group toxicity and potential health risks are likely to be overestimated.</p> |

In summary, all assumptions made in the evaluation of potential human health risks are such that chemical exposures and chemical toxicity (individual and group) were likely overestimated. No adverse health effects are expected to occur where an RQ value equal to or below unity (i.e., ≤ 1) is determined. It can be further concluded with high certainty that adverse health effects would not be associated with RQ values slightly above unity (i.e., between 1 and 2) predicted for the MPOI locations or for chemical groups, considering the exposure and toxicity assumptions inherent to these RQ values were very conservative and likely overestimate potential risk.

5.2 Risk Characterization Results

5.2.1 Acute Exposure Conditions

The maximum acute RQ values determined under existing (2011) exposure conditions were below 1 for agricultural, residential, commercial and recreational receptor locations. At the locations of the highest predicted acute air concentrations within Delta and Richmond (i.e., MPOI), RQ values were predominately ≤ 1 . The exceptions were RQ values of 2 predicted for exposure to PM_{10} and assuming combined exposure to eye irritants (i.e., RQ values added for ammonia, acrolein, formaldehyde, and naphthalene). The locations of these MPOI are located in close proximity to the tunnel entrances from Delta and Richmond.

The maximum acute RQ values determined for future (2031) exposure conditions, with and without the Project, were below 1 for agricultural, residential, commercial, recreational and MPOI locations. The lowest acute RQ values were determined for predicted future (2031) conditions with the Project compared to existing (2011) conditions or future (2031) conditions without the Project.

5.2.2 Chronic Exposure Conditions

The maximum chronic RQ values determined under existing exposure conditions were below 1 for residential and commercial receptors. A maximum RQ value of 2 was determined for agricultural receptor exposure to NO_2 . A closer examination of the results indicated that RQ values for chronic exposure to NO_2 were less than 1 for the majority (16/17) of the agricultural receptor locations evaluated. The maximum RQ value was predicted for location #49, near the interchange between the Westminster Highway and Highway 99 (**Figure 2**).

The maximum chronic RQ values determined for future (2031) exposure conditions, with and without the Project, were below 1 at agricultural, residential, and commercial receptor locations. The lowest chronic RQ values were determined for predicted future (2031) conditions with the Project compared to existing (2011) conditions or future (2031) conditions without the Project.

All RQ values determined for incremental exposure to carcinogens as a result of the Project alone (i.e., Future with Project minus Future without Project) were <1 indicating a negligible increase in cancer risk (i.e., <1 in 100,000) as a result of exposure to carcinogenic chemicals in Project emissions. Further review of the predicted annual air concentrations for carcinogens under future conditions with the Project versus without the Project, indicated an overall decline in the annual air concentrations of the following carcinogens: acetaldehyde (20 receptor locations), benzene and B[a]P (19 receptor locations), DPM (38 receptor locations), 1,3-butadiene (18 receptor locations) and formaldehyde (23 receptor locations).

5.3 Summary

No adverse effects on human health are predicted as a result of Project emissions to air. All RQ values determined for the future with Project scenario were below 1 and predominately less than, sometimes equal to, RQ values predicted under existing conditions or future conditions without the Project. Air concentrations were predicted to improve under future conditions, both without and with the Project, as a result of improvements in vehicle technology (i.e., lower emissions). The lowest air concentrations were predicted for future conditions with the Project, as a result of better airflow and dispersion of vehicle emissions with the new bridge compared to the Tunnel.

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ATTACHMENT A
Toxicity Profiles

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Acronyms

| | |
|--------------------|--|
| µg | Microgram |
| µg/kg/day | Microgram per kilogram body weight /day |
| µg/m ³ | Microgram per cubic metre |
| 95UCLM | 95 th upper confidence limit on the mean |
| AAQO | Ambient Air Quality Objective (Alberta) |
| ACGIH | American Conference of Governmental Industrial Hygienists |
| AENV | Alberta Environment |
| AESRD | Alberta Environment and Sustainable Resource Development |
| ATSDR | Agency for Toxic Substances and Disease Registry |
| BMC | Benchmark Concentration |
| BMCL ₀₅ | Benchmark Concentration, 95% Lower confidence limit of the concentration expected to produce a response rate of 5% |
| BMD | Benchmark Dose |
| BMDL ₀₅ | Benchmark Dose, 95% Lower confidence limit of the dose expected to produce a response rate of 5% |
| CCME | Canadian Council of Ministers of the Environment |
| COHb | Carboxyhemoglobin |
| COPC | Chemicals of Potential Concern |
| CR | Carcinogenic Risk (RIVM) |
| CWS | Canada-Wide Standards |
| d | day |
| DPM | Diesel Particulate Matter |
| EPA | Environmental Protection Agency |
| ESL | Effects Screening Level (TCEQ) |
| HEC | Human Equivalent Concentration |
| HHRA | Human Health Risk Assessment |
| HSDB | Hazardous Substances Databank |
| IARC | International Agency for Research on Cancer |
| ILCR | Incremental Lifetime Cancer Risk |
| IRIS | Integrated Risk Information System |
| LEC05 | Lower 95% confidence interval on the effective concentration associated with a 5% response rate |
| LOAEL | Lowest-observable-adverse-effects level |
| m ³ | cubic metre |

| | |
|-------------------|--|
| MAL | Maximum acceptable level (B.C. MOE) |
| MDL | Maximum desirable level (B.C. MOE) |
| mg | milligram |
| mg/kg | milligrams per kilogram |
| MOE | Ministry of Environment |
| mg/m ³ | milligram per cubic metre |
| MRL | Minimal Risk Level |
| NAAQO | National Ambient Air Quality Objective (Canada) |
| NAAQS | National Ambient Air Quality Standard (US) |
| NIOSH | National Institute of Occupational Safety and Health |
| NOAEL | No-observable-adverse-effects level |
| NTP | National Toxicity Program |
| OEHHA | Office of Environmental Health Hazard Assessment (California EPA) |
| OSHA | Occupational Safety and Health Administration |
| PAH | Polycyclic Aromatic Hydrocarbon |
| PEF | Potency equivalency factor |
| PHC | Petroleum hydrocarbon |
| PM _{2.5} | Particulate matter less than 2.5 microns in diameter (fine particulate matter) |
| PM ₁₀ | Particulate matter less than 10 microns in diameter (coarse particulate matter) |
| POD | Point of departure - A dose considered to be in the range of observed responses, without significant extrapolation. A POD can be a data point or an estimated point that is derived from observed dose-response data. A POD is used to mark the beginning of extrapolation to determine risk associated with lower environmentally relevant human exposures. |
| ppb | Parts per billion |
| ppm | Parts per million |
| REL | Reference Exposure Level (OEHHA) |
| ReV | Inhalation Reference Value (TCEQ) |
| RfC | Reference Concentration |
| RfD | Reference Dose |
| RIVM | Rijksinstituut Voor Volksgezondheid En Milieu (Dutch National Institute for Public Health and the Environment) |
| RQ | Risk Quotient |
| RsC | Risk Specific Concentration |
| RsD | Risk Specific Dose |
| TC | Tolerable Concentration |

| | |
|------------------|---|
| TC ₀₅ | Tumourigenic Concentration resulting in a 5% increase in the incidence of, or death due to, tumours |
| TCA | Tolerable Concentration in Air |
| TCEQ | Texas Commission on Environmental Quality |
| TD | Tolerable Dose |
| TDI | Tolerable Daily Intake |
| TD ₀₅ | Tumourigenic Dose resulting in a 5% increase in the incidence of, or death due to, tumours |
| TPHCWG | Total Petroleum Hydrocarbon Criteria Working Group |
| TRV | Toxicity Reference Value |
| US | United States |
| WHO | World Health Organization |

1.0 Introduction

Hazard identification is the process in which the potential adverse health effects resulting from exposure to a chemical agent are determined. The outcome of this process is the identification of a safe exposure level at which adverse health effects are not predicted to occur, that is, an exposure limit. This appendix describes the exposure limits identified for the assessment of human health effects associated with exposure to chemicals identified in Project emissions. Exposure limits specific to acute and chronic inhalation were reviewed for all chemicals identified in Project emissions. Exposure limits specific to the ingestion (oral) pathway were reviewed for non-volatile chemicals (i.e., benzo[a]pyrene and formaldehyde). Oral exposure limits were also assumed for the assessment of dermal exposure as exposure limits specific to dermal contact were not available.

1.1 Exposure Limit Selection

The following profiles describe the recommended exposure limits for airborne chemicals of potential concern (COPC) that are predicted to be released from the Project. For each of the chemicals identified, the available exposure limits recommended by the following provincial, federal and international regulatory agencies were reviewed:

- Agency for Toxic Substances and Disease Registry (ATSDR)
- British Columbia Ministry of Environment (B.C. MOE)
- California Office of Environmental Health Hazard Assessment (OEHHA)
- Canadian Council of Ministers of the Environment (CCME)
- Health Canada
- Metro Vancouver (MV)
- Texas Commission on Environmental Quality (TCEQ)
- United States Environmental Protection Agency (US EPA)
- World Health Organization (WHO)
- Netherlands National Institute of Public Health and the Environment (RIVM)

The following attributes were reviewed and summarised for each exposure limit:

- Key toxicology (animal) or epidemiology (human) study
- Primary effect or chemical mode of action
- Point of departure (POD) or starting point for subsequent extrapolations and analyses (lowest Effect dose that is adequately supported by dose-response data)
- Dosimetric adjustments for animal to human exposures
- Uncertainty factors

In general, the most stringent of exposure limits recommended for COPC in Project emissions were used in the HHRA, which included uncertainty factors that further reduced the acceptable exposure limit for the protection of individuals who may be more sensitive to chemical exposure.

1.2 Chemical Grouping

The primary health effect associated with the exposure limit selected for each individual chemical was reviewed and chemicals with similar endpoints (i.e., respiratory irritation) were grouped together and assumed to act in an additive manner. **Table 1-1** summarises the chemical groups for acute and chronic inhalation effects for the COPC evaluated in the current assessment. No groups were identified for the oral/dermal exposure pathway as the health endpoints for these COPC were unique to each chemical.

Table 1-1 Chemical Mixtures

| Exposure Duration | Health Endpoint of Chemical Mixtures | COPCs in Chemical Mixtures |
|--------------------|--------------------------------------|---|
| Acute Inhalation | Eye irritation | Acrolein |
| | | Formaldehyde |
| | | Naphthalene |
| | Respiratory irritation | Acetaldehyde |
| | | Naphthalene |
| | | Nitrogen Dioxide |
| | | Sulphur Dioxide |
| Chronic Inhalation | Nasal irritation | Acetaldehyde |
| | | Acrolein |
| | | Formaldehyde |
| | | Naphthalene |
| | Nasal tumours | Acetaldehyde |
| | | Formaldehyde |
| | | Naphthalene |
| | Lung tumours | Diesel Particulate Matter Benzo[a]pyrene |
| | Leukemia | 1,3-Butadiene |
| | | Benzene |

2.0 Acetaldehyde

2.1 Inhalation Exposure Limits

2.1.1 Acute Inhalation

Table 2-1 presents the acute inhalation exposure limits for acetaldehyde.

Table 2-1 Acute Inhalation Exposure Limits for Acetaldehyde

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|--------------------------|---|--|-----------------|--|---------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | 1-hour REL 8-hour REL | 470 300 | Respiratory irritation Nasal irritation | Humans and Rats | Prieto et al. 2000; Appelman et al. 1982; 1986 | OEHHA 2014; 2008 |
| TCEQ | 1-hour ESL | 15 | Odour | - | - | TCEQ 2014 |

- not available

The OEHHA (2014) recommend a 1-hour REL of $470 \mu\text{g}/\text{m}^3$ for acetaldehyde. This REL was derived from responses observed in asthmatic individuals following controlled, short-term (2-5 minutes) exposures to acetaldehyde (Prieto et al. 2000). A LOAEL of $142 \text{mg}/\text{m}^3$ for bronchoconstriction was identified from this study. The OEHHA (2008) applied a 300-fold uncertainty factor to this LOAEL account for use of a LOAEL (10), variability in human response ($\sqrt{10}$) and potential asthma exacerbation in children (10). This exposure limit was determined by the OEHHA (2008) to also be protective of potential eye irritation associated with acute exposure to acetaldehyde, following review of another controlled exposure study in humans (Silverman et al. 1946).

An 8-hour REL of $300 \mu\text{g}/\text{m}^3$ is also recommended for acetaldehyde by the OEHHA (2014). This REL was derived from a NOAEL of $270 \text{mg}/\text{m}^3$ for the degeneration of olfactory epithelium in rats intermittently exposed (6 hours/day, 5 days/week) to acetaldehyde over a 4 week period

(Appelman et al. 1982; 1986). The 8-hour REL was not considered for the acute exposure assessment as it was based on a subchronic exposure study and is intended for repeated 8-hour exposures.

The TCEQ (2014) recommend an acute (1-hour) ESL of 15 µg/m³ for acetaldehyde based on odour; no supporting documentation was provided for this ESL.

The OEHHA 1-hour REL of 470 µg/m³ was considered the most appropriate health-based guideline for the assessment of acute exposure to acetaldehyde as it was based on acute responses in humans and considered sensitive individuals. Although considered protective of eye and nasal irritation, the exposure limit was specific to respiratory irritation and therefore acetaldehyde was only included in the chemical group for respiratory irritation following acute inhalation exposures.

2.1.2 Chronic Inhalation

Table 2-2 presents the chronic inhalation exposure limits for acetaldehyde.

Table 2-2 Chronic Inhalation Exposure Limits for Acetaldehyde

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------------|---------|---|------------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | TC RsC | 390 17 | Nasal lesions Nasal tumours | Rat | Appelman et al. 1982; 1986 Woutersen et al. 1986 | Health Canada 2000 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | REL RsC | 140 3.7 | Nasal lesions Nasal tumours | Rat | Appelman et al. 1982; 1986 Woutersen et al. 1986 | OEHHA 2014; 2011; 2008 |
| RIVM | - | - | - | - | - | RIVM 2001 |

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|--------|---------------------|---|--------------------------------|---------|---|-------------|
| TCEQ | ESL | 45 | - | - | - | TCEQ 2014 |
| US EPA | RfC RsC | 9 5 | Nasal lesions Nasal tumours | Rat | Appelman et al. 1982; 1986 Woutersen and Appleman 1984 | US EPA 1991 |
| WHO | - | - | - | - | - | WHO 2000 |

- not available

IARC (2014) has classified acetaldehyde as possibly carcinogenic to humans (Group 2B). Health Canada (2000), the OEHHA (2011) and US EPA (1991) have established chronic inhalation guidelines based on evidence in rats of an association between chronic inhalation exposure to acetaldehyde and nasal tumours (Woutersen et al. 1986; Woutersen and Appleman, 1984). These agencies also established guidelines based on nasal lesions in rats (Appelman et al. 1982; 1986) following acetaldehyde inhalation.

Health Canada (2000) developed a TC of $390 \mu\text{g}/\text{m}^3$ for the noncarcinogenic effects of acetaldehyde following chronic inhalation exposure. This guideline was based on the Appelman et al. (1982; 1986) inhalation studies reporting nasal lesions in rats intermittently exposed (6 hours/day, 5 days/week) to acetaldehyde over a 4 week period. The THRESH program (Howe 1995) was used to calculate a BMC_{05} of $218 \text{ mg}/\text{m}^3$ for non-neoplastic lesions in the nasal olfactory epithelium of male rats. The BMC_{05} was adjusted for continuous exposure (6h/24h, 5d/7d) and an uncertainty factor of 100 applied to account for extrapolation from an animal study (10) and variability in human response (10) (Health Canada 2000). An additional uncertainty factor to account for use of a short term study was not considered appropriate based on evidence that there was *no indication that severity of the critical effects increases with duration of exposure* (Health Canada 2000).

A TC_{05} of $86 \text{ mg}/\text{m}^3$ was also recommended by Health Canada (2000) based on the incidence of tumours in the nasal cavity of rats exposed to acetaldehyde for 6 hours/day, 5 days/week over 28 months (Woutersen et al., 1986). The TC_{05} was derived using multistage modeling and adjusted for continuous exposure (Health Canada 2000). The TC_{05} is associated with a 5% increase in tumour incidence over background. Dividing the TC_{05} by a factor of 5,000 results in an RsC of $17 \mu\text{g}/\text{m}^3$ for a 1 in 100,000 incremental cancer risk level.

The OEHHA (2014) recommends an REL of 140 $\mu\text{g}/\text{m}^3$ for the noncarcinogenic effects of acetaldehyde following chronic inhalation exposure. This REL was derived from the same rat inhalation studies (Appelman et al. 1982; 1986) identified for the 8-hour OEHHA REL. A study NOAEL of 270 mg/m^3 for degeneration of olfactory epithelium was identified. The OEHHA (2008) applied benchmark modelling (US EPA 2003) to determine a BMC_{05} of 178 mg/m^3 for the incidence of degeneration of olfactory epithelium. The BMC_{05} was converted to a human equivalent concentration of 242 mg/m^3 using a pharmacokinetic model specific to acetaldehyde (Teeguarden et al. 2008) and adjusted for continuous exposure to result in a $\text{BMC}_{05\text{HEC}}$ of 43.2 mg/m^3 . A cumulative uncertainty factor of 300 was applied to account for subchronic exposure ($\sqrt{10}$), extrapolation from an animal study ($\sqrt{10}$), variability in human response ($\sqrt{10}$) and potential asthma exacerbation in children (10) (OEHHA 2008).

A unit risk factor of 0.0000027 per $\mu\text{g}/\text{m}^3$ was recommended for acetaldehyde by the OEHHA (2011). Similar to Health Canada, this risk factor was calculated from the incidence of nasal tumours in rats (obligate nose breathers) following exposure to acetaldehyde for 6 hours/day, 5 days/week and up to 28 months (Woutersen et al. 1986). However, the OEHHA (2011) also applied an interspecies surface area correction factor (based on relative bodyweight) to account for potential exposure of the entire human respiratory tract, including the lung. The unit risk factor translates to an RsC of 3.7 $\mu\text{g}/\text{m}^3$, assuming an acceptable incremental cancer risk of 1 in 100,000.

The TCEQ (2014) recommends a chronic ESL of 45 $\mu\text{g}/\text{m}^3$ for acetaldehyde; however, no supporting documentation was provided for this exposure limit.

The US EPA (1991) recommends an RfC of 9 $\mu\text{g}/\text{m}^3$ for acetaldehyde based on noncarcinogenic effects following chronic exposure. A NOAEL of 273 mg/m^3 for degeneration of olfactory epithelium was identified from the Appelman et al. (1982; 1986) studies. The US EPA adjusted the NOAEL for continuous exposure and calculated a $\text{NOAEL}_{\text{HEC}}$ of 8.7 mg/m^3 for a gas:respiratory effect in the extra thoracic region. A 1,000-fold uncertainty factor was applied to the $\text{NOAEL}_{\text{HEC}}$ to account for use of a subchronic study (10), extrapolation from an animal study/incompleteness of the database (10) and variability in human response (10).

The US EPA (1991) recommends a unit risk factor of 0.0000022 per $\mu\text{g}/\text{m}^3$ for acetaldehyde. This risk factor was calculated from the incidence of nasal tumours in rats following exposure to acetaldehyde for 6 hours/day, 5 days/week for 27 months (Woutersen and Appleman 1984). The unit risk factor translates to an RsC of 5 $\mu\text{g}/\text{m}^3$ assuming a 1 in 100,000 incremental cancer risk.

The TC of 390 µg/m³ recommended by Health Canada was selected for the evaluation of noncarcinogenic effects following chronic inhalation exposure to acetaldehyde. The Health Canada TC was considered more appropriate than the exposure limits recommended by the US EPA and OEHHA as the TC was developed using benchmark modelling to determine a POD (unlike the US EPA) and the study on which all of these guidelines were based did not indicate that an additional safety factor for use of a subchronic study (as assigned by the US EPA and OEHHA) was warranted. Acetaldehyde was included in the chemical group for nasal irritation following chronic inhalation exposures.

The RsC of 3.7 µg/m³ (OEHHA) was selected for the assessment of carcinogenic effects following chronic inhalation exposure to acetaldehyde. Both the OEHHA and Health Canada selected results from the more recently published Woutersen et al. (1986) study for the determination of a unit risk factor. The OEHHA accounted for the fact that humans are not obligate nose breathers and adjusted the unit risk estimate to take into account the greater surface area of the human respiratory tract. Acetaldehyde was included in the chemical group for nasal tumours following chronic inhalation exposures.

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3.0 Acrolein

3.1 Inhalation Exposure Limits

3.1.1 Acute Inhalation

Table 3-1 presents the acute inhalation exposure limits for acrolein.

Table 3-1 Acute Inhalation Exposure Limits for Acrolein

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|--------------------------|---|--|--------------|--|------------------|
| ATSDR | 1-hour MRL | 7 | Decreased respiratory rate; respiratory tract irritation | Human | Weber-Tschopp et al. 1977 | ATSDR 2013; 2007 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | 1-hour REL 8-hour REL | 2.5 0.7 | Eye irritation Respiratory irritation | Human Rat | Darley et al. 1960; Weber-Tschopp et al. 1977; Dorman et al., 2008 | OEHHA 2014; 2008 |
| TCEQ | 1-hour ReV | 11 | Decreased respiratory rate; eye and respiratory tract irritation | Human | Weber-Tschopp et al. 1977 | TCEQ 2014 |
| US EPA | - | - | - | - | - | US EPA 2003a |

- not available

The ATSDR (2013), OEHHA (2014) and TCEQ (2014) all recommend 1-hour exposure limits for acrolein based on eye, nasal and respiratory irritation reported in controlled human exposure studies (Weber-Tschopp et al. 1977; Darley et al. 1960). The US EPA do not recommend an acute exposure limit for acrolein but cites the clinical study by Weber-Tschopp et al. (1977) as the most comprehensive for describing the acute effects of acrolein inhalation in humans (US EPA 2003a).

The ATSDR (2013) 1-hour MRL for acrolein is $7 \mu\text{g}/\text{m}^3$. The MRL was based on a LOAEL of 0.3 ppm ($700 \text{ mg}/\text{m}^3$) for decreased respiratory rate as well as nose and throat irritation in human volunteers exposed to acrolein for 60 minutes (Weber-Tschopp et al. 1977). An uncertainty factor of 100 was applied to the LOAEL to account for use of a LOAEL (10) and variation in human response (10) (ATSDR 2007).

The OEHHA (2014) recommend a 1-hour REL of $2.5 \mu\text{g}/\text{m}^3$ for acrolein. The OEHHA (2008) identified a LOAEL of 0.06 ppm ($140 \mu\text{g}/\text{m}^3$) for eye irritation in human volunteers following short-term (5-minutes) exposure to acrolein (Darley et al. 1960). Ocular irritation was first reported by Weber-Tschopp et al. (1977) during 40 minutes exposure to increasing concentrations of acrolein at a similar LOAEL (0.07 ppm or $160 \mu\text{g}/\text{m}^3$). Acute REL values of 2.3 and $2.7 \mu\text{g}/\text{m}^3$ were determined for each study LOAEL after an uncertainty factor of 60 was applied to account for use of a LOAEL for a mild effect (6) and variation in human response (10). No time adjustment was made to the RELs as the critical effect was a sensory irritancy effect. The geometric mean of the REL values from these studies (i.e., $2.5 \mu\text{g}/\text{m}^3$) was selected as the 1-hour REL for acrolein (OEHHA 2008).

An 8-hour REL of $0.7 \mu\text{g}/\text{m}^3$ was also recommended for acrolein by the OEHHA (2014). This REL was based on a subchronic study where a NOAEL of 0.2 ppm ($465 \mu\text{g}/\text{m}^3$) was identified for lesions in the respiratory epithelium of rats exposed to acrolein 6 hours/day, 5 days/week over 65 days (Dorman et al. 2008). The 8-hour REL for acrolein was not considered for the acute exposure assessment as it was based on subchronic exposure data in animals and is intended for repeated 8-hour exposures.

An acute ReV of $11 \mu\text{g}/\text{m}^3$ is recommended for acrolein by the TCEQ (2014). Similar to the ATSDR (2007), the TCEQ (2010) identified a LOAEL of 0.3 ppm ($700 \text{ mg}/\text{m}^3$) for eye, nose, throat irritation and decreased respiratory rate in human volunteers exposed for 60 minutes to acrolein (Weber-Tschopp et al. 1977). An uncertainty factor of 63 was applied to the LOAEL to account for use of a LOAEL (6.3) and variation in human response (10) (TCEQ 2010).

The 1-hour exposure limit of 2.5 µg/m³ (OEHHA, 2008) was selected for the assessment of acute exposure to acrolein as it was based on the most sensitive human response (eye irritation) to acute acrolein exposure and supported by more than 1 study. This acute exposure limit for acrolein is considered very conservative. As described below, the limit identified for chronic exposure to acrolein, based on nasal lesions, is very similar to this 1-hour exposure limit. Although protective of nasal and respiratory irritation, the 1-hour exposure limit was specific to eye irritation and therefore acrolein was only included in the chemical group for eye irritation following acute inhalation exposures.

3.1.2 Chronic Inhalation

Table 3-2 presents the chronic inhalation exposure limits for acrolein.

Table 3-2 Chronic Inhalation Exposure Limits for Acrolein

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------|---------|--------------------|--------------------|
| ATSDR | - | - | - | - | - | ATSDR 2012 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | TC | 0.4 | Nasal Lesions | Rat | Cassee et al. 1996 | Health Canada 2000 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | REL | 0.35 | Nasal Lesions | Rat | Dorman et al. 2008 | OEHHA 2013; 2008 |
| RIVM | - | - | - | - | - | RIVM 2001 |
| TCEQ | ReV | 2.7 | Nasal Lesions | Rat | Dorman et al. 2008 | TCEQ 2014 |
| US EPA | RfC | 0.02 | Nasal Lesions | Rat | Feron et al. 1978 | US EPA 2003b |
| WHO | - | - | - | - | - | WHO 2000 |

- not available

Health Canada (2000) recommends a TC of $0.4 \mu\text{g}/\text{m}^3$ for chronic exposure to acrolein. The THRESH program (Howe 1995) was used to calculate a BMC_{05} of $0.14 \text{ mg}/\text{m}^3$, the air concentration representing a 5% increase in the incidence of nasal lesions in rats following inhalation (nose-only) exposure to acrolein for 6 hours/day over a 3 day period (Cassee et al. 1996). The BMC_{05} was adjusted for continuous exposure and an uncertainty factor of 100 applied to account for use of an animal study (10) and variability in human response (10). No uncertainty factor was applied for less than chronic exposure.

Health Canada (2000) noted the degenerative changes observed by Cassee et al. (1996) following short-term exposures were consistent with observations in longer term bioassays in rats (Feron et al. 1978) and hamsters (Feron and Krusysse, 1977).

The OEHHA (2014) recommend a chronic REL of $0.35 \mu\text{g}/\text{m}^3$ for acrolein. Similar to the 8-hour REL, the chronic REL was based on a NOAEL of 0.2 ppm ($465 \mu\text{g}/\text{m}^3$) for lesions in the respiratory epithelium of rats exposed to acrolein 6 hours/day, 5 days/week for 13 weeks (Dorman et al. 2008). The OEHHA (2008) calculated a $\text{NOAEL}_{\text{HEC}}$ of 0.03 ppm ($70 \mu\text{g}/\text{m}^3$) after adjusting the NOAEL for continuous exposure and applying a dosimetric adjustment factor (DAF) of 0.85 based on comparative modeling of gas flux in human and rat nasal passages with formaldehyde. An uncertainty factor of 200 was applied to account for extrapolation from an animal study ($\sqrt{10}$), use of a subchronic study ($\sqrt{10}$), variability in human response (10) and use of a DAF for formaldehyde, an analogue chemical, to determine the human exposure concentration for acrolein (2).

The TCEQ (2014) recommend an ReV of $2.7 \mu\text{g}/\text{m}^3$ for chronic exposure to acrolein. Similar to the OEHHA (2008), this guideline was based on a NOAEL of 0.2 ppm ($465 \mu\text{g}/\text{m}^3$) for hyperplasia of the respiratory epithelium of rats exposed to acrolein 6 hours/day, 5 days/week for 13 weeks (Dorman et al. 2008). The study investigated duration and concentration effects for several exposure groups and evaluated the histopathology and recovery of the respiratory tract post-exposure. The TCEQ (2014) calculated a $\text{NOAEL}_{\text{HEC}}$ of 35.7 ppb ($83 \mu\text{g}/\text{m}^3$) for acrolein after adjusting the NOAEL for continuous exposure. An uncertainty factor of 30 was applied to the $\text{NOAEL}_{\text{HEC}}$ account for extrapolation from an animal study (3) and variability in human response (10). No adjustment was made for use of a subchronic response as the TCEQ (2014) concluded that concentration played more of a role in the irritant effects of acrolein than duration of exposure. Unlike the OEHHA, the TCEQ (2014) did not consider the use of a DAF based on formaldehyde appropriate for acrolein due to differences in nasal dosimetry patterns for acrolein and formaldehyde and did not apply an additional 2-fold uncertainty factor for use of a DAF.

The US EPA (2003b) recommends an RfC of 0.02 $\mu\text{g}/\text{m}^3$ for acrolein based on a LOAEL of 0.9 mg/m^3 for nasal lesions in rats exposed to acrolein for 5 days/week over 13 days (Feron et al. 1978). The US EPA calculated a LOAEL (HEC) of 0.02 mg/m^3 after adjusting for continuous exposure and applied a 1000-fold uncertainty factor to account for use of a minimal LOAEL (3), use of a subchronic study (10), extrapolation from an animal study (3) and variability in human response (10). The US EPA selected the Feron et al. (1978) study over the Cassee et al. (1996) selected by Health Canada, based on the reporting of results for a higher number of test animals (including both sexes of rats, hamsters, and rabbits), a longer exposure duration, and better characterization of multiple endpoints and the dose-response by Feron et al. (1978).

The US EPA (2003b) recommended the lowest chronic inhalation guideline for acrolein; however, this guideline was based on an older study which identified a LOAEL which required a higher uncertainty factor. The OEHHA and TCEQ identified guidelines for acrolein based on the most recent study for nasal irritation in rats which identified a NOAEL for nasal lesions (Dorman et al. 2008); however, the OEHHA REL included use of a DAF that is not considered relevant to acrolein (TCEQ 2014). Therefore, the ReV of 2.7 $\mu\text{g}/\text{m}^3$ recommended by the TCEQ (2014) was considered the most appropriate for the assessment of chronic inhalation exposure to acrolein. Acrolein was included in the chemical group for nasal irritation following chronic inhalation exposures.

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4.0 Ammonia

4.1 Inhalation Exposure Limits

4.1.1 Acute Inhalation

Table 4-1 presents the acute inhalation exposure limits for ammonia.

Table 4-1 Acute Inhalation Exposure Limits for Ammonia

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ/ Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------------|---------|--|---------------|
| ATSDR | MRL | 1,200 | Eye and respiratory irritation | Human | Verberk et al. 1977 | ATSDR 2004 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | 1-hour REL | 3,200 | Eye and respiratory irritation | Human | Industrial Biotest Laboratories 1973; MacEwan et al 1970; Silverman et al 1949; Verberk 1977 | OEHHA 1999 |
| TCEQ | 1-hour ReV | 590 | Eye and respiratory irritation | Human | Sundblad et al. 2004 | TCEQ 2014 |

The ATSDR (2004) established an acute MRL of 1,200 $\mu\text{g}/\text{m}^3$ (1.7 ppm) for ammonia. The MRL was based on a LOAEL of 50 ppm (35 mg/m^3) for mild irritation to the eye, nose, and throat and cough in human volunteers acutely exposed to ammonia gas (50, 80, 110, or 140 ppm) (Verberk et al. 1977). An uncertainty factor of 30 was applied to the LOAEL to account for use of a LOAEL (3) and variation in human response (10) (ATSDR 2004).

The OEHHA (1999) recommend a 1-hour REL of 3,200 µg/m³ (4.5 ppm) for ammonia. Eye and respiratory irritation effects were reported by human volunteers following acute exposures to various concentrations of ammonia (ranging from 30 to 500 ppm) in four studies (Industrial Biotest Laboratories, 1973; MacEwen et al., 1970; Silverman et al., 1949; Verberk, 1977). The acute REL is based on a benchmark concentration of 13.6 ppm representing a 5% response rate (BC₀₅) to 1-hour ammonia exposures, derived from the four studies using a log-normal probit analysis, plus an uncertainty factor of 3 to account for variation in human response (OEHHA 1999).

An acute ReV of 590 µg/m³ (0.83 ppm) is proposed for ammonia by the TCEQ (2014). This ReV is based on a study of human volunteers exposed to 5 or 25 ppm ammonia for 3 hours, during which volunteers alternated every 30 minutes between rest and activity (bicycle) (Sundblad et al. 2004). No treatment related effects on lung function, bronchial responsiveness or pulmonary inflammation response were observed. The lowest exposure dose (5 ppm) was associated with temporary symptoms of eye discomfort, headache, dizziness, and feelings of intoxication and was identified as a LOAEL for the acute ReV. An uncertainty factor of 6 was applied to the LOAEL to account for variation in human response (TCEQ 2014).

The 1-hour ReV of 590 µg/m³ (TCEQ 2014) was selected for the assessment of acute exposure to ammonia as it is based on a recent, well conducted study that evaluated the effects of ammonia at the lowest exposure concentrations. Ammonia was included in the chemical groups for eye irritation and respiratory irritation following acute inhalation exposures.

4.1.2 Chronic Inhalation

Table 4-2 presents the chronic inhalation exposure limits for ammonia.

Table 4-2 Chronic Inhalation Exposure Limits for Ammonia

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ/ Effect | Species | Study | Source |
|---------------|---------------------|---|------------------------|---------|---------------------|--------------------|
| ATSDR | MRL | 70 | Pulmonary function | Human | Holness et al. 1989 | ATSDR 2004 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | - | - | - | - | - | Health Canada 2010 |

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ/ Effect | Species | Study | Source |
|-----------------|---------------------|---|------------------------|---------|---------------------|-------------|
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | REL | 200 | Pulmonary function | Human | Holness et al 1989 | OEHHA 2000 |
| RIVM | - | - | - | - | - | RIVM 2001 |
| TCEQ | ReV | 320 | Pulmonary function | Human | Holness et al. 1989 | TCEQ 2014 |
| US EPA | RfC | 100 | Pulmonary function | Human | Holness et al. 1989 | US EPA 1991 |
| WHO | - | - | - | - | - | WHO 2000 |

- not available

The ASTDR (2004), OEHHA (2000), TCEQ (2014) and US EPA (1991) all identified a study by Holness et al (1989) for the development of their chronic inhalation exposure limits for ammonia. This study examined the effects of chronic occupational exposure to ammonia in a soda ash plant on worker lung function and respiratory symptoms.

The ATSDR (2004) recommend a chronic MRL of $70 \mu\text{g}/\text{m}^3$ (0.1 ppm) for ammonia. A mean time-weighted-average exposure concentration of 9.2 ppm was identified as a NOAEL for significant changes in lung function parameters in workers exposed to ammonia for an average of 12.2 years in a soda ash plant (Holness et al. 1989). This NOAEL was adjusted for continuous exposure (8/24 hours x 5/7 days) and an uncertainty factor of 30 was applied to account for variation in human response (10) and a lack of reproductive and developmental studies of chronic exposure to ammonia (3) (ATSDR 2004).

The OEHHA (2000) identified the same air concentration 9.2 ppm from Holness et al (1989) as a NOAEL for pulmonary function following chronic exposure to ammonia. The NOAEL was adjusted for continuous exposure (i.e., $10 \text{ m}^3/20 \text{ m}^3$ x 5/7 days). An uncertainty factor of 10 was applied to the NOAEL to account for variation in human response, resulting in a chronic REL of $200 \mu\text{g}/\text{m}^3$ (0.3 ppm) (OEHHA 2000).

The TCEQ (2014) recommend an ReV of 320 $\mu\text{g}/\text{m}^3$ (0.45 ppm) for chronic exposure to ammonia. The TCEQ identified a higher NOAEL of 12.5 ppm (8.8 mg/m^3) from the Holness et al (1989) study, corresponding to the highest worker exposure group. This air concentration was selected as a NOAEL due to the absence of self-reported symptoms or effects on measured lung function parameters in workers highly exposed to ammonia. The NOAEL was adjusted for continuous inhalation exposure (i.e., 10 $\text{m}^3/20 \text{m}^3 \times 5/7$ days); an uncertainty factor of 10 was applied to account for variation in human response (TCEQ 2014).

The US EPA (1991) currently recommends an RfC of 100 $\mu\text{g}/\text{m}^3$ for ammonia. This chronic exposure limit is based on a NOAEL of 9.2 ppm (6.4 mg/m^3) or the mean time-weighted-average exposure concentration for the absence of respiratory effects in workers exposed to ammonia 5 days/week over 12.2 years (Holness et al. 1989). The US EPA adjusted the NOAEL for continuous inhalation exposure (i.e., 10 $\text{m}^3/20 \text{m}^3 \times 5/7$ days) and applied an uncertainty factor of 30 to account for sensitive individuals and database deficiencies.

Ammonia is currently under re-assessment by the US EPA and an RfC of 300 $\mu\text{g}/\text{m}^3$ is being proposed (US EPA 2012). This reassessment identified a higher NOAEL of 8.8 mg/m^3 for chronic inhalation exposure to ammonia, corresponding to the highest reported exposure concentration associated with no adverse effects on lung function from the Holness et al (1989) study. The NOAEL was adjusted to account for non-continuous, occupational exposure (i.e., 10/20 $\text{m}^3 \times 5/7$ days) and an uncertainty factor of 10 was applied for potentially sensitive individuals.

All of the agencies established exposure limits for ammonia based on the Holness et al (1989) occupational study. The OEHHA (2000) guideline of 200 $\mu\text{g}/\text{m}^3$ for changes in lung function was selected for the current assessment of chronic inhalation exposure to ammonia, in recognition that an uncertainty factor for database deficiencies is lacking in recent exposure limit development. This exposure limit is considered conservative as the TCEQ has considered and the US EPA is currently considering, a higher NOAEL for ammonia.

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5.0 Benzene

1.1 Inhalation Exposure Limits

5.1.1 Acute Inhalation

Table 5-1 presents the acute inhalation exposure limits for benzene.

Table 5-1 Acute Inhalation Exposure Limits for Benzene

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ/ Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------------------|---------|------------------|--------------------|
| ATSDR | 24-hour MRL | 30 | Haematological/ Immunological | Mice | Rozen et al 1984 | ATSDR 2013; 2007 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | 6-hour REL | 1,300 | Reproductive/ developmental toxicity | Rats | Coate et al 1984 | OEHHA 1999a; 2014a |
| TCEQ | 1-hour ReV | 580 | Haematological/ Immunological | Mice | Rozen et al 1984 | TCEQ 2007 |
| US EPA | - | - | - | - | - | US EPA 2002 |

- not available

The ATSDR recommend an acute (24-hour) MRL of $30 \mu\text{g}/\text{m}^3$ for benzene (ATSDR 2013). This MRL is based on an observed decrease in mitogen-induced lymphocyte proliferation following the exposure of mice to benzene vapours for 6 hours per day over a 6 day period (Rozen et al 1984). The study LOAEL of 10.2 ppm ($33 \text{ mg}/\text{m}^3$) was adjusted from intermittent to 24-hour exposure and converted to an human equivalent concentration (HEC) of 2.55 ppm ($8 \text{ mg}/\text{m}^3$) using US EPA (1994) methodology for the extrarrespiratory effects of a category 3 gas. The 24-hour LOAEL_{HEC} was divided by a 300-fold uncertainty factor to account for use of a LOAEL (10), extrapolation from animals (3) to humans and human variability (10) (ATSDR 2007).

The OEHHA (2014a) recommend an acute REL of 1,300 for 6-hour exposure to benzene. This REL was derived from a study of developmental toxicity in rats conducted by Coate et al. (1984). The study addressed the most sensitive noncancer endpoint associated with benzene inhalation which was lowered fetal body weights in offspring following dam exposure for 6 hours/day on gestational days 6 to 15 (OEHHA 1999a). It is noted the OEHHA reference exposure levels for benzene are currently under review and a 1-hour REL based on haematological effects in mice (Keller and Snyder et al. 1988) is being proposed (OEHHA 2014b).

The TCEQ (2007) developed a 1-hour ReV of 580 $\mu\text{g}/\text{m}^3$ for benzene using the same study and LOAEL identified by the ATSDR. The hematotoxic effects observed in the Rozen et al. 1984 study were supported by two additional studies in mice (Dempster and Snyder 1991; Corti and Snyder, 1996). The TCEQ (2007) converted the LOAEL of 10.2 ppm (33 mg/m^3) to a 1-hour HEC of 18.5 ppm (59 mg/m^3) which was then divided by a 100-fold uncertainty factor to account for use of a LOAEL (3), extrapolation from animals to humans (3) and human variability (10).

The US EPA do not recommend an acute exposure limit for benzene but do cite a variety of animal studies examining the acute effects of benzene inhalation which confirm that acute exposure to high benzene concentrations results in hematotoxic effects with a greater sensitivity observed in mice over rats (US EPA 2002).

The TCEQ 1-hour ReV of 580 $\mu\text{g}/\text{m}^3$ was selected for the current assessment of acute exposure to benzene as the effect of benzene on lymphocyte response in mice was supported by several studies and the 1-hour exposure duration selected by the TCEQ was considered the most appropriate for the response observed.

5.1.2 Chronic Inhalation

Table 5-2 presents the chronic inhalation exposure limits for benzene.

Table 5-2 Chronic Inhalation Exposure Limits for Benzene

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ/ Effect | Species | Study | Source |
|-----------------|---------------------|---|----------------------------|---------|--|--------------------------|
| ATSDR | MRL | 9.8 | Haematological | Human | Lan et al 2004 | ATSDR 2013; 2007 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | RsC | 3 | Leukemia | Human | Rinsky et al 1987 | Health Canada 2010 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | REL RsC | 60 0.3 | Haematological Leukemia | Human | Tsai et al 1983 Rinsky et al 1981 | OEHHA 1999b; 2011; 2014a |
| RIVM | CR (adjusted) | 2 | Leukemia | Human | Adopted from WHO 2000 | RIVM 2001 |
| TCEQ | ReV ESL | 280 4.5 | Haematological Leukemia | Human | Rothman et al 1996 Rinsky et al 1981; 1987 | TCEQ 2007 |
| US EPA | RfC RsC | 30 1.3 to 4.5 | Haematological Leukemia | Human | Rothman et al. 1996 Rinsky et al 1981; 1987 | US EPA 2003; 2000 |
| WHO | RsC | 1.7 | Leukemia | Human | Crump and Allen, 1984; Rinsky et al. 1987; Paustenbach et al. 1992 | WHO 2000 |

- not available

IARC (2014) has classified benzene as carcinogenic to humans (Group 1). With the exception of ATSDR, all the regulatory agencies reviewed have established chronic inhalation guidelines based on epidemiological evidence of an association between chronic occupational exposure to benzene and leukemia mortality rates. The ATSDR, OEHHA, TCEQ and US EPA have also established chronic inhalation guidelines based on haematological/immunological effects (i.e., lymphocyte response).

The ATSDR (2013) recommend a chronic MRL of $9.8 \mu\text{g}/\text{m}^3$ for benzene. The MRL was derived from a study of workers in Chinese shoe manufacturing industries (Lan et al 2004) which reported an exposure-response relationship between benzene exposure levels (measured by individual vapour monitors) and decreased lymphocyte (B cell) count in workers exposed an average of 6.1 years (ATSDR 2007). A $\text{BMCL}_{0.25\text{sd}}$ of 0.10 ppm ($0.33 \text{ mg}/\text{m}^3$), representing the lower 95% confidence limit for a 0.25 standard deviation reduction below the control mean B cell count, was identified as the point of departure (POD) for the chronic MRL. The $\text{BMCL}_{0.25\text{sd}}$ was adjusted for continuous exposure and an uncertainty factor of 10 applied for human variability to result in a chronic MRL of 0.003 ppm ($0.0098 \text{ mg}/\text{m}^3$).

Health Canada (2010) derived a TC_{05} of $15 \text{ mg}/\text{m}^3$ for benzene based on the incidence of mortality from leukemia in a cohort of rubber hydrochloride (pliofilm workers) (Rinsky et al. 1987). The exposure concentration associated with a 5% increase in mortality from acute myelogenous leukemia (TC_{05}) was derived using cancer potencies based on exposure estimates of Crump and Allen (1984) as described in Health Canada (1993). When divided by 5,000 the TC_{05} translates to an RsC of $3 \mu\text{g}/\text{m}^3$ for a 1 in 100,000 incremental increase in mortality from acute myelogenous leukemia.

An REL of $60 \mu\text{g}/\text{m}^3$ was derived by OEHHA (2014a) for chronic exposure to benzene. This REL was based on haematological effects following occupational exposure of a cohort of 454 male petroleum refinery workers exposed to benzene (personal monitors) over an average for 7.4 years (Tsai et al. 1983). Again, the OEHHA reference exposure levels for benzene are currently under review and a chronic REL based on haematological effects in Chinese shoe workers (Lan et al 2004), is being proposed (OEHHA 2014b).

The OEHHA (2011) also recommend a unit risk factor of 0.000029 per $\mu\text{g}/\text{m}^3$ for benzene based on mortality from leukemia in pliofilm workers as reported by Rinsky et al (1981) using a weighted cumulative exposure/relative risk procedure by CDHS (1984). This unit risk factor translates to a RsC of $0.3 \mu\text{g}/\text{m}^3$ for a 1 in 100,000 incremental increase in mortality from leukemia.

The RIVM (2001) has established a CR of $20 \mu\text{g}/\text{m}^3$ for benzene assuming an excess cancer risk of 1 in 10,000. This was divided by 10-fold to determine an air concentration of $2 \mu\text{g}/\text{m}^3$ for an excess cancer (leukemia) risk of 1 in 100,000 for comparison with other agencies. The RIVM (2001) adopted the lower limit of the EU (1999) cancer risk estimates for chronic exposure to benzene, which is equivalent to the unit risk recommended by the WHO (2000).

An ReV of $280 \mu\text{g}/\text{m}^3$ is recommended for benzene by the TECQ (2007). This guideline is based on hematotoxic effects (reduced lymphocyte count) in Chinese workers occupationally exposed to benzene for an average of 6.3 years (Rothman et al 1996). The critical effect of decreased lymphocyte count is supported by the results of Lan et al (2004) for workers in Chinese shoe manufacturing industries exposed to benzene for an average of 6.1 years (TCEQ 2007). The TCEQ (2007) derived a benchmark concentration (BMC) of $8.4 \text{mg}/\text{m}^3$ (adjusted for continuous exposure) from the Rothman et al (1996) study to which an uncertainty factor of 30 was applied to account for human variability (10) and a lack of data for reproductive/developmental effects (3).

The TCEQ (2007) also recommend a chronic ESL ($^{\text{chronic}}\text{ESL}_{\text{linear(c)}}$) of $4.5 \mu\text{g}/\text{m}^3$ for an excess lifetime cancer risk of 1 in 100,000 following chronic exposure to benzene. This air concentration was derived using the cancer potency estimates of Crump and Allen (1994) for acute myelogenous leukemia in the pliofilm cohort described by Rinsky et al. (1981; 1987).

The US EPA (2003) recommends a RfC of $30 \mu\text{g}/\text{m}^3$ for benzene. This RfC was based on the effect of reduced absolute lymphocyte count in Chinese workers reported in the Rothman et al (1996) study. A BMC of $8.2 \text{mg}/\text{m}^3$ was calculated and adjusted by an uncertainty factor of 300 to account for human variability (10), extrapolating from a LOAEL to a NOAEL (3), extrapolating from subchronic to chronic exposure (3) and database uncertainties (3) (US EPA 2002).

The US EPA (2000) also recommends unit risk factors for benzene based on the incidence of acute myelogenous leukemia reported in workers exposed to benzene. Air concentrations recommended for benzene at a 1 in 100,000 cancer risk level range from 1.3 to $4.5 \mu\text{g}/\text{m}^3$ and were determined from the pliofilm cohort described by Rinsky et al. (1981; 1987) using risk calculations recommended by Paustenbach et al. (1993); Crump and Allen (1984); Crump (1994) and U.S. EPA (1998).

The WHO (2001) recommend an air quality of guideline of $1.7 \mu\text{g}/\text{m}^3$ for an excess lifetime cancer (leukemia) risk of 1 in 100,000 following chronic exposure to benzene. This guideline was derived from a range of studies reporting risk estimates for mortality from leukemia in the pliofilm cohort of workers (Crump and Allen, 1984; Rinsky et al. 1987; Paustenbach et al. 1992).

The lowest air concentration recommended by the ATSDR (2007) for haematological/immunological effects ($9.8 \mu\text{g}/\text{m}^3$) was selected for the assessment of non-carcinogenic effects following chronic inhalation exposure to benzene.

The range of air concentrations identified by the US EPA (2003) for a 1 in 100,000 cancer risk level is supported by similar exposure limits derived by Health Canada, RIVM, TCEQ and WHO for the same response (i.e., leukemia). An important distinction of the Health Canada guideline was the identification of the exposure concentration associated with mortality from, rather than incidence of, leukemia. For the purpose of this assessment, the lowest air concentration recommended by the US EPA ($1.3 \mu\text{g}/\text{m}^3$) was selected for the evaluation of potential carcinogenic effects following chronic inhalation exposure to benzene. Benzene was included in the chemical group for leukemia following chronic inhalation exposures.

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6.0 Benzo[a]pyrene

6.1 Inhalation Exposure Limits

6.1.1 Acute Inhalation

IARC (2014) has classified benzo[a]pyrene (B[a]P) as carcinogenic to humans (Group 1). Studies on the carcinogenic potential of B[a]P and mixtures of polycyclic aromatic hydrocarbons (PAHs) following chronic inhalation or oral exposures are outlined in ATSDR (1995); Health Canada (2010); RIVM (2001); and US EPA (1994).

The effects of acute inhalation exposure to B[a]P have not been characterized and no acute exposure limits with supporting documentation were identified (**Table 6-1**). As a C20 aromatic hydrocarbon B[a]P has extremely low volatility and inhalation of the chemical in isolation from particulate matter is unlikely. Controlled inhalation and intratracheal instillation studies in animals have demonstrated the carcinogenicity of B[a]P over long-term (chronic) exposure periods as described below.

Table 6-1 Acute Inhalation Exposure Limits for B[a]P

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------|---------|-------|---------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | - | - | - | - | - | OEHHA 2014 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| WHO | - | - | - | - | - | WHO 2000 |

- not available

6.1.2 Chronic Inhalation

Table 6-2 presents the chronic inhalation exposure limits for B[a]P.

Table 6-2 Chronic Inhalation Exposure Limits for B[a]P

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|---------------------------|----------|----------------------------|--------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | RsC | 0.32 | Respiratory tract tumours | Hamsters | Thyssen et al., 1981 | Health Canada 2010 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | RsC | 0.009 | Respiratory tract tumours | Hamsters | Thyssen et al., 1981 | OEHHA 2011 |
| RIVM | - | - | - | - | - | RIVM 2001 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | - | - | - | - | - | US EPA 1994 |
| WHO | RsC | 0.00012 | Lung cancer | Human | Redmond, 1976; US EPA 1984 | WHO 2000; 1987 |

- not available

Health Canada (2010) developed a unit risk factor of 0.031 per $\mu\text{g}/\text{m}^3$ for B[a]P. This unit risk factor was determined using multistage modeling of the tumour incidence in the respiratory tract of hamsters exposed by inhalation (nose only) to B[a]P for 4.5 hours/day, 7 days/week during the first 10 weeks of the study and 3 hours/day, 7 days/week for the remainder of the study (up to 96 weeks) (Thyssen et al. 1981). This unit risk factor translates to an RsC of 0.32 $\mu\text{g}/\text{m}^3$ based on a 1 in 100,000 excess lifetime cancer risk.

A unit risk factor of 0.0011 per $\mu\text{g}/\text{m}^3$ was derived for B[a]P by the OEHHA (2011). Similar to Health Canada, the linearized multistage model was fit to respiratory tract tumour data in hamsters as reported by Thyssen et al. (1981). The OEHHA (2011) further calculated an oral risk factor (0.43 per mg/kg body weight/day) based on the exposure conditions described in the study and the inhalation rate and body weight of hamsters. A human equivalent unit risk factor for the inhalation pathway was then determined by applying an interspecies surface area correction factor, based on bodyweight and surface area, to the oral risk factor. The resulting OEHHA (2011) unit risk factor corresponds to an RsC of 0.009 $\mu\text{g}/\text{m}^3$ for a 1 in 100,000 excess lifetime cancer risk. It is noted that while the bodyweight scaling approach selected by the OEHHA (2011) is consistent with US EPA (2005) cancer risk assessment guidance for oral exposures, the EPA does not recommend this approach for determining human equivalent exposures for the inhalation pathway.

The US EPA (1994) does not currently recommend an inhalation unit risk estimate for B[a]P; however, the potential inhalation toxicity of B[a]P is currently under review by the US EPA with a draft human health assessment released August 2013 for independent peer review and public comment (US EPA 2013).

The WHO (1987; 2000) selected B[a]P as an indicator of the carcinogenic potential of PAH mixtures in air and developed a unit risk factor of 0.0087 per $\mu\text{g}/\text{m}^3$ using a linearized multistage model and epidemiological data for mortality due to lung cancer in workers exposed to mixtures of PAH in coke-oven emissions (Redmond 1976; US EPA 1984). Using this unit risk factor, a B[a]P air concentration of 0.00012 $\mu\text{g}/\text{m}^3$ would be associated with a 1 in 100,000 increased risk of mortality as a result of lung cancer. The WHO (1987; 2000) guideline for B[a]P represents an index of PAH mixtures from coke oven emissions and similar combustion processes. The WHO (2000) noted that although the PAH composition in coke-oven emissions may not correlate to PAH in ambient air, epidemiological studies involving other PAH mixtures have determined similar cancer risks and a unit risk within the same order of magnitude was determined for B[a]P from animal data (i.e., Heinrich et. al 1994).

The WHO (2000) guideline for B[a]P was considered the most appropriate for the assessment of a mixture of carcinogenic PAH in Project emissions. B[a]P was included in the chemical group for lung tumours following chronic inhalation exposures.

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7.0 1,3-Butadiene

7.1 Inhalation Exposure Limits

7.1.1 Acute Inhalation

Table 7-1 presents the acute inhalation exposure limits for 1,3-Butadiene.

Table 7-1 Acute Inhalation Exposure Limits for 1,3-Butadiene

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|--------------------------|---|-------------------------------|---------|-------------------------------|-------------------|
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| ATSDR | - | - | - | - | - | ATSDR 2012 |
| OEHHA | 1-hour REL 8-hour REL | 660 9 | Developmental Ovarian atrophy | Mice | Hackett et al. 1987; NTP 1993 | OEHH A 2014; 2013 |
| TCEQ | 6-hour ReV | 3,700 | Developmental | Mice | Hackett et al. 1987 | TCEQ 2008 |
| US EPA | 24-hour RfC | 15 | Developmental | Mice | Hackett et al. 1987 | US EPA 2002 |

- not available

The OEHHA (2014), TCEQ (2008) and US EPA (2002) have all developed acute inhalation exposure guidelines for 1,3-butadiene based on a study of developmental toxicity in mice (Hackett et al., 1987). Hackett et al. (1987) examined the reproductive and developmental effects of 1,3-butadiene on pregnant CD-1 mice and their offspring. The mice were exposed via inhalation to 0, 40 ppm (88.4 mg/m^3), 200 ppm (442 mg/m^3) or 1,000 ppm (2,210 mg/m^3) 1,3-butadiene for 6 hours/day on gestational days 6 to 15 and sacrificed on gestational day 18 (Hackett et al., 1987).

The OEHHA (2013) 1-hour REL of $660 \mu\text{g}/\text{m}^3$ (0.297 ppm) was based on lowered fetal body weights in male offspring following dam exposure for 6 hours/day on gestational days 6 to 15 (Hackett et al. 1987). A BMCL_{05} of 17.7 ppm was identified for lowered male fetal weights using values reported by Green (2003) following a re-analysis of the Hackett et al. (1987) data. A dosimetric adjustment factor was used to calculate an HEC of 29.7 ppm ($65.6 \text{ mg}/\text{m}^3$) to which an uncertainty factor of 100 was applied to account for use of an animal study (3) and variability in human response (30) (OEHHA 2013).

The OEHHA (2013) also developed an 8-hour limit of $9 \mu\text{g}/\text{m}^3$ (0.0042 ppm) for 1,3 butadiene based on a chronic NTP (1993) bioassay study that reported ovarian atrophy in female mice exposed via inhalation for 6 h/day, 5 d/wk over 103 weeks. This guideline was not selected for the current assessment of acute inhalation exposure as it was based on a response to chronic inhalation exposure and is intended for repeated 8-hour exposures.

The US EPA (2002) subchronic RfC of $15 \mu\text{g}/\text{m}^3$ (0.007 ppm) was also based on decreased fetal bodyweights in mice (Hackett et al. 1987). The US EPA (2002) used benchmark modeling to identify an LEC_{05} of 2.9 ppm ($6.4 \text{ mg}/\text{m}^3$) for a 24-hour exposure period and applied an uncertainty factor of 400 to account for extrapolation from an animal study (3), variability in human response (10), use of a lowest effect level (4) and database deficiencies (3).

The TCEQ (2008) 6-hour ReV of $3,700 \mu\text{g}/\text{m}^3$ (1.7 ppm) was based on the maternal toxicity of 1,3 butadiene in mice (Hackett et al. 1987). A BMCL_1 of 51.3 ppm ($113.4 \text{ mg}/\text{m}^3$) was determined for decreased maternal extragestational weight gain as a result of daily 6 hour exposures on gestational days 6 to 15. An uncertainty factor of 30 was applied to account for use of an animal study (3) and variability in human response (10).

The REL of $660 \mu\text{g}/\text{m}^3$ recently developed by OEHHA (2014) using a re-analysis of the Hackett et al. (1987) data was selected for the assessment of 1-hour exposures to 1,3-butadiene. The lowest guideline of $15 \mu\text{g}/\text{m}^3$ recommended by the US EPA was also selected for assessment of 24-hour exposures to 1,3-butadiene. Use of these two guidelines in the acute inhalation assessment was considered protective of 6-hour exposures to 1,3-butadiene.

It is noted that the limited data available suggests that mice are more sensitive to the developmental effects of butadiene compared to rats or humans due to a greater rate of metabolism of butadiene to the reactive metabolites responsible for butadiene toxicity (OEHHA 2013; ATSDR 2012; TCEQ 2008)). The ATSDR has not developed an acute inhalation exposure limit for 1,3-butadiene due to the lack of available data to account for the significant differences in the metabolism of 1,3-butadiene between species and the concern that exposure limits based on responses observed in mice may overestimate the potential risks to human health (ATSDR 2012).

7.1.2 Chronic Inhalation

Table 7-2 presents the chronic inhalation exposure limits for 1,3-Butadiene.

Table 7-2 Chronic Inhalation Exposure Limits for 1,3-Butadiene

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|-----------------------------------|---------------|---|---------------------|
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| ATSDR | - | - | - | - | - | ATSDR 2012 |
| HEALTH CANADA | RsC (based on TC01) | 1.7 | Leukemia | Human | Delzell et al., 1995 | Health Canada 2000 |
| OEHHA | RsC RfC | 0.06 2.2 | Lung neoplasms Ovarian atrophy | Mice | Melnick et al. 1990 NTP 1993 | OEHHA 2013; 2011 |
| RIVM | RsC | 0.3 | Leukemia | Human | Health Canada, 2000; Delzell et al., 1995 | RIVM 2009 |
| TCEQ | RsC ReV | 20 33 | Leukemia Ovarian atrophy | Human Mice | Delzell et al., 1995, 1996, others NTP 1993 | TCEQ 2008 |
| US EPA | RsC RfC | 0.3 2 | Leukemia Ovarian atrophy | Human Mice | Health Canada, 2000; Delzell et al., 1995 NTP 1993 | US EPA 2002 |
| WHO | - | - | - | - | - | WHO 2000 |

-not available

1,3-Butadiene has been classified as carcinogenic to humans (Group 1) by the International Agency for Research on Cancer (IARC 2008; 2013). An increased incidence of leukemia in

workers exposed to 1,3-butadiene in styrene butadiene rubber plants has been reported by Delzell et al. (1995). Health Canada (2000), the RIVM (2009), TCEQ (2008) and US EPA (2002) have all considered the results of this occupational study in the development of chronic inhalation exposure limits. The OEHHA (2011) developed a chronic inhalation exposure limit for 1,3-butadiene based on the occurrence of lung tumours in mice as reported by Melnick et al. (1990).

Health Canada (2000) compiled exposure-response data for workers from 6 styrene butadiene rubber plants (Delzell et al. 1995) and used regression analyses to identify a butadiene concentration of 1.7 mg/m^3 associated with a 1% (0.01) excess probability of mortality as a result of leukemia (TC_{01}). By extrapolation the air concentration associated with a 1 in 100,000 or 0.00001 leukemia mortality risk would be $1.7 \text{ } \mu\text{g/m}^3$.

The US EPA (2002) considered the Health Canada (2000) analyses of the Delzell et al (1995) data as well as age-specific data on leukemia incidence rates for 1994-1998 from SEER (Surveillance, Epidemiology and End Results) program of the National Cancer Institute to estimate the incidence of (rather than mortality from) leukemia as a result of chronic inhalation exposure to butadiene. An inhalation unit risk of $0.3 \text{ } \mu\text{g/m}^3$ at the 1 in 100,000 risk level was recommended by the US EPA (2002) for chronic exposure to butadiene. This RsC was adopted by RIVM as the chronic inhalation limit value for the evaluation of 1,3-butadiene in air (2009).

The TCEQ (2008) have recommended a risk specific concentration of $20 \text{ } \mu\text{g/m}^3$ for 1 in 100,000 (1×10^{-5}) excess cancer risk associated with chronic inhalation of butadiene. This exposure limit was also based on the Delzell et. al. (1995) study but incorporated exposure estimates, epidemiological studies and dose-response modeling not available at the time of the Health Canada and US EPA assessments. Relative risks were determined using Texas specific rates of leukemia mortality and survival for up to 70 years exposure, whereas the US EPA considered 85 years exposure (TERA 2010).

The OEHHA (2011) recommended a risk specific concentration of $0.06 \text{ } \mu\text{g/m}^3$ at the 1×10^{-5} excess cancer risk for butadiene. In contrast to Health Canada, the OEHHA (2011) considered the available epidemiological data to be insufficient for unit risk calculation. The RsD was instead derived from chronic inhalation studies in mice (Melnick et al. 1990) which reported the occurrence of malignant neoplasms in the lung.

The US EPA (2002) RsC of $0.3 \text{ } \mu\text{g/m}^3$ for 1×10^{-5} excess risk of leukemia incidence was selected for the evaluation of chronic inhalation exposure to 1,3-butadiene. This guideline was selected over the Health Canada guideline as it was based on an incidence rate for leukemia rather than

leukemia mortality rates. The US EPA guideline was selected over the TCEQ guideline as it was more conservative and considered national leukemia incidence rates and a longer exposure term. The OEHHA recommended the lowest guideline for the carcinogenicity of 1,3-butadiene based on the response in mice, however the consensus of four agencies on the use of an occupational study did not support the selection of the OEHHA guideline. 1,3-butadiene was included in the chemical group for leukemia following chronic inhalation exposures.

Chronic inhalation exposure limits for the non-carcinogenic effects of 1,3-butadiene have also been developed by the OEHHA (2014), TCEQ (2008) and US EPA (2002). All of these agencies developed non-cancer guidelines based on the NTP (1993) study of reproductive effects (ovarian atrophy) in mice following up to 2 years inhalation exposure to 1,3-butadiene.

The OEHHA (2013) identified a $BMCL_{05}$ HEC of 0.66 mg/m^3 (0.30 ppm) for ovarian atrophy from the NTP (1993) study. This was adjusted by an uncertainty factor of 300, to account for uncertainty in response between species (30) and sensitive individuals (10), resulting in a chronic REL of $2.2 \text{ } \mu\text{g/m}^3$ (0.001 ppm).

Similarly, the TCEQ (2008) determined a $BMCL_{05}$ HEC of 1.02 mg/m^3 (0.462 ppm) for ovarian atrophy based on the NTP (1993) study. An uncertainty factor of 30 was applied to account for sensitive individuals (10) and an incomplete database (3), resulting in a chronic ReV of $33 \text{ } \mu\text{g/m}^3$ (0.015 ppm). An interspecies uncertainty factor was not applied as an HEC was determined from the POD.

The US EPA (2002) determined a $BMCL_{10}$ HEC of 1.9 mg/m^3 (0.88 ppm) for ovarian atrophy based on the NTP (1993) study. This was adjusted by an uncertainty factor of 1,000, to account for uncertainty in response between species (3), an incomplete database (3), sensitive individuals (10) and extrapolation to a level below the 10% effect level (similar to a LOAEL-to-NOAEL extrapolation), resulting in a chronic RfC of $2 \text{ } \mu\text{g/m}^3$ (0.001 ppm).

The lowest recommended exposure limit of $2 \text{ } \mu\text{g/m}^3$ was selected for the current assessment of the non-carcinogenic effects of 1,3-butadiene, based on the US EPA (2002) RfC and supported by the OEHHA (2013) REL.

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8.0 Carbon Monoxide

8.1 Inhalation Exposure Limits

8.1.1 Acute Inhalation

Table 8-1 presents the acute inhalation exposure limits for carbon monoxide.

Table 8-1 Acute Inhalation Exposure Limits for Carbon Monoxide

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------------|---|---|---------|--|-------------------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013; 2012 |
| B.C. MOE | 1-hour 8-hour AAQO | 14,300 5,500 | - | - | - | B.C. MOE 2013 |
| CCME | 1-hour 8-hour NAAQO | 15,000 6,000 | COHb blood level | Human | Various epidemiological studies; PBPK modelling Coburn et al., 1965 | CCME 1999; Health Canada 1994 |
| METRO VANCOUVER | 1-hour 8-hour AAQO | 30,000 10,000 | - | - | - | MV 2011 |
| OEHHA | 1-hour REL | 23,000 | COHb blood level, cardiovascular system | Human | Aronow, 1981 | OEHHA 2014; 1999 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|--------|---------------------------|---|--------------------------|---------|--|----------------------|
| US EPA | 1-hour 8-hour NAAQS | 40,000 10,000 | COHb blood level | Human | Various epidemiological studies; PBPK modelling Coburn et al., 1965 | US EPA 2010; 2012 |
| WHO | 1-hour 8-hour | 30,000 10,000 | COHb blood level | Human | Various epidemiological studies; PBPK modelling Coburn et al., 1965 | WHO 2000 |

- not available

The toxicity associated with carbon monoxide is largely attributed to its ability to bind hemoglobin and form carboxyhemoglobin (COHb), which reduces the oxygen carrying capacity of blood and impairs the release of oxygen to tissues (WHO 2000). Toxicological and epidemiological research indicates that exposure to low levels of carbon monoxide (below concentrations resulting in overt poisoning) can result in adverse effects on tissues with the greatest oxygen demand, including the heart and brain (ATSDR 2012).

Individuals sensitive to the effects of carbon monoxide exposure include those with cardiovascular and/or respiratory disease (ATSDR 2012). However, the ATSDR has not developed MRL values for carbon monoxide based on the following rationale:

- The production of CO is physiologically regulated within the body and plays a role in regulating physiological processes, including those that underlie the adverse effects observed in the available human clinical, epidemiological or animal studies (e.g., brain and muscle oxygen storage and utilization);
- The exposure threshold for carbon monoxide, considering its physiological role, is likely at or near the endogenous production rate, therefore any external exposure to CO could exceed the threshold and result in adverse effects;
- The available animal and clinical studies do not identify NOAELs and when uncertainty factors are applied to the identified LOAELs, the resultant MRLs are within the range of ambient CO concentrations in the United States and would result in internal doses that would be similar to endogenous CO production; and,

- Considering the variation in heme production at different altitudes and the modes of action of carbon monoxide that involve competition with oxygen for heme binding sites, MRLs relevant to exposures at sea level may not apply at higher altitudes with lower oxygen partial pressures (ATSDR 2012).

The desirable Canadian NAAQOs for carbon monoxide are 15,000 $\mu\text{g}/\text{m}^3$ for a 1-hour averaging time and 6,000 $\mu\text{g}/\text{m}^3$ over 8 hours (CCME 1999). These objectives were based on the maintenance of COHb levels in the blood below 1% or the upper end of the range of COHb resulting from endogenous production in humans. The 1-hour and 8-hour averaged air concentrations of carbon monoxide that correspond to <1% COHb were determined using the PBPK model of Coburn, Forster, and Kane (CFK) (Coburn et al. 1965). B.C. MOE (2013) has adopted slightly lower 1-hour (14,300 $\mu\text{g}/\text{m}^3$) and 8-hour (5,500 $\mu\text{g}/\text{m}^3$) AAQOs as Provincial Level A Pollution Control Objectives for carbon monoxide. However no supporting documentation were available for these objectives.

The US EPA (2010; 2012) have developed 1-hour and 8-hour NAAQS for carbon monoxide of 40,000 $\mu\text{g}/\text{m}^3$ and 10,000 $\mu\text{g}/\text{m}^3$, respectively, to protect against COHb concentrations in the range at which adverse health effects could occur (>2%) based on the health outcomes reported in numerous epidemiological studies. The US EPA (2010) also utilized the CFK PBPK model (Coburn et al. 1965) to determine these air quality standards.

The OEHHA (2013) derived a 1-hour REL of 23,000 $\mu\text{g}/\text{m}^3$ for exposure to carbon dioxide. This exposure limit was set to achieve approximately 1% COHb, based on a LOAEL of 2% COHb reported by Aronow (1981) for the aggravation of angina in an epidemiological study (OEHHA 1999).

The WHO (2000) recommended 1-hour and 8-hour guidelines of 30,000 and 10,000 $\mu\text{g}/\text{m}^3$, respectively, for exposure to carbon monoxide. These guidelines were based on the maintenance of COHb levels below 2.5% using the CFK PBPK model (Coburn et al. 1965). The WHO (2000) considered these guidelines to be protective of non-smoking population groups with coronary artery disease (i.e., against acute ischemic heart attacks) and fetuses of nonsmoking pregnant women (i.e., against hypoxic effects) (WHO, 2000). The 1-hour and 8-hour WHO guidelines have been adopted as AAQOs by Metro Vancouver (2011)

The various acute exposure limits for carbon monoxide were all based on COHb levels in the blood. The Canadian NAAQOs were recommended for the maintenance of <1% COHb in blood or the upper end of the range of COHb resulting from endogenous production in humans (Health Canada 1994). The NAAQO 1-hour and 8-hour values of 15,000 and 6,000 $\mu\text{g}/\text{m}^3$, respectively, were selected for the current assessment of the acute inhalation effects of carbon

monoxide as they represent objectives that would result in COHb blood levels within the endogenous range. It is noted that the more recent and extensive evaluations completed by the US EPA (2010; 2012) and WHO (2000) suggest that higher levels of COHb in the blood (i.e., >2%) would be required before adverse effects are observed.

8.1.2 Chronic Inhalation

Table 8-2 presents the chronic inhalation exposure limits for carbon monoxide.

Table 8-2 Chronic Inhalation Exposure Limits for Carbon Monoxide

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------|---------|-------|-------------------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013; 2012 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| CCME | - | - | - | - | - | CCME 1999; Health Canada 1994 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | - | - | - | - | - | OEHHA 2014; 1999 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | - | - | - | - | - | US EPA 2010; 2012 |
| WHO | - | - | - | - | - | WHO 2000 |

- not available

The majority of studies of adverse effects of carbon monoxide in humans emphasize steady-state %COHb values following exposures of acute duration. The formation of COHb following exposure to a fixed concentration of CO was reported to reach steady state after 6-8 hours of exposure (WHO 2000). Chronic exposure limits have not been established for carbon monoxide by any of the regulatory agencies reviewed and therefore chronic exposure to carbon monoxide was not considered in the current assessment.

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9.0 Diesel Exhaust Particulate

9.1 Inhalation Exposure Limits

9.1.1 Acute Inhalation

No acute inhalation exposure limits were identified for DPM from the agencies reviewed; therefore the assessment of DPM was limited to chronic exposures (**Table 9-1**).

Table 9-1 Acute Inhalation Exposure Limits for DPM

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------|---------|-------|---------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | - | - | - | - | - | OEHHA 2014 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| WHO | - | - | - | - | - | WHO 1996 |

- not available

9.1.2 Chronic Inhalation

Table 9-2 presents the chronic inhalation exposure limits for DPM.

Table 9-2 Chronic Inhalation Exposure Limits for DPM

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|-----------------------------------|---------------|--|--------------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | - | - | - | - | - | Health Canada 2010 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | REL RsC | 5 0.03 | Respiratory system Lung cancer | Rats Human | Ishinishi et al. 1988 Garshick et al. 1987; 1988 | OEHHA 1998 OEHHA 2011 |
| RIVM | - | - | - | - | - | RIVM 2001 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | RfC | 5 | Respiratory system | Rats | Ishinishi et al. 1988 | US EPA 2014; 2003 |
| WHO | - | - | - | - | - | WHO 1996 |

- not available

Diesel engine exhaust contains thousands of chemicals which can complicate measurements of exposure. The carbonaceous fraction of diesel particulate, also known as elemental carbon, has been identified as a marker for diesel engine exhaust exposure. Elemental carbon represents a large fraction of the particulate mass of diesel exhaust and can be quantified at low levels. In the case of occupational studies, the diesel engine represents the only significant source for elemental carbon in the workplace (Birch and Cary 1996).

The US EPA (2003) and OEHHA (1998) have established chronic exposure limits for diesel particulate matter (DPM). The US EPA (2014) RfC of $5 \mu\text{g}/\text{m}^3$ is based on respiratory effects, including pulmonary inflammation and histopathological effects (fibrosis), in rats exposed to diesel exhaust for 16 hr/day, 6 days/week over 130 weeks (Ishinishi et al. 1988). A NOAEL of $460 \mu\text{g DPM}/\text{m}^3$ was identified from the study. This exposure concentration was converted to a human NOAEL_{HEC} of $144 \mu\text{g DPM}/\text{m}^3$ using a mathematical model of DPM deposition and clearance and assuming that equal pulmonary surface loadings in rats and humans would be associated with similar effects (US EPA 2003). An uncertainty factor of 30 was applied to the NOAEL_{HEC} to account for the response of sensitive individuals (10) and interspecies extrapolation (3). The OEHHA (1998) adopted the US EPA RfC of $5 \mu\text{g}/\text{m}^3$ as their chronic REL for diesel exhaust.

The US EPA (2003) RfC of $5 \mu\text{g}/\text{m}^3$ was selected for the evaluation of non-carcinogenic effects associated with exposure to DPM.

The National Toxicology Program (NTP) has classified diesel exhaust particulate as *reasonably anticipated to be a human carcinogen* based on studies in humans with supporting evidence from animal and mechanistic studies (NTP 2014). Diesel exhaust particles, which contain mutagenic and carcinogenic chemicals, are small enough to penetrate and persist in the lower lung region and were considered likely to account for observed human lung cancers; this is supported by evidence of a lack of lung tumours in rats exposed to diesel exhaust that was filtered to remove particles (NTP 2014). The International Agency for Research on Cancer (IARC 2012; 2014) has classified diesel engine exhaust as *carcinogenic to humans* (Group 1) based on sufficient epidemiological evidence for increased risk of lung cancer.

The OEHHA conducted a meta-analysis of studies reporting a relationship between lung cancer and exposure to diesel exhaust and determined that there was a positive association between occupational exposure to diesel exhaust and an increased risk of developing lung cancer (OEHHA, 2011). A unit risk factor of 0.0003 per $\mu\text{g}/\text{m}^3$ was recommended for particulate matter from diesel-fueled engines, based on the incidence of lung tumours reported in a case control study (Garshick et al. 1987) and a retrospective cohort study (Garshick et al. 1988) of US railway workers occupationally exposed to diesel exhaust. This unit risk factor translates to an RsC of $0.03 \mu\text{g}/\text{m}^3$, assuming an acceptable lifetime cancer risk of 1 in 100,000.

The Health Effects Institute (HEI) organized a Diesel Epidemiology Expert Panel to review two sets of epidemiological studies on diesel exhaust available at the time, including the Garshick (1987; 1988) studies of railroad workers as well as studies of truck drivers (Steenland et al. 1990) (HEI 1999). The panel recommended against using the railroad worker data following a

limited analysis of the exposure-response associations which, although suggesting lung cancer risk was greater in worker groups with higher exposure, also suggested that lung cancer risk decreased with increasing duration of employment (HEI 1999).

The US EPA reported that the weight of available evidence from epidemiology studies indicates that occupational exposure to diesel exhaust may pose a lung cancer risk (US EPA 2002; 2003). The studies on railroad workers (Garshick et al. 1987; 1988) and truck drivers (Steenland et al. 1990) were considered to have the best available exposure-response information for estimating cancer risk from occupational exposures; however, the US EPA (2003) did not consider these data suitable to derive a cancer risk estimate for environmental exposures, stating there was too much uncertainty in the available data and outlining gaps that would require evaluation before a confident quantitative dose-response analysis and subsequent derivation of cancer unit risk can be performed. The US EPA did consider the supporting data for DPM carcinogenicity in animals but found the data, particularly for rats, not relevant to human exposures as the tumour incidences reported were non-linear and associated with exposure concentrations high enough to produce lung particle overload (US EPA 2003).

Among the evidence for the IARC (2012) classification of diesel engine exhaust as carcinogenic to humans was a recently conducted US National Cancer Institute/National Institute for Occupational Safety and Health study which reported an increased risk of death from lung cancer in non-metal miners (silica limestone, salt, trona and potash mines), following chronic occupational exposure to diesel emissions (Silverman et al. 2012; Attfield et al. 2012). The results from the nested case-control (Silverman et al. 2012) and cohort mortality (Attfield et al. 2012) studies of diesel exhaust exposure in non-metal miners provided evidence (robust exposure-response relationships) for an effect on lung cancer from diesel exhaust exposure in both underground mine workers as well as surface-only workers, suggesting that diesel exhaust may be hazardous in both confined and open spaces and represents a potential public health as well as an industrial health hazard.

This same group of authors (Silverman, Attfield, and Garshick et al.) released exposure-response estimates for diesel engine exhaust and lung cancer mortality (Vermeulen et al. 2014). Following a meta-regression analysis of lung cancer mortality and cumulative exposure to elemental carbon (EC), an excess of 21 lung cancer deaths per 10,000 individuals was predicted following lifetime environmental exposure (through 80 years of age) to $0.8 \mu\text{g}/\text{m}^3$ EC (Vermeulen et al. 2014).

Elemental carbon (EC) refers to the carbon-containing components of DPM and is considered the carbonaceous fraction of a diesel particle. The EC content of DPM from heavy duty diesel engines can vary widely (from 20 to 90%) but recent emissions profiles (based on the limited data available) suggests that EC comprises approximately 75% of DPM from heavy duty diesel engines (US EPA 2002). So an excess of 21 lung cancer deaths per 10,000 individuals following exposure to $0.8 \mu\text{g}/\text{m}^3$ EC could be interpreted as an excess of 21 lung cancer deaths per 10,000 individuals following exposure to $1 \mu\text{g}/\text{m}^3$ DPM (i.e., $0.8 \mu\text{g}/\text{m}^3$ EC/0.75) and a DPM air concentration $0.005 \mu\text{g}/\text{m}^3$ would be associated with a 1 in 100,000 lifetime risk of lung cancer. This is a more conservative cancer risk estimate for DPM than the RsC (i.e., $0.03 \mu\text{g}/\text{m}^3$) currently recommended by the OEHHA (2011). It is important to note that the risk estimate presented for EC by Vermeulen et al. (2014) is still preliminary and no agency has adopted it as an exposure limit. The extrapolation of this information to a DPM air concentration is provided only for comparison sake (i.e., to a cancer risk estimate available from a recognized regulatory agency).

Exposure characterization remains a source of significant uncertainty in determining the potential human cancer risks of diesel particulate matter in diesel exhaust. Concerns have been raised that lung cancer risks based on exposures to past diesel exhaust emissions do not represent lung cancer risks from exposure to current or future emissions. These concerns are based on the recent modifications to diesel engines which serve to filter out diesel particulate matter and modifications to diesel fuel, including ultra-low sulphur content fuel, which also lowers the particulate content in emissions.

Despite the uncertainty associated with the cancer risk estimate available for DPM, the carcinogenic effects of inhalation exposure to DEP were considered for the current assessment, based on the IARC (2012) decision and recent epidemiological evidence presented. The OEHHA (2011) RsC of $0.03 \mu\text{g}/\text{m}^3$ was selected as it is the only regulatory guideline available for cancer risk. The data provided by Vermeulen et al. (2014) suggests that the OEHHA (2011) RsC is within an order of magnitude of a recent estimate for lung cancer risk associated with EC exposure. DPM was included in the chemical group for lung tumours following chronic inhalation exposures.

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10.0 Formaldehyde

10.1 Inhalation Exposure Limits

10.1.1 Acute Inhalation

Table 10-1 presents the acute inhalation exposure limits for formaldehyde.

Table 10-1 Acute Inhalation Exposure Limits for Formaldehyde

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------------|---|--|---------|--|--------------------------|
| ATSDR | MRL 2-hour | 50 | Eye and nasal irritation | Human | Pazdrak et al. 1993 | ATSDR 2013; 1999 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | Short-term IAQG 1-hour | 123 | Eye Irritation | Humans | Kulle et al. 1993 | Health Canada 2006 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | REL 1-hour 8-hour | 55 9 | Eye irritation Respiratory irritation | Human | Kulle et al. 1987 Wilhelmsson and Holmstrom, 1992 | OEHH A 2014; OEHH A 2008 |
| TCEQ | ReV 1-hour | 50 | Eye and nasal irritation | Human | Pazdrak et al. 1993; Krakowiak et al. 1998 | TCEQ 2008 |
| WHO | 30 min | 100 | Eye irritation | Human | Lang et al. 2008; Kulle et al. 1987 | WHO 2010 |

- not available

The ATSDR (2013) recommend an acute inhalation MRL of 50 $\mu\text{g}/\text{m}^3$ for formaldehyde. The MRL was based on a study by Pazdrak et al. (1993) which reported eye and nose irritation in human volunteers, including individuals with skin sensitivity to formaldehyde, following 2 hours exposure to 0.4 ppm (0.5 mg/m^3) formaldehyde. A 10-fold uncertainty factor was applied to the exposure concentration to account for use of a LOAEL (3) and variability in human response (3) (ATSDR 1999).

Health Canada (2006) recommends an acute (1 hour) indoor air quality guideline of 123 $\mu\text{g}/\text{m}^3$ for formaldehyde. This guideline represents one-fifth of the NOAEL of 1,230 $\mu\text{g}/\text{m}^3$ for eye irritation in human clinical studies (Kulle 1993).

A 1-hour ReV of 50 $\mu\text{g}/\text{m}^3$ was recommended by the TCEQ (2008) for acute exposure to formaldehyde. Similar to the ATSDR (1999), this ReV was based on eye and nose irritation in human volunteers, including individuals with skin sensitivity to formaldehyde (Pazdrak et al. 1993) as well as individuals with asthmatic symptoms (Krakowiak et al 1998) following 2 hours exposure to 0.5 mg/m^3 formaldehyde. A 10-fold uncertainty factor was applied to the exposure concentration (0.5 mg/m^3) to account for use of a LOAEL (3) and variability in human response (3) (TCEQ 2008).

The OEHHA (2014) recommend a 1-hour REL of 55 $\mu\text{g}/\text{m}^3$ and an 8-hour REL of 9 $\mu\text{g}/\text{m}^3$ as acute exposure limits for formaldehyde. The 1-hour REL of 55 $\mu\text{g}/\text{m}^3$ (0.044 ppm) is based on a NOAEL of 0.5 ppm for mild to moderate eye irritation in nonasthmatic humans exposed to 0.5-3.0 ppm formaldehyde for a 3 hour period (Kulle et al. 1987). The OEHHA (2008) calculated a BMCL_{05} of 0.44 ppm for eye irritation which was adjusted by an uncertainty factor of 10 to account for potential asthma exacerbation.

The OEHHA 8-hour REL of 9 $\mu\text{g}/\text{m}^3$ was based on an occupational study (Wilhelmsson and Holmstrom 1992) reporting nasal, eye and respiratory tract irritation in chemical plant workers exposed to a mean air concentration of 0.26 mg/m^3 formaldehyde over an average of 10 years (OEHHA 2008). The 8-hour REL was not considered for the acute exposure assessment as it was based on chronic exposure data and is intended for repeated 8-hour exposures.

The WHO (2010) recommended a short-term (30 minute) indoor air quality guideline of 100 $\mu\text{g}/\text{m}^3$ for formaldehyde. This guideline was derived from a NOAEL of 0.63 mg/m^3 for eye irritation (Lang et al. 2008; Kulle et al. 1987). The NOAEL was adjusted by a factor of 5, derived from the standard deviation of nasal pungency, resulting in a short term exposure guideline of 0.1 mg/m^3 . The short-term guideline was also considered protective of long-term health effects associated with formaldehyde exposure, including cancer. The carcinogenic effects of formaldehyde (i.e., nasal carcinomas in rats) were attributed to increased cell proliferation as a result of cell damage from exposure to concentrations at and above 2.5 mg/m^3 (WHO 2010).

The lowest 1-hour guideline of 50 µg/m³ (ATSDR, 1999; TCEQ 2008), based on eye and nasal irritation, was selected for the current assessment of acute inhalation exposure to formaldehyde. Formaldehyde was included in the chemical group for eye irritation following acute inhalation exposures.

10.1.2 Chronic Inhalation

Table 10-2 presents the chronic inhalation exposure limits for formaldehyde.

Table 10-2 Chronic Inhalation Exposure Limits for Formaldehyde

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------------------|---|---|--------------|---|--------------------|
| ATSDR | MRL | 10 | Eye and respiratory irritation | Human | Holmstrom et al. 1989 | ATSDR 2013; 1999 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | RsC | 1.9 | Nasal tumours | Rats | Monticello et al. 1996 | Health Canada 2001 |
| HEALTH CANADA | Long-term IAQG (8 hour average) | 50 | Asthma Hospitalization | Human | Rumchev et al. 2002 | Health Canada 2006 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | REL RsC | 9 2 | Respiratory irritation | Human Rat | Wilhelmsso n and Holmstrom, 1992 Kerns et al. 1983 | OEHHA 2008 2011 |
| RIVM | - | - | - | - | - | RIVM, 2001 |
| TCEQ | ReV RsC | 11 18 | Respiratory irritation Cell proliferation ¹ | Human Rat | Wilhelmsso n and Holmstrom, 1992 Schlosser et al. 2003 | TCEQ 2008 |
| US EPA | RsC | 0.8 | Nasal tumours | Rat | Kerns et al. 1983 | US EPA 1991 |

- not available

¹ Key precursor event to tumourigenesis

The ATSDR (2013) recommend a chronic MRL of $10 \mu\text{g}/\text{m}^3$ (0.008 ppm) for formaldehyde. This MRL was based on a LOAEL of 0.24 ppm as an average 8-hour TWA for mild irritation of the eye and respiratory tract and mild damage to nasal epithelium in chemical plant workers occupationally exposed to formaldehyde for an average of 10.4 years (Holmstrom et al. 1989). The LOAEL was adjusted by an uncertainty factor of 30 for use of a LOAEL for mild effects (3) and human variability (10). No adjustment was made for extrapolation to continuous exposure based on evidence provided by Wilmer et al. (1987) that formaldehyde exposure concentration was more important than the product of exposure duration and concentration for determining the severity of epithelial damage of the upper respiratory tract (ATSDR 1999).

The OEHHA (2014) recommend a chronic REL of $9 \mu\text{g}/\text{m}^3$ for noncarcinogenic effects following chronic exposure to formaldehyde. This exposure limit is based on the Wilhelmsson and Holmstrom (1992) study NOAEL ($0.09 \text{ mg}/\text{m}^3$) and uncertainty factor (10) identified for the 8-hour REL for nasal, eye and respiratory tract irritation in chemical plant workers exposed to formaldehyde (OEHHA 2008).

The TCEQ (2008) recommend a chronic ReV of $11 \mu\text{g}/\text{m}^3$ for noncarcinogenic effects associated with chronic exposure to formaldehyde. This exposure limit is based on the Wilhelmsson and Holmstrom (1992) study NOAEL ($0.09 \text{ mg}/\text{m}^3$) for nasal, eye and respiratory tract irritation in chemical plant workers exposed to formaldehyde for 8 hours/day, 5 days/week over an average of 10 years. The NOAEL was adjusted for continuous exposure ($0.032 \text{ mg}/\text{m}^3$) and an uncertainty factor of 3 was applied to account for human variability (TCEQ 2008).

Health Canada (2006) recommended a long term indoor air quality guideline of $50 \mu\text{g}/\text{m}^3$ (based on an 8 hour average) for formaldehyde. This guideline is based on a study, by Rumchev et al. (2002), that reported an association between formaldehyde concentrations in indoor air and hospitalization for asthma in children from six months to three years of age. An air concentration of $50 \mu\text{g}/\text{m}^3$ represents the lower end of the exposure concentration range associated with no significant increase of asthma hospitalization. Although an increase in rat nasal carcinomas was reported in studies of exposures to high formaldehyde concentrations, this was considered the result of proliferative regeneration in response to cytotoxicity. Negligible cancer risks were predicted from lifetime exposure to $50 \mu\text{g}/\text{m}^3$ as this air concentration was considered to be sufficiently low to prevent irritation and inflammatory responses (Health Canada 2006).

IARC (2014) has classified formaldehyde as *carcinogenic to humans* (Group 1) and the NTP (2014) has listed formaldehyde as *known to be a human carcinogen*. Although not completely understood, there is evidence for a genotoxic mode of action for nasal tumours and lymphohematopoietic cancers observed in human and animal chronic formaldehyde exposure

studies (NTP 2014). Health Canada (2001), OEHHA (2011), TECQ (2007) and US EPA (1991) have developed chronic inhalation exposure limits based on the carcinogenic potential of formaldehyde.

The US EPA (1991) identified an inhalation unit risk of 1.3×10^{-5} per $\mu\text{g}/\text{m}^3$ from a study reporting nasal squamous cell carcinomas in rats following chronic (2 year) inhalation exposure to formaldehyde (Kerns et al. 1983). This unit risk is equivalent to an RsC of $0.8 \mu\text{g}/\text{m}^3$ assuming a 1 in 100,000 incremental cancer risk level. It is noted that the potential inhalation toxicity of formaldehyde is currently under review by the US EPA with a draft human health assessment released on June 2, 2010 for independent peer review and public comment (US EPA 2012).

The OEHHA (2011) derived an inhalation unit risk of 6×10^{-6} per $\mu\text{g}/\text{m}^3$ using the Kerns et al. (1983) data for nasal squamous cell carcinomas in rats. The OEHHA unit risk is equivalent to an RsC of $2 \mu\text{g}/\text{m}^3$ for an incremental cancer risk of 1 in 100,000. The upper range of cancer risks predicted by the OEHHA (2011) using the rat bioassay data were determined to be consistent with lung cancer mortality risk estimates for workers (cohort of over 26,000) exposed to formaldehyde (Blair et al. 1986).

Health Canada (2001) determined a TC_{05} of $9.5 \text{ mg}/\text{m}^3$ using data for the incidence of nasal squamous tumours in a more recent study in rats (Monticello et al. 1996). This air concentration is associated with a 5% (1 in 20) increase in tumour incidence over background. Dividing the TC_{05} by a factor of 5,000 results in an RsC of $1.9 \mu\text{g}/\text{m}^3$ for a 1 in 100,000 incremental cancer risk level.

The TCEQ (2008) recommend an RsC of $18 \mu\text{g}/\text{m}^3$ for formaldehyde assuming a 1 in 100,000 cancer risk level. This exposure limit was derived from Schlosser et al. (2003) who reported BMC and POD values for tumour incidence and cell proliferation in 3 data sets (including Kerns et al. 1983) describing these effects in rats following chronic formaldehyde inhalation. Nasal cell proliferation was the POD selected for guideline development as it represents a key event in formaldehyde-induced carcinogenesis. A POD_{HEC} of 0.44 ppm, representing the 95% BMCL_{01} , was determined for this endpoint. The RsC of 0.015 ppm ($18 \mu\text{g}/\text{m}^3$) was developed by applying an uncertainty factor of 30 to the POD to account for extrapolation from animal data (3) and human variability (10).

An exposure limit of 9 µg/m³, recommended by the OEHHA and supported by the ATSDR and TCEQ limits, was selected for the evaluation of non-carcinogenic effects following chronic inhalation exposure to formaldehyde. Formaldehyde was included in the chemical groups for nasal irritation following chronic inhalation exposures.

An exposure limit of 2 µg/m³, recommended by the OEHHA, was selected for the evaluation of carcinogenic effects following chronic inhalation exposure to formaldehyde. Although the US EPA provided the most conservative guideline (currently under review), the OEHHA conducted a more recent evaluation of the available data and considered the results of animal as well as human studies. Formaldehyde was included in the chemical group for nasal tumours following chronic inhalation exposures.

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11.0 Naphthalene

11.1 Inhalation Exposure Limits

11.1.1 Acute Inhalation

Table 11-1 presents the acute inhalation exposure limits for naphthalene.

Table 11-1 Acute Inhalation Exposure Limits for Naphthalene

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|--------------------------|---------|-------|---------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | - | - | - | - | - | OEHHA 2014 |
| TCEQ | ESL | 200 | Odour | - | - | TCEQ 2014 |
| WHO | - | - | - | - | - | WHO 2001 |

- not available

The TCEQ have recommended an interim ESL of $200 \mu\text{g}/\text{m}^3$ for short-term exposure to naphthalene based on odour (TCEQ 2014). This guideline is not health-based and no supporting documentation was provided for the odour threshold identified.

No other acute inhalation guidelines were identified for public exposure to naphthalene; however the American Conference of Governmental Industrial Hygienists (ACGIH) recommends a short-term exposure limit (STEL) of $79 \text{ mg}/\text{m}^3$ for naphthalene based on the potential for eye and respiratory tract irritation (OSHA 2012). This STEL was established for occupational exposures up to 15 minutes duration. A 1-hour exposure limit was derived from the ACGIH STEL as follows: $79 \text{ mg}/\text{m}^3 \times 15 \text{ min} = X \text{ mg}/\text{m}^3 \times 60 \text{ min}$. This assumes that the biological response to acute naphthalene exposure will be a constant that is a function of time and exposure concentration (i.e., Habers law). Using this assumption, a limit of $20 \text{ mg}/\text{m}^3$ was determined for 1-hour exposure to naphthalene. The STEL was developed for worker exposure

and therefore a 10-fold uncertainty factor was applied to the 1-hour air concentration to account for sensitive individuals in the general population. The resulting exposure limit of 2 mg/m³ (2,000 µg/m³) was selected for the evaluation of acute inhalation exposure to naphthalene. Naphthalene was included in the chemical groups for eye irritants and respiratory irritants following acute inhalation exposures.

11.1.2 Chronic Inhalation

Table 11-2 presents the chronic inhalation exposure limits for naphthalene.

Table 11-2 Chronic Inhalation Exposure Limits for Naphthalene

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|----------------------------------|---|--------------------------|---------|-----------------------------|--------------------|
| ATSDR | MRL | 4 | Nasal lesions | Rat | Abdo et al., 2001; NTP 2000 | ATSDR 2013; 2005 |
| B.C. MOE | - | - | - | - | - | B.C. MOE 2013 |
| HEALTH CANADA | TC | 3 | Nasal lesions | Mouse | NTP, 1992; US EPA 1998 | Health Canada 2010 |
| HEALTH CANADA | Long-term IAQG (24 hour average) | 10 | Nasal lesions | Rats | NTP 2000 | Health Canada 2013 |
| METRO VANCOUVER | - | - | - | - | - | MV 2011 |
| OEHHA | RfC | 9 | Nasal lesions | Mouse | NTP 1992 | OEHHA 2000 |
| RIVM | - | - | - | - | - | RIVM, 2001 |
| TCEQ | ESL | 50 | - | - | - | TCEQ 2014 |
| US EPA | RfC | 3 | Nasal lesions | Mouse | NTP, 1992 | US EPA 2014; 1998 |
| WHO | Long-term IAQG | 10 | Nasal lesions | Rats | Various | WHO 2010 |

- not available

The ATSDR (2005) recommend a chronic inhalation MRL of $4 \mu\text{g}/\text{m}^3$ for naphthalene. This MRL was based on the occurrence of nasal lesions as reported in two chronic inhalation studies in mice (NTP 1992) and rats (Abdo et al. 2001; NTP 2000). Mice were exposed to naphthalene concentrations of 0, 10 or 30 ppm for 6 hours/day, 5 days/week over 104 weeks (NTP 1992). Rats were exposed to 0, 10, 30 or 60 ppm naphthalene for 6 hours/day, 5 days/week over 105 weeks (Abdo et al. 2001; NTP 2000). Nasal lesions were observed in both species at the lowest exposure level (LOAEL of 10 ppm or $52 \text{ mg}/\text{m}^3$). A $\text{LOAEL}_{\text{HEC}}$ of $1.04 \text{ mg}/\text{m}^3$ (0.2 ppm) was determined for rat nasal lesions, after adjusting for continuous exposure and using EPA (1994) inhalation dosimetry for a category 1 gas to derive a human equivalent concentration (from rat to human) (ATSDR 2005). An uncertainty factor of 300 was applied to the $\text{LOAEL}_{\text{HEC}}$ to account for use of a LOAEL (10), extrapolation from rats to humans, with dosimetric adjustment (3) and human variability (10). The ATSDR MRL was not selected for the current assessment based on their use of inhalation dosimetry for a category 1 gas when there is evidence to suggest that naphthalene is a category 3 gas, as described below.

An RfC of $9 \mu\text{g}/\text{m}^3$ is recommended by the OEHHA (2000) for non-carcinogenic effects following chronic inhalation exposure to naphthalene. This RfC was based on the NTP (1992) LOAEL of $52 \text{ mg}/\text{m}^3$ (10 ppm) for the occurrence of nasal lesions in mice exposed to naphthalene 6 hours/day, 5 days/week over 104 weeks. This LOAEL was adjusted for continuous exposure ($9 \text{ mg}/\text{m}^3$) and a 1000-fold uncertainty factor was applied to account for use of a LOAEL (10), extrapolation from mice to humans without dosimetric adjustment (10) and human variability (10). In keeping with the US EPA (1998) IRIS approach, the OEHHA (2000) treated naphthalene as a category 3 gas, based on its low water solubility, low direct reactivity and data to suggest that the toxic effects of naphthalene on the respiratory tract are the result of a reactive oxygenated metabolite that may be formed in the liver or respiratory tract.

The TCEQ have recommended an interim ESL of $50 \mu\text{g}/\text{m}^3$ for long-term exposure to naphthalene based on health (TCEQ 2014), although no supporting documentation was provided for this ESL.

The US EPA (1998) developed an RfC of $3 \mu\text{g}/\text{m}^3$ for naphthalene. Similar to the OEHHA (2000), this guideline was based on a LOAEL of 10 ppm ($52 \text{ mg}/\text{m}^3$) for nasal lesions in mice chronically exposed to naphthalene (NTP 1992). The US EPA (1998) determined a $\text{LOAEL}_{\text{HEC}}$ of $9 \text{ mg}/\text{m}^3$ after adjusting for continuous exposure and following inhalation dosimetry guidance for a category 3 gas. An uncertainty factor of 3000 was applied to account for use of a LOAEL (10), extrapolation from mice to humans (10), human variability (10) and deficiencies in the database, including lack of a 2-generation reproductive toxicity study and lack of chronic inhalation data for other animal species (3).

Health Canada (2010) also established a TC of $3 \mu\text{g}/\text{m}^3$ for the noncarcinogenic effects of naphthalene based on the US EPA (1998) RfC.

The WHO (2010) and Health Canada (2013) both established indoor air quality guidelines of $10 \mu\text{g}/\text{m}^3$ for chronic exposure to naphthalene. The WHO (2010) indoor air quality guideline is based on a LOAEL of $53 \text{mg}/\text{m}^3$ for nasal lesions in rats chronically exposed (105 weeks) to naphthalene (NTP 2000). This LOAEL was adjusted to account for continuous exposure (6/24 hours \times 5/7 days) and an uncertainty factor of 1000 was applied to the LOAEL to account for extrapolation from rats to humans (10), human variability (10) and use of a LOAEL rather than a NOAEL. This annual average guideline is considered to be protective of the carcinogenic risks of naphthalene exposure (WHO 2010).

The Health Canada (2013) indoor air quality guideline was also established based on the NTP (2000) chronic inhalation study in rats. Similar to the WHO, Health Canada adjusted a LOAEL of $52 \text{mg}/\text{m}^3$ for continuous exposure and applied an uncertainty factor of 1000 to account for extrapolation from rats to humans (10), human variability (10) and deficiencies in the database. This guideline is considered to be protective of nasal cytotoxicity which can lead to nasal tumour development in rats following chronic naphthalene exposure. The minimum recommended sampling time for this guideline is 24 hours (Health Canada 2013).

IARC (2014) has classified naphthalene as possibly carcinogenic to humans (Group 2B) and the NTP (2014) has stated naphthalene is *reasonably anticipated to be a human carcinogen*. The supporting evidence for the NTP classification was provided in an NTP (2000) study in which chronic exposure to naphthalene produced highly malignant and extremely rare tumours of the lining of the nose of rats. The mechanism for naphthalene carcinogenesis is not clear but formation of a specific stereoisomer of naphthalene oxide (1R,2S-) as well as oxidative damage and DNA breakage may play a role (NTP 2014).

The OEHHA (2011) recommend a unit risk value of 0.034 per mg/m^3 for carcinogenic effects following chronic inhalation exposure to naphthalene. This corresponds to an RsC of $0.3 \mu\text{g}/\text{m}^3$ assuming 1 in $100,000$ (1×10^{-5}) excess lifetime cancer risk. Unit risk factors were developed for naphthalene using benchmark dose methodology and tumour incidence data for female mice, male rats and female rats (NTP 1992; 2000). The selected unit risk factor was for the male rat (NTP 2000), the species most sensitive to naphthalene exposure via inhalation (OEHHA 2011).

Health Canada (2013) and WHO (2010) recently developed an indoor air quality guideline of $10 \mu\text{g}/\text{m}^3$ for chronic exposure to naphthalene, which was considered protective of nasal cytotoxicity and tumour development. Both agencies attributed nasal and lung tumor development to a progression of effects from tissue damage in the nasal cavities and lungs as a result of high exposure concentrations, rather than a direct acting carcinogenic effect.

The majority of agencies have developed chronic inhalation exposure limits based on the non-carcinogenic effects (nasal lesions) of naphthalene reported in mice and rats. For the purpose of this assessment the lowest recommended RfC of 3 µg/m³ (US EPA, Health Canada) was selected for the assessment of noncarcinogenic effects following chronic inhalation exposure to naphthalene. Naphthalene was included in the chemical group for nasal irritation following chronic inhalation exposures.

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12.0 Nitrogen Dioxide

12.1 Inhalation Exposure Limits

12.1.1 Acute Inhalation

Table 12-1 presents the acute inhalation exposure limits for nitrogen dioxide.

Table 12-1 Acute Inhalation Exposure Limits for Nitrogen Dioxide

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|----------------------------|---|--------------------------|---------|------------------|-------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | 1-hour | 188 | - | - | - | B.C. MOE 2014 |
| CCME | 1-hour 24-hour NAAQO | 400 200 | - | - | - | CCME 1999 |
| METRO VANCOUVER | 1-hour AAQO | 200 | - | - | Adopted NAAQO | MV 2011 |
| OEHHA | 1-hour REL | 470 | Respiratory system | Human | CARB, 1992 | OEHHA 2008; 2014 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | 1-hour NAAQS | 188 | Respiratory system | Human | Various | US EPA 2008; 2012 |
| WHO | 1-hour | 200 | Respiratory system | Human | Various | WHO 2006 |

- not available

Clinical studies of controlled human exposure have reported increased airway responsiveness to inhaled allergens in sensitive individuals as a result of acute exposure to nitrogen dioxide while epidemiological studies have correlated ambient nitrogen dioxide exposure with increased respiratory symptoms, emergency department visits and hospital admissions (AENV 2011; 2007; US EPA 2008).

The desirable Canadian NAAQOs for NO₂ are 400 µg/m³ for a 1-hour averaging time and 200 µg/m³ over 24 hours (CCME 1999). The Metro Vancouver (2011) 1-hour AAQO reflects the Canadian 1-hour desirable NAAQO for nitrogen dioxide. Supporting health-based documentation is not available for the nitrogen dioxide NAAQO values. Canada Ambient Air Quality Standards (CAAQS), defined by Environment Canada (2013) as *health-based air quality objectives for pollutant concentrations in outdoor air*, are being developed for Canada under the current Air Quality Management System. There are currently no CAAQS for nitrogen dioxide, although work has been initiated by federal, provincial and territorial governments (CCME 2013; Environment Canada 2013).

The OEHHA (2008; 2013) recommends a 1-hour REL of 470 µg/m³. This REL was equivalent to a NOAEL for increased airway reactivity in asthmatics exposed to nitrogen dioxide for 1 hour (CARB, 1992).

The US EPA (2008; 2012) has implemented a 1-hour NAAQS of 188 µg/m³ to protect against the respiratory effects of nitrogen dioxide. This standard considers the 3-year average of the 98th percentile of the yearly distribution of 1-hour daily maximum nitrogen dioxide concentrations. B.C. MOE (2014) recommends the same objective (188 µg/m³) for 1-hour exposure to nitrogen dioxide, with achievement based on the annual 98th percentile of daily 1-hour maximum values, over one year.

In controlled exposure studies, acute effects on the pulmonary function of asthmatics were observed at nitrogen dioxide concentrations levels greater than 500 µg/m³, with one meta-analysis suggesting an increase in bronchial responsiveness in asthmatics exposed to air concentrations above 200 µg/m³ (Folinsbee, 1992; WHO 2006). The WHO (2006) has therefore set a 1-hour exposure limit of 200 µg/m³ for short-term exposure to nitrogen dioxide.

Considering the weight of available evidence for airway reactivity of susceptible individuals (i.e., asthmatics) exposed to nitrogen dioxide, the lowest reported exposure limit, US EPA NAAQS of 188 µg/m³, was selected for use in the acute effects assessment of nitrogen dioxide. Nitrogen dioxide was included in the chemical group for respiratory irritation following acute inhalation exposures.

12.1.2 Chronic Inhalation

Table 12-2 presents the chronic inhalation exposure limits for nitrogen dioxide.

Table 12-2 Chronic Inhalation Exposure Limits for Nitrogen Dioxide

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|----------------------|---|--------------------------|---------|---------|-------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | Annual AAQO | 60 | | | | B.C. MOE 2014 |
| CCME | Annual Average NAAQO | 60 | - | - | - | CCME 1999 |
| METRO VANCOUVER | Annual AAQO | 40 | - | - | - | MV 2011 |
| OEHHA | - | - | - | - | - | OEHHA 2014 |
| RIVM | - | - | - | - | - | RIVM, 2001 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | Annual Average NAAQS | 100 | Respiratory system | Human | Various | US EPA 2008; 2012 |
| WHO | Annual Average | 40 | Respiratory system | Human | Various | WHO 2006; 2000 |

- not available

The desirable annual average NAAQO for NO_2 is $60 \mu\text{g}/\text{m}^3$ (CCME 1999) which is the same as the B.C. MOE annual air quality objective for NO_2 (B.C. MOE 2014). No supporting documentation was available for these objectives. The WHO (2000; 2006) established an annual average guideline value of $40 \mu\text{g}/\text{m}^3$ for NO_2 . In the absence of a particular study or set of studies that clearly support an annual average guideline, the WHO considered background ambient levels of $15 \mu\text{g}/\text{m}^3$ and evidence of a 20% increase in respiratory illness in primary children with an increase of $28 \mu\text{g}/\text{m}^3$ nitrogen dioxide indoors (averaged over 1 year) (WHO 1997). The annual AAQO recommended for nitrogen dioxide by Metro Vancouver (2011) reflects the WHO (2000; 2006) guideline.

The US EPA (2012) annual standard for NO₂ is 100 µg/m³. This exposure limit is based on limited evidence to support a link between long-term exposure to nitrogen dioxide and adverse respiratory effects, particularly for persons with pre-existing pulmonary dysfunction (US EPA 2008).

Considering the available evidence for respiratory illness in children and individuals with pre-existing pulmonary dysfunction following long-term exposure to NO₂, the lowest WHO guideline of 40 µg/m³ was selected for the assessment of chronic inhalation exposure to NO₂.

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13.0 Particulate Matter

13.1 Inhalation Exposure Limits

13.1.1 Acute Inhalation

Tables 13-1 and 13-2 presents the acute inhalation exposure limits for fine PM ($\leq 2.5 \mu\text{m}$ in diameter; $\text{PM}_{2.5}$) and coarse PM ($\leq 10 \mu\text{m}$ in diameter; PM_{10}) respectively.

Table 13-1 Acute Inhalation Exposure Limits for Fine PM ($\leq 2.5 \mu\text{m}$ in Diameter)

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|------------------------------------|---------|---------|-------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | 24 hour AAQO | 25 | - | - | - | B.C. MOE 2013 |
| CCME | 24-hour CWS/CAA QS | 27-30 | Population mortality and morbidity | Human | Various | CCME 2012; 2000 |
| CARB | 24 hour AAQS | - | - | - | - | CARB 2009 |
| METRO VANCOUVER | 24 hour AAQO | 25 | - | - | - | MV 2011 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | 24-hour | 35 | Population mortality and morbidity | Human | Various | US EPA 2012; 2009 |
| WHO | 24-hour | 25 | Population mortality and morbidity | Human | Various | WHO 2006 |

- not available

Table 13-2 Acute Inhalation Exposure Limits for Coarse PM ($\leq 10 \mu\text{m}$ in Diameter)

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|------------------------------------|---------|----------------------------|-------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | 24 hour AAQO | 50 | - | - | - | B.C. MOE 2013 |
| CCME | - | - | - | - | - | CCME 2012; 2000 |
| CARB | 24 hour AAQS | 50 | Population mortality and morbidity | Human | Various | CARB 2009 |
| METRO VANCOUVER | 24 hour AAQO | 50 | - | - | - | MV 2011 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | 24-hour | 150 | Population mortality and morbidity | Human | Various | US EPA 2012; 2009 |
| WHO | 24-hour | 50 | Based on $\text{PM}_{2.5}$ | Human | Based on $\text{PM}_{2.5}$ | WHO 2006 |

- not available

The CCME (2000) developed a 24-hour Canada Wide Standard (CWS) of $30 \mu\text{g}/\text{m}^3$ for fine particulate matter ($\text{PM}_{2.5}$). The CWS is based on the 3 year average of the annual 98th percentile of the 24-hour average concentrations. The $\text{PM}_{2.5}$ CWS was based on the weight of available evidence for an association between acute exposure to ambient fine particulate matter and increased population mortality and morbidity, particularly related to the cardiovascular and respiratory systems, reported in numerous epidemiological studies from the US, Canada, Britain and Europe (WGAQOG 1998; Health Canada 2000; US EPA 2009).

The available data (epidemiological studies of large populations) have not identified a threshold concentration below which adverse effects do not occur; therefore actions to reduce ambient $\text{PM}_{2.5}$ concentrations is considered an improvement in air quality that will be beneficial to human health (CCME, 2000; WHO 2006). In addition to the CWS for fine particulate matter, the CCEM (2000) provides guidance for i) continuous improvement and ii) keeping clean areas. This guidance is intended to reinforce the health benefits of lowering ambient $\text{PM}_{2.5}$ air concentrations and dissuade actions that could result in "polluting up" to the CWS in areas where ambient $\text{PM}_{2.5}$ concentrations are low.

In May 2013, the Canadian Ambient Air Quality Standards (CAAQS) for PM_{2.5} were published in the Canada Gazette (Vol 147, No. 21). The CAAQS replaced the existing CWS for fine particulate matter, based on amendments to the Canadian Environmental Protection Act in 2013. In keeping with the intent for continuous improvement of air quality, the 24-hour PM_{2.5} standard, to be achieved by 2015, was to be 28 µg/m³ with a slightly more stringent standard of 27 µg/m³ recommended for 2020 (CCME 2012). The CAAQS is based on the 3 year average of the annual 98th percentile of the 24-hour average concentrations. The CCME (2000; 2012) have not established standards specific to coarse particulate matter (PM₁₀) as the management of PM_{2.5} was considered to result in the greatest health benefits and reductions in fine particulate matter are expected to reduce concentrations of coarse particulate matter (CCME 2000).

The California Air Resources Board (CARB, 2009) have established an acute ambient air quality standard of 50 µg/m³ (24-hour average) for PM₁₀. The acute health effects noted for coarse particulate matter exposure include worsening symptoms of asthma and acute bronchitis, particularly in the elderly and very young, as well as increased mortality or risk of hospitalization due to respiratory illness and lung disease (CARB 2009).

The US EPA (2012) implemented a 24-hour primary standard (NAAQS) of 35 µg/m³ for PM_{2.5} based on the 3-year average of 98th percentile concentrations. This standard is intended to increase protection against adverse health effects associated with acute exposure to respirable particles, including cardiovascular and respiratory effects and premature mortality (US EPA 2009). The US EPA (2012) also recommend an acute NAAQS of 150 µg/m³ for PM₁₀ which is not to be exceeded more than once per year over a 3 year average. Similar to PM_{2.5}, this standard is based on evidence of a causal relationship between acute exposure to coarse particulate matter (PM_{10-2.5}) and cardiovascular effects, respiratory effects and mortality. The evidence for these associations was limited in comparison to the evidence for PM_{2.5} and these associations were only apparent for short-term (not long-term) exposures to PM_{10-2.5} (US EPA 2009).

The WHO (2006) recommends a 24-hour guideline of 25 µg/m³ for PM_{2.5} and a 24-hour guideline of 50 µg/m³ for PM₁₀. The 24-hour guidelines refer to the 99th percentile of the distribution of daily values, i.e. the fourth next highest value of the year. The acute PM guidelines are intended to protect against peaks of pollution that could result in excess morbidity or mortality. The acute PM_{2.5} guideline was established based on relationships between the distributions of 24-hour means and annual average PM concentrations. The acute guideline for PM₁₀ was developed using PM_{2.5} as an indicator of potential health effects and applying a PM_{2.5}/PM₁₀ ratio of 0.5, which represents the approximate ratio of PM_{2.5}/PM₁₀ observed in urban areas. It is noted that the WHO (2006) prefers the use of the PM_{2.5} guideline for the evaluation of PM exposure.

Similar to the WHO (2006), the B.C. MOE (2013; 2009) also recommend 24-hour guidelines of 25 $\mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and 50 $\mu\text{g}/\text{m}^3$ for PM_{10} , which have been adopted by Metro Vancouver (2011).

The WHO (2006) also recommend three interim 24-hour target levels as a stepped approach for countries as they develop abatement measures to move towards eventual compliance with the guidelines. The highest interim targets are 75 and 150 $\mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and PM_{10} , respectively. These targets are associated with an approximate 5% increase in short-term mortality risk, relative to the short-term mortality risk at the recommended air quality guidelines. The next interim targets of 50 $\mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and 100 $\mu\text{g}/\text{m}^3$ for PM_{10} are associated with ~2.5% increase in short-term mortality risk compared to the guidelines. The lowest interim targets of 37.5 and 75 $\mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and PM_{10} , respectively, are associated with ~1.2% increase in short-term mortality. These risk estimates were determined using published risk coefficients from multi-centre epidemiological studies and meta-analyses (WHO 2006).

The lowest recommended 24-hour guidelines of 25 $\mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and 50 $\mu\text{g}/\text{m}^3$ for PM_{10} (WHO 2006) were selected for the assessment of potential health risks following acute inhalation exposure to fine and coarse particulate matter, recognizing the health benefits of maintaining ambient $\text{PM}_{2.5}$ air concentrations as low as possible.

$\text{PM}_{2.5}$ and PM_{10} were included in the population mortality/morbidity group for acute (24-hour) inhalation exposures.

13.1.2 Chronic Inhalation

Tables 13-3 and 13-4 presents the chronic inhalation exposure limits for PM_{2.5} and PM₁₀ respectively.

Table 13-3 Chronic Inhalation Exposure Limits for PM_{2.5}

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|----------------------|---|---------------------------------|---------|---------------------------|-------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | Annual Average AAQO | 8 (objective) 6 (goal) | - | - | - | B.C. MOE 2013 |
| CCME | Annual Average CAAQS | 8.8-10 | Premature mortality | Human | Various | CCME 2012; 2000 |
| CARB | Annual Average | 12 | Population mortality /morbidity | Human | Various | CARB 2009 |
| METRO VANCOUVER | Annual Average AAQO | 8 (objective) 6 (goal) | - | - | - | MV 2011 |
| RIVM | - | - | - | - | - | RIVM, 2001 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | Annual Average NAAQS | 12 | Population mortality/ morbidity | Human | Various | US EPA 2012; 2009 |
| WHO | Annual Average | 10 | Population mortality/ morbidity | Human | Pope et al., 2002, others | WHO 2006; 2000 |

- not available

Table 13-4 Chronic Inhalation Exposure Limits for PM₁₀

| Agency | Exposure Limit Type | Exposure Limit Value (µg/m ³) | Critical Organ or Effect | Species | Study | Source |
|-----------------|---------------------|---|---------------------------------|---------|----------------------------|-------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013 |
| B.C. MOE | Annual Average AAQO | | - | - | - | B.C. MOE 2013 |
| CCME | - | - | - | - | - | CCME 2012; 2000 |
| CARB | Annual Average | 20 | Population mortality /morbidity | Human | Various | CARB 2009 |
| METRO VANCOUVER | Annual Average AAQO | 20 | - | - | - | MV 2011 |
| RIVM | - | - | - | - | - | RIVM, 2001 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | - | - | - | - | - | US EPA 2012; 2009 |
| WHO | Annual Average | 20 | Based on PM _{2.5} | | Based on PM _{2.5} | WHO 2006; 2000 |

- not available

Annual average CAAQS for PM_{2.5} were published in the Canada Gazette in May 2013. The annual average standard to be achieved by 2015 will be 10 µg/m³ with a slightly more stringent standard of 8.8 µg/m³ recommended for 2020. The CAAQS is based on the 3 year average of the annual average concentrations (CCME 2012).

The CARB (2009) established annual ambient air quality standards of 12 and 20 µg/m³ (arithmetic means) for PM_{2.5} and PM₁₀, respectively. These standards are intended to protect against increased risk of hospitalization for lung and heart-related illness, premature death of the elderly and individuals with compromised pulmonary function, and reduced lung function or increased respiratory symptoms/illness in children.

The US EPA (2012) has implemented a primary annual standard (NAAQS) of $12 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ based on the 3-year average of 98th percentile concentrations. The annual standard is intended to continue protection against adverse health effects associated with chronic exposure to respirable particles, including cardiovascular effects, respiratory effects, and premature mortality (US EPA 2009).

The WHO (2006) established an annual mean guideline of $10 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$. This guideline represents the lower end of the air concentration range in the American Cancer Society (ACS) epidemiological study at which robust associations were reported between mortality and long-term exposure to $\text{PM}_{2.5}$ (Pope et al., 2002). Although threshold levels were not identified, the long-term epidemiological studies reported robust associations between $\text{PM}_{2.5}$ exposure and mortality and annual average target concentrations for $\text{PM}_{2.5}$ should take precedence over 24-hour average concentrations (WHO 2006). An annual mean guideline of $20 \mu\text{g}/\text{m}^3$ is recommended for PM_{10} assuming a $\text{PM}_{2.5}/\text{PM}_{10}$ ratio of 0.5 and using $\text{PM}_{2.5}$ as an indicator of potential health effects.

Three interim target levels were developed for the annual mean guidelines for PM as a stepped approach for countries as they develop successive and sustained abatement measures to move towards eventual compliance with the recommended air quality guidelines (WHO 2006). The highest interim targets (35 and $70 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and PM_{10} , respectively) are associated with a 15% higher long-term mortality risk relative to the mortality risk at the lowest recommended air quality guideline. Attainment of intermediate interim targets (25 and $50 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and PM_{10} , respectively) is expected to lower the mortality risks by 6% when compared to the highest interim targets. The lowest interim targets (15 and $30 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$ and PM_{10} , respectively) would reduce by the mortality risks by a further 6%, compared to the intermediate targets (WHO 2006).

The B.C. MOE (2013; 2009) have established an annual air quality objective of $8 \mu\text{g}/\text{m}^3$ and, in the absence of a safe threshold for human health effects, a planning goal of $6 \mu\text{g}/\text{m}^3$ for $\text{PM}_{2.5}$. The intent of the planning goal being *to guide airshed planning efforts and encourage communities to maintain good air quality in the face of economic growth and development* (B.C. MOE 2009). The annual objectives recommended for $\text{PM}_{2.5}$ by B.C. MOE (2013) have been adopted by Metro Vancouver (2011).

In the absence of an identified threshold for mortality risks associated with long-term exposure to $\text{PM}_{2.5}$ (WHO 2006), the lowest recommended guideline of $6 \mu\text{g}/\text{m}^3$ (B.C. MOE 2013) was adopted for the current assessment of risks associated with chronic inhalation exposure to $\text{PM}_{2.5}$. The chronic guideline of $20 \mu\text{g}/\text{m}^3$, supported by WHO (2006), CARB (2009); B.C. MOE (2013) and Metro Vancouver (MV 2011), was selected for the assessment of long-term exposure to PM_{10} .

PM_{2.5} and PM₁₀ were included in the population mortality/morbidity group for chronic inhalation exposures.

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14.0 Sulphur Dioxide

14.1 Inhalation Exposure Limits

14.1.1 Acute Inhalation

Table 14-1 presents the acute inhalation exposure limit for sulphur dioxide.

Table 14-1 Acute Inhalation Exposure Limits for Sulphur Dioxide

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|----------------------------|---|--|---------|--------------------------------------|-------------------|
| ATSDR | Acute MRL | 26 | Respiratory system | Human | Sheppard et al. 1981 | ATSDR 2013; 1998 |
| B.C. MOE | 1-hour | 200 | - | - | - | B.C. MOE 2014 |
| CCME | 1-hour 24-hour NAAQO | 450 150 | - | - | - | CCME 1999 |
| METRO VANCOUVER | 1-hour 24-hour AAQO | 450 125 | - | - | Adopted 1-hour NAAQO | MV 2011 |
| OEHHA | 1-hour REL | 660 | Respiratory system | Human | Roger et al., 1985; Linn et al. 1987 | OEHHA 2014; 2008 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | 1-hour NAAQS | 200 | Respiratory system | Human | Various | US EPA 2012; 2010 |
| WHO | 10-min 24-hour | 500 20-125 | Respiratory system Population morbidity/ mortality | Human | Various | WHO 2006 |

- not available

The ATSDR (2013) recommend a MRL of 26 $\mu\text{g}/\text{m}^3$ for acute exposure to SO_2 . This MRL was derived from a controlled exposure study which examined bronchoconstriction (changes in specific airway resistance) in mild asthmatics directly exposed, via a mouthpiece, to SO_2 during 10 minutes of exercise (Sheppard et al. 1981). The ATSDR do not recommend an averaging time for this MRL. It is noted that bronchoconstrictive responses to SO_2 exposures were reported to be highly variable in individual asthmatics (ATSDR 1998) and that the LOAEL identified from this study was based on the response of 2 out of a total of 7 individuals examined.

The desirable Canadian NAAQOs for SO_2 are 450 $\mu\text{g}/\text{m}^3$ for a 1-hour averaging time and 150 $\mu\text{g}/\text{m}^3$ over 24 hours (CCME 1999). The Metro Vancouver (2011) 1-hour AAQO for sulphur dioxide reflects the Canadian desirable NAAQO (450 $\mu\text{g}/\text{m}^3$), while the 24-hour AAQO of 125 $\mu\text{g}/\text{m}^3$ is slightly lower. Supporting health-based documentation is not available for the sulphur dioxide NAAQO or AAQO values. Canada Ambient Air Quality Standards (CAAQS), defined by Environment Canada (2013) as *health-based air quality objectives for pollutant concentrations in outdoor air*, are being developed for sulphur dioxide under the current Air Quality Management System. There are currently no CAAQS for sulphur dioxide, although work has been initiated by federal, provincial and territorial governments (CCME 2013; Environment Canada 2013).

The OEHHA (2013) recommends a 1-hour REL of 660 $\mu\text{g}/\text{m}^3$. This exposure limit was based on NOAELs reported in studies of respiratory effects in healthy, asthmatic and atopic individuals following controlled exposure to SO_2 with or without exercise (Roger et al., 1985; Linn et al. 1987).

To protect against respiratory effects, the US EPA (2012) has implemented a 1-hour NAAQS of 200 $\mu\text{g}/\text{m}^3$ for SO_2 . This standard considers the 3-year average of the 99th percentile of 1-hour daily maximum SO_2 concentrations. The basis for this exposure limit was the protection of sensitive individuals (including asthmatic children) from adverse respiratory effects during periods of exertion. This standard also considered epidemiological studies reporting causal associations between 1-hour daily maximum SO_2 concentrations and respiratory morbidity (increased hospital admissions). The 1-hour NAAQS was expected to substantially limit asthmatics short-term exposure (5-10 minutes) to SO_2 concentrations above 500 $\mu\text{g}/\text{m}^3$ (US EPA 2010). B.C. MOE (2014) has established the same 1-hour concentration of 200 $\mu\text{g}/\text{m}^3$ as an objective for SO_2 , with achievement based on the annual 99th percentile of daily 1-hour maximum values, over one year.

Breathing difficulties in response to SO₂ can occur within the first few minutes of exposure and may provoke asthma attacks, particularly during exercise; therefore, the WHO (2006) has recommended a 10 minute time-weighted average guideline of 500 µg/m³ for acute exposures to SO₂.

The WHO (2006) also recommends a 24-hour guideline of 20 µg/m³ for SO₂, with two interim 24-hour target levels of 125 µg/m³ and 50 µg/m³ as countries move towards compliance with the more stringent guideline. These recommendations are based on epidemiological studies that report an association between mortality, morbidity or lung function changes and 24-hour average SO₂ concentrations in ambient air (WHO 2006), similar to the observed associations with 24 hour concentrations of particulate matter. However, as discussed by WHO (2006), these epidemiological studies involve exposure to multiple chemicals and there remains considerable uncertainty as to whether SO₂ is the chemical responsible for the effects observed or whether SO₂ is a surrogate for ultrafine particles or another correlated substance. Given this considerable uncertainty and considering that 24-hour guidelines for particulate matter are being considered, the 24-hour guideline for sulphur dioxide was not included in the current assessment.

The US EPA NAAQS of 200 µg/m³ was selected for the evaluation of 1-hour exposures to sulphur dioxide as it was the most recently established acute guideline for SO₂ and is based on the results of a range of epidemiological studies that considered sensitive individuals, including asthmatic children. The WHO (2006) 10-min guideline of 500 µg/m³ was also selected based on the potential for asthma attacks within minutes of exposure to SO₂ during exercise. Sulphur dioxide was included in the chemical group for respiratory irritation following acute inhalation exposures.

14.1.2 Chronic Inhalation

Table 14-2 presents the chronic inhalation exposure limit for sulphur dioxide.

Table 14-2 Chronic Inhalation Exposure Limits for Sulphur Dioxide

| Agency | Exposure Limit Type | Exposure Limit Value ($\mu\text{g}/\text{m}^3$) | Critical Organ or Effect | Species | Study | Source |
|-----------------|----------------------|---|--------------------------|---------|-------|-------------------|
| ATSDR | - | - | - | - | - | ATSDR 2013; 1998 |
| B.C. MOE | Annual Average AAQO | 25 | - | - | - | B.C. MOE 2013 |
| CCME | Annual Average NAAQO | 30 | - | - | - | CCME 1999 |
| METRO VANCOUVER | Annual Average AAQO | 30 | - | - | - | MV 2011 |
| OEHHA | - | - | - | - | - | OEHHA 2014; 2008 |
| TCEQ | - | - | - | - | - | TCEQ 2014 |
| US EPA | - | - | - | - | - | US EPA 2012; 2010 |
| WHO | - | - | - | - | - | WHO 2006 |

- not available

The desirable Canadian NAAQO for SO_2 over an annual averaging period is $30 \mu\text{g}/\text{m}^3$ (CCME 1999). Metro Vancouver (2011) also recommends an annual average AAQO of $30 \mu\text{g}/\text{m}^3$. The lowest B.C. MOE Pollution Control Objective recommended for annual air concentrations of SO_2 is $25 \mu\text{g}/\text{m}^3$.

Although documentation to support the basis for these objectives could not be located, for the purpose of this assessment, the B.C. MOE AAQO of $25 \mu\text{g}/\text{m}^3$ was selected for the evaluation of chronic exposure to SO_2 , as this represents the lowest of the annual average guidelines recommended by Canadian federal and provincial agencies.

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ATTACHMENT B

Predicted Air Concentrations and Risk Quotient Values

C-1.0 Existing Conditions (2011)
Table C-1.1 Acute Inhalation Exposures and Risk Quotients

| Receptor | Formaldehyde | | | Acetaldehyde | | | Acrolein | | |
|---------------|--------------------------|-----------------------------------|------|--------------------------|-----------------------------------|------|--------------------------|-----------------------------------|------|
| | 1-h | | | 1-h | | | 1-h | | |
| | Existing modeled (ug/m3) | Existing plus Ambient Air (ug/m3) | RQ | Existing modeled (ug/m3) | Existing plus Ambient Air (ug/m3) | RQ | Existing modeled (ug/m3) | Existing plus Ambient Air (ug/m3) | RQ |
| 1 | 2.4 | 8.8 | 0.18 | 1.9 | 7.4 | 0.02 | 0.1 | 0.3 | 0.12 |
| 2 | 2.4 | 8.8 | 0.18 | 2.0 | 7.5 | 0.02 | 0.1 | 0.3 | 0.13 |
| 3 | 1.9 | 8.3 | 0.17 | 1.6 | 7.1 | 0.02 | 0.1 | 0.3 | 0.11 |
| 4 | 1.9 | 8.3 | 0.17 | 1.5 | 7.0 | 0.01 | 0.1 | 0.3 | 0.11 |
| 5 | 2.3 | 8.7 | 0.17 | 1.9 | 7.4 | 0.02 | 0.1 | 0.3 | 0.12 |
| 6 | 2.7 | 9.1 | 0.18 | 2.1 | 7.6 | 0.02 | 0.2 | 0.3 | 0.13 |
| 7 | 3.7 | 10.1 | 0.20 | 3.0 | 8.5 | 0.02 | 0.2 | 0.4 | 0.16 |
| 8 | 3.1 | 9.5 | 0.19 | 2.5 | 8.0 | 0.02 | 0.2 | 0.4 | 0.14 |
| 9 | 2.7 | 9.1 | 0.18 | 1.9 | 7.4 | 0.02 | 0.2 | 0.3 | 0.13 |
| 10 | 6.2 | 12.6 | 0.25 | 4.3 | 9.8 | 0.02 | 0.4 | 0.6 | 0.23 |
| 11 | 2.2 | 8.6 | 0.17 | 1.5 | 7.0 | 0.01 | 0.1 | 0.3 | 0.12 |
| 12 | 1.9 | 8.3 | 0.17 | 1.4 | 6.8 | 0.01 | 0.1 | 0.3 | 0.12 |
| 13 | 4.0 | 10.4 | 0.21 | 2.7 | 8.2 | 0.02 | 0.3 | 0.4 | 0.17 |
| 14 | 1.5 | 7.9 | 0.16 | 1.0 | 6.5 | 0.01 | 0.1 | 0.3 | 0.11 |
| 15 | 2.2 | 8.6 | 0.17 | 1.5 | 7.0 | 0.01 | 0.1 | 0.3 | 0.12 |
| 16 | 6.4 | 12.8 | 0.26 | 4.6 | 10.1 | 0.02 | 0.4 | 0.6 | 0.23 |
| 17 | 2.8 | 9.2 | 0.18 | 2.0 | 7.5 | 0.02 | 0.2 | 0.3 | 0.14 |
| 18 | 1.8 | 8.2 | 0.16 | 1.3 | 6.7 | 0.01 | 0.1 | 0.3 | 0.11 |
| 19 | 2.1 | 8.5 | 0.17 | 1.4 | 6.9 | 0.01 | 0.1 | 0.3 | 0.12 |
| 20 | 7.9 | 14.3 | 0.29 | 5.4 | 10.9 | 0.02 | 0.5 | 0.7 | 0.27 |
| 21 | 7.2 | 13.6 | 0.27 | 4.9 | 10.4 | 0.02 | 0.5 | 0.6 | 0.25 |
| 22 | 2.7 | 9.1 | 0.18 | 1.9 | 7.4 | 0.02 | 0.2 | 0.3 | 0.14 |
| 23 | 2.2 | 8.6 | 0.17 | 1.6 | 7.1 | 0.02 | 0.1 | 0.3 | 0.12 |
| 24 | 5.2 | 11.6 | 0.23 | 3.7 | 9.1 | 0.02 | 0.3 | 0.5 | 0.20 |
| 25 | 3.6 | 10.0 | 0.20 | 2.5 | 8.0 | 0.02 | 0.2 | 0.4 | 0.16 |
| 26 | 3.5 | 9.9 | 0.20 | 2.4 | 7.9 | 0.02 | 0.2 | 0.4 | 0.16 |
| 27 | 2.4 | 8.8 | 0.18 | 1.6 | 7.1 | 0.02 | 0.1 | 0.3 | 0.13 |
| 28 | 1.6 | 8.0 | 0.16 | 1.4 | 6.9 | 0.01 | 0.1 | 0.3 | 0.11 |
| 29 | 1.6 | 8.0 | 0.16 | 1.4 | 6.9 | 0.01 | 0.1 | 0.3 | 0.11 |
| 30 | 2.3 | 8.7 | 0.17 | 2.0 | 7.5 | 0.02 | 0.1 | 0.3 | 0.12 |
| 31 | 2.3 | 8.7 | 0.17 | 2.0 | 7.5 | 0.02 | 0.1 | 0.3 | 0.12 |
| 32 | 1.3 | 7.7 | 0.15 | 1.1 | 6.6 | 0.01 | 0.1 | 0.2 | 0.10 |
| 33 | 1.3 | 7.7 | 0.15 | 1.1 | 6.6 | 0.01 | 0.1 | 0.2 | 0.10 |
| 34 | 1.3 | 7.7 | 0.15 | 1.1 | 6.6 | 0.01 | 0.1 | 0.2 | 0.10 |
| 35 | 1.3 | 7.7 | 0.15 | 1.1 | 6.6 | 0.01 | 0.1 | 0.2 | 0.10 |
| 36 | 2.5 | 8.9 | 0.18 | 2.0 | 7.5 | 0.02 | 0.1 | 0.3 | 0.13 |
| 37 | 1.5 | 7.9 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.3 | 0.10 |
| 38 | 1.8 | 8.2 | 0.16 | 1.4 | 6.9 | 0.01 | 0.1 | 0.3 | 0.11 |
| 39 | 1.8 | 8.2 | 0.16 | 1.4 | 6.9 | 0.01 | 0.1 | 0.3 | 0.11 |
| 40 | 2.2 | 8.6 | 0.17 | 2.0 | 7.4 | 0.02 | 0.1 | 0.3 | 0.12 |
| 41 | 1.4 | 7.8 | 0.16 | 1.1 | 6.5 | 0.01 | 0.1 | 0.3 | 0.10 |
| 42 | 2.3 | 8.7 | 0.17 | 1.8 | 7.3 | 0.02 | 0.1 | 0.3 | 0.12 |
| 43 | 2.2 | 8.6 | 0.17 | 1.7 | 7.2 | 0.02 | 0.1 | 0.3 | 0.12 |
| 44 | 1.5 | 7.9 | 0.16 | 1.2 | 6.6 | 0.01 | 0.1 | 0.3 | 0.11 |
| 45 | 1.5 | 7.9 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.3 | 0.11 |
| 46 | 1.9 | 8.3 | 0.17 | 1.5 | 7.0 | 0.01 | 0.1 | 0.3 | 0.11 |
| 47 | 1.5 | 7.9 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.3 | 0.11 |
| 48 | 1.6 | 8.0 | 0.16 | 1.3 | 6.7 | 0.01 | 0.1 | 0.3 | 0.11 |
| 49 | 6.2 | 12.6 | 0.25 | 5.3 | 10.8 | 0.02 | 0.4 | 0.5 | 0.21 |
| 50 | 1.5 | 7.9 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.3 | 0.11 |
| 51 | 1.7 | 8.1 | 0.16 | 1.4 | 6.8 | 0.01 | 0.1 | 0.3 | 0.11 |
| MPOI-Richmond | 26.3 | 32.7 | 0.65 | 18.1 | 23.6 | 0.05 | 1.7 | 1.8 | 0.74 |
| MPOI-Delta | 25.1 | 31.5 | 0.63 | 17.5 | 23.0 | 0.05 | 1.6 | 1.8 | 0.70 |

bold: RQ >1

*10 min SO2 from 1-hour data us

C-2.0 Future Conditions (2031) Without the Project
Table C-2.1 Acute Inhalation Exposures and Risk Quotients

| Receptor | Formaldehyde | | | Acetaldehyde | | | Acrolein | | |
|---------------|-----------------------------------|--|------|-----------------------------------|--|------|-----------------------------------|--|------|
| | 1-h | | | 1-h | | | 1-h | | |
| | Future no Project modeled (ug/m3) | Future no Project plus Ambient Air (ug/m3) | RQ | Future no Project modeled (ug/m3) | Future no Project plus Ambient Air (ug/m3) | RQ | Future no Project modeled (ug/m3) | Future no Project plus Ambient Air (ug/m3) | RQ |
| 1 | 1.4 | 7.8 | 0.16 | 1.0 | 6.5 | 0.01 | 0.1 | 0.2 | 0.09 |
| 2 | 1.4 | 7.8 | 0.16 | 1.0 | 6.5 | 0.01 | 0.1 | 0.2 | 0.10 |
| 3 | 1.1 | 7.5 | 0.15 | 0.8 | 6.3 | 0.01 | 0.1 | 0.2 | 0.09 |
| 4 | 1.2 | 7.6 | 0.15 | 0.8 | 6.3 | 0.01 | 0.1 | 0.2 | 0.09 |
| 5 | 1.3 | 7.7 | 0.15 | 1.0 | 6.4 | 0.01 | 0.1 | 0.2 | 0.09 |
| 6 | 1.6 | 8.0 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.2 | 0.10 |
| 7 | 2.1 | 8.5 | 0.17 | 1.5 | 7.0 | 0.01 | 0.1 | 0.3 | 0.11 |
| 8 | 1.8 | 8.2 | 0.16 | 1.3 | 6.8 | 0.01 | 0.1 | 0.3 | 0.10 |
| 9 | 1.7 | 8.1 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.3 | 0.10 |
| 10 | 4.2 | 10.6 | 0.21 | 2.5 | 8.0 | 0.02 | 0.2 | 0.4 | 0.15 |
| 11 | 1.5 | 7.9 | 0.16 | 0.9 | 6.4 | 0.01 | 0.1 | 0.2 | 0.10 |
| 12 | 1.3 | 7.7 | 0.15 | 0.8 | 6.3 | 0.01 | 0.1 | 0.2 | 0.09 |
| 13 | 2.7 | 9.1 | 0.18 | 1.6 | 7.1 | 0.02 | 0.1 | 0.3 | 0.12 |
| 14 | 1.0 | 7.4 | 0.15 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 15 | 1.5 | 7.9 | 0.16 | 0.9 | 6.4 | 0.01 | 0.1 | 0.2 | 0.10 |
| 16 | 4.4 | 10.8 | 0.22 | 2.6 | 8.1 | 0.02 | 0.2 | 0.4 | 0.15 |
| 17 | 1.8 | 8.2 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.3 | 0.10 |
| 18 | 1.2 | 7.6 | 0.15 | 0.7 | 6.2 | 0.01 | 0.1 | 0.2 | 0.09 |
| 19 | 1.4 | 7.8 | 0.16 | 0.8 | 6.3 | 0.01 | 0.1 | 0.2 | 0.10 |
| 20 | 5.4 | 11.8 | 0.24 | 3.1 | 8.6 | 0.02 | 0.3 | 0.4 | 0.17 |
| 21 | 4.9 | 11.3 | 0.23 | 2.8 | 8.3 | 0.02 | 0.2 | 0.4 | 0.16 |
| 22 | 1.8 | 8.2 | 0.16 | 1.1 | 6.6 | 0.01 | 0.1 | 0.3 | 0.10 |
| 23 | 1.4 | 7.8 | 0.16 | 0.9 | 6.4 | 0.01 | 0.1 | 0.2 | 0.10 |
| 24 | 3.5 | 9.9 | 0.20 | 2.1 | 7.6 | 0.02 | 0.2 | 0.3 | 0.14 |
| 25 | 2.5 | 8.9 | 0.18 | 1.4 | 6.9 | 0.01 | 0.1 | 0.3 | 0.12 |
| 26 | 2.4 | 8.8 | 0.18 | 1.4 | 6.9 | 0.01 | 0.1 | 0.3 | 0.11 |
| 27 | 1.6 | 8.0 | 0.16 | 0.9 | 6.4 | 0.01 | 0.1 | 0.2 | 0.10 |
| 28 | 1.0 | 7.4 | 0.15 | 0.7 | 6.2 | 0.01 | 0.0 | 0.2 | 0.09 |
| 29 | 1.0 | 7.4 | 0.15 | 0.7 | 6.2 | 0.01 | 0.0 | 0.2 | 0.09 |
| 30 | 1.3 | 7.7 | 0.15 | 1.0 | 6.5 | 0.01 | 0.1 | 0.2 | 0.09 |
| 31 | 1.3 | 7.7 | 0.15 | 1.0 | 6.5 | 0.01 | 0.1 | 0.2 | 0.09 |
| 32 | 0.8 | 7.2 | 0.14 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.08 |
| 33 | 0.8 | 7.2 | 0.14 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.08 |
| 34 | 0.8 | 7.2 | 0.14 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.08 |
| 35 | 0.8 | 7.2 | 0.14 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.08 |
| 36 | 1.5 | 7.9 | 0.16 | 1.1 | 6.5 | 0.01 | 0.1 | 0.2 | 0.10 |
| 37 | 1.0 | 7.4 | 0.15 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 38 | 1.1 | 7.5 | 0.15 | 0.7 | 6.2 | 0.01 | 0.1 | 0.2 | 0.09 |
| 39 | 1.1 | 7.5 | 0.15 | 0.8 | 6.2 | 0.01 | 0.1 | 0.2 | 0.09 |
| 40 | 1.2 | 7.6 | 0.15 | 1.0 | 6.5 | 0.01 | 0.1 | 0.2 | 0.09 |
| 41 | 0.9 | 7.3 | 0.15 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 42 | 1.4 | 7.8 | 0.16 | 1.0 | 6.4 | 0.01 | 0.1 | 0.2 | 0.09 |
| 43 | 1.3 | 7.7 | 0.15 | 0.9 | 6.4 | 0.01 | 0.1 | 0.2 | 0.09 |
| 44 | 1.0 | 7.4 | 0.15 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 45 | 1.0 | 7.4 | 0.15 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 46 | 1.1 | 7.5 | 0.15 | 0.8 | 6.3 | 0.01 | 0.1 | 0.2 | 0.09 |
| 47 | 1.0 | 7.4 | 0.15 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 48 | 1.0 | 7.4 | 0.15 | 0.7 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 49 | 3.4 | 9.8 | 0.20 | 2.6 | 8.1 | 0.02 | 0.2 | 0.3 | 0.13 |
| 50 | 1.0 | 7.4 | 0.15 | 0.6 | 6.1 | 0.01 | 0.0 | 0.2 | 0.09 |
| 51 | 1.1 | 7.5 | 0.15 | 0.7 | 6.2 | 0.01 | 0.1 | 0.2 | 0.09 |
| MPOI-Richmond | 18.1 | 24.5 | 0.49 | 10.5 | 16.0 | 0.03 | 0.9 | 1.0 | 0.41 |
| MPOI-Delta | 17.1 | 23.5 | 0.47 | 10.1 | 15.6 | 0.03 | 0.8 | 1.0 | 0.40 |

bold: RQ >1

*10 min SO2 from 1-hour data using

C-5.0 Ambient Air Concentrations
Table C-5.1 Ambient Air Concentrations Considered for the HHRA

| Chemical | Averaging Period ¹ | Ambient Air Concentration (ug/m ³) | Inhalation exposure limit |
|----------------------|-------------------------------|--|---------------------------|
| CO | 1-hour | 1,271 | 15,000 |
| | 8-hour | 1,116 | 6,000 |
| NO ₂ | 1-hour (98th %ile) | 43.5 | 188 |
| | Annual (98th %ile) | 12.2 | 40 |
| SO ₂ | 10-min ² | 16.3 | 500 |
| | 1-hour | 9.9 | 200 |
| | Annual | 2.0 | 25 |
| PM ₁₀ | 24-hour (98th %ile) | 24 | 50 |
| | Annual (98th %ile) | 11.1 | 20 |
| PM _{2.5} | 24-hour (98th %ile) | 10.1 | 25 |
| | Annual (98th %ile) | 3.4 | 6 |
| DPM | Annual ³ | 0.646 | 5 |
| Acetaldehyde | 1-hour | 5.48 | 470 |
| | Annual | 1.72 | 390 |
| Acrolein | 1-hour | 0.17 | 2.5 |
| | Annual | 0.06 | 2.7 |
| Ammonia ⁴ | 1-hour | 4 | 590 |
| | Annual | 0.4 | 200 |
| Benzene | 1-hour | 2.44 | 580 |
| | Annual | 0.635 | 9.8 |
| 1,3-Butadiene | 1-hour | 0.43 | 660 |
| | 24-hour | 0.43 | 15 |
| | Annual | 0.08 | 2 |
| Formaldehyde | 1-hour | 6.4 | 50 |
| | Annual | 1.89 | 9 |
| Naphthalene | 1-hour | 0.82 | 2,000 |
| | Annual | 0.24 | 3 |

¹Ambient concentrations based on values reported in the Air Quality Assessment (Appendix A) unless otherwise noted.

² 10 min SO₂ calculated from 1-hour data using a conversion factor of 1.65 as per Ontario Air Dispersion Modeling Guideline A-11 (2009)

³Ambient annual DPM concentrations were not measured but were assumed to be 19% of PM_{2.5} for the GVRD as per the Levelton (2007): Air Toxics Emission Inventory and Human Health Risk Assessment, prepared for GVRD

⁴Rocky Point Park Monitoring Station (2003) as reported in Port Mann/Highway 1 Environmental Assessment Certificate Application: Local Air Quality and Human Health Impact Assessment. Available at: http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_247_24666.html

APPENDIX C

Human Health Risk Assessment – Atmospheric Noise and Vibration

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Acronyms and Abbreviations

| Term | Definition |
|-------------------|---|
| %HA | per cent highly annoyed |
| dB | Decibel |
| FTA | Federal Transit Administration |
| HHRA | human health risk assessment |
| Ld | daytime equivalent noise level |
| Ldn | day-night equivalent noise level |
| Leq | 24-hour equivalent sound level |
| LAm _{ax} | maximum A-weighted sound pressure level |
| Ln | nighttime equivalent sound level |
| SEL | sound exposure level |
| VdB | ground-borne vibration level |
| U.S. EPA | United States Environmental Protection Agency |
| U.S. FHA | United States Federal Highways Administration |
| WHO | World Health Organization |

Glossary

| Term | Definition |
|--|--|
| airborne noise | The propagation of noise through the air via vibrating air molecules |
| A-weighted decibel | The human ear and brain system is much more sensitive to sounds at mid-range and higher frequencies (or pitches) than at lower frequencies. Sound level meters are equipped with electronic filtering (or weighting) networks that replicate the ear’s frequency sensitivity. The most widely used of such a weighting network is called A-weighting, and sound levels measured with this weighting in place are expressed in dBA. |
| component noise level | Community noise environments typically feature contributions from a variety of sources, natural and otherwise. Measured community noise levels include the contributions of all sources in a noise environment. To model existing or future noise levels, however, it is often necessary to break the noise environment into its various components. Each significant noise source then contributes its own component noise level. The logarithmic sum of the component noise levels is then equal to the total noise level in a community. Component noise level is a generic term in which “noise level”, depending on the context, can refer to various specific noise metrics such as Ldn, Ld or Ln. |
| day-night equivalent sound level (Ldn) | Similar to the 24-hour equivalent sound level (Leq), the Ldn is an energy-averaged descriptor of 24-hour noise exposure expressed in dBA. In computing Ldn, all noise levels occurring between 10 p.m. and 7 a.m. are increased by 10 dBA to reflect the greater sensitivity of residential communities to noise at night. |
| daytime equivalent sound level (Ld) | The equivalent sound level for the time period from 7 a.m. to 10 p.m. |
| decibel | The standard unit of measurement for sound pressure level in which the reference value is 20 micropascals. This unit is a logarithmic ratio, multiplied by a factor of 10, of a physical quantity and a standard reference value. |
| equivalent sound level (Leq) | This is a steady sound level which, over a given 24-hour period, would result in the same overall sound energy exposure as would the actual fluctuating level. This term is expressed in units of dBA. |
| ground-borne vibration | Vibration produced by sources such as heavy trucks, trains, and construction activities that travels from the source to the receiver via the ground, often as a mixture of surface waves and compressive (longitudinal) waves |

| Term | Definition |
|---|--|
| impulsive noise | Noise such as from hammering, metal forming, and pile driving, that is characterized by the rapid rise and fall in noise levels, and the duration of which is brief (less than one second) compared to the interval between the noise events; also known as impact noise |
| low-frequency noise | Typically considered to be noise at frequencies below 200 hertz (Hz), low-frequency noise is of particular concern because it propagates more efficiently through the atmosphere, and penetrates more readily through building façades than higher-frequency noise. The human ear is, however, less sensitive to low-frequency sound than middle and higher-frequency sound. |
| maximum A-weighted sound pressure level (LAmax) | The maximum value of the sound pressure level during a noise event measured with a sound level meter using a fast time weighting. This level can be applied to pass-by noise from transportation noise sources and impulsive noise events. |
| nighttime equivalent sound level (Ln) | The equivalent sound level for the time period from 10 p.m. to 7 a.m. |
| ninety percent exceedance level (L90) | The noise level that is exceeded for 90% of a given time period. It is often considered to be representative of the background noise level. |
| noise | In general, noise is considered as unwanted sound. |
| per cent highly annoyed | The percentage of a population or community who are highly annoyed as a result of exposure to noise. |
| sensitive receptor | In the context of noise travelling through the air, and vibration travelling through soil or rock, a receptor refers to humans that might experience the sound and vibration energies. A sensitive receptor in this context is a person who is most influenced by such noise or vibration propagations by virtue of where he or she lives relative to the sources. Specific behaviour and physiology (e.g., age, general health) may make a person more vulnerable to noise and vibration. |
| sound | Sound consists of minute fluctuations in atmospheric (air) pressure usually created by vibrating objects. Human can sense sound pressure fluctuations occurring over the audible frequency range (approximately 20 Hz to 20,000 Hz). |
| sound exposure level | A logarithmic measure of the sound energy content of a well-defined noise event such as a vehicle pass-by or aircraft overflight, SEL is also a function of the intensity and the duration of the event. For example, the SEL of an event that features a steady noise at level L (dB) for a duration of T (seconds), would be presented as $SEL = L + 10 \log (T)$ dB. |

| Term | Definition |
|-------------------|---|
| sound level | The intensity of sound expressed on a logarithmic scale similar to the Richter scale of earthquake magnitude. The basic unit of sound levels is dB. The wide range of human hearing sensitivity is then compressed to sound level range from the threshold of hearing at approximately 0 dB to the threshold of pain at approximately 130 dB. |
| sound level meter | An instrument that measures, and often logs, sound pressure levels. A Type 1 sound level meter is the industry standard for precision field measurements used in environmental noise assessments and is accurate to ± 1 dBA. |
| tonal sound | Noise containing prominent audible tones such as backup alarms on trucks. |
| transient noise | Noise that is intermittent, coming and going over regular or irregular intervals. Examples of transient noise are noises from cyclical or irregular industrial or agricultural processes, the passing of trucks or trains, or the overflights of aircraft. |

1.0 Scope and Objectives

This Human Health Risk Assessment (HHRA) for atmospheric noise and vibration was undertaken to assess potential changes in human health risk as a result of Project-related changes in air quality and noise. The HHRA objectives, methods, and findings are described in the following section. The HHRA draws from the results of the assessment presented in **Section 4.10 Atmospheric Noise**. Potential health effects associated with current and future exposures to noise and vibration, at specific receptor locations, based on existing conditions and assumed future conditions associated with Project activities were considered.

2.0 Methods

2.1 Human Health Risk Assessment Approach

The HHRA for noise and vibration has been completed following a widely accepted risk assessment framework wherein potential hazards, exposure pathways, and receptors are evaluated to determine whether or not a human health risk is present. If all three of the conditions of hazard, exposure pathway, and receptor are met, then a potential risk to human health may exist. If such a potential does exist, then the health risk potential can be further quantified by directly comparing numerical estimates (measurements or predictions) of human exposures with guidelines for health effects that are promulgated by various authoritative health agencies.

The framework followed for this HHRA consists of the following components:

- **Hazard identification:** Identification of the environmental hazards that may pose a health risk (i.e., noise and ground-borne vibration)
- **Receptor identification:** Identification of the receptors that may be exposed to the above hazards
- **Exposure assessment:** Qualitative or quantitative evaluation of the likelihood and/or degree to which the receptors will be exposed to the hazards
- **Effects assessment:** Identification of published, scientifically reviewed threshold of effect values or guidelines to which exposure levels can be compared
- **Risk characterization:** Qualitative or quantitative assessment of the actual health risk each hazard poses to each receptor, based on the degree of exposure
- **Uncertainty assessment:** Review the uncertainty associated with the risk estimation

2.2 Noise and Vibration Measurements and Modelling

Noise monitoring was conducted at 41 sites located within the Highway 99 corridor which are considered representative of sensitive receptor locations within the study area. The study area for noise is defined as 500 m from either side of the Project alignment, except in the vicinity of the new bridge where it extends 1,600 m from either side of the Project alignment.

Noise effects were quantified using measurable parameters including daytime and nighttime equivalent continuous sound levels (L_d and L_n , respectively) and adjusted day-night sound level (L_{dn}). Daytime sound level is a time-averaged sound level over the 15-hour daytime period from 7 a.m. to 10 p.m. Nighttime sound level is a time-averaged sound level over the nighttime period from 10 p.m. to 7 a.m. The adjusted day-night sound level is time-averaged over a 24-hour period, with the nighttime contributions adjusted by 10 decibels to account for the expected increased annoyance due to noise-induced sleep disturbance and the increased residential population at night relative to daytime. The L_{dn} is calculated using the L_d and L_n .

2.2.1 Impulsive and Tonal Noise

Impulsive and tonal noise are often perceived as annoying and may have a high potential to disturb receptors; therefore, it is important that these source noise characteristics are accounted for in the noise assessment through the use of adjustments. The concept of the %HA indicator and the adjustments (i.e., impulsiveness and tonality) are described in detail in ISO (2003) and ANSI (2005).

Tonal noise is noise that contains prominent audible tones, such as backup alarms on trucks. Impulsive sound can be classified into one of three categories, as follows:

1. High energy impulsive – this refers to sound from one of several enumerated categories of sound sources, including quarry and mining explosives, sonic booms, demolition and industrial processes that use high explosives, military ordnance, explosive ignition of rockets and missiles, explosive industrial circuit breakers, and any other explosive source where the equivalent mass of dynamite exceeds 25 grams.
2. Highly impulsive – This refers to sound from one of several enumerated categories of sound sources, including small-arms gunfire, metal hammering, wood hammering, drop hammering, pile driving, drop forging, pneumatic hammering, pavement breaking, metal impacts during rail-yard shunting operations, and riveting.
3. Regular impulsive – This refers to impulsive noise from sources that are neither highly impulsive nor high-energy impulsive, for example, slamming car doors and truck tailgates, outdoor ball games, and church bells.

Impulsive and tonal characteristics of source noise are accounted for with adjustments in the L_{dn} level from the Project since their presence can increase the potential annoyance of sound. These adjustments correspond to a 12 dB, 5 dB, and 5 dB level change (that is, sound quality penalty) for highly impulsive, impulsive, and prominent tonal noises, respectively.

2.3 Hazard Identification

This first step in the HHRA framework comprises identification of environmental hazards that may pose a human health risk. Because the primary objective of this HHRA is to evaluate whether noise and vibration emanating from the Project may have an effect on human health, the hazards identified are as follows:

1. Noise – Noise metrics considered include time-averaged daytime noise level (L_d), time-averaged nighttime noise level (L_n), and time-averaged day-night noise level (L_{dn}). Source characteristics of the noise, for example, impulsiveness and tonality, are also considered and expressed as L_{Amax} .
2. Ground-borne vibration – Vibration that travels from the source to the receiver via the ground, often as a mixture of surface waves and compressive (longitudinal) waves. Vibration levels are characterized as ground-borne vibration level (VdB).

2.4 Receptor and Health Effect Identification

The HHRA for atmospheric noise and vibration involved identifying appropriate human health endpoints, and comparing published guidelines for these endpoints to Project-related exposure levels for both noise and ground-borne vibration. Of relevance to human health, a number of potential health effect endpoints associated with noise and ground-borne vibration exposure have been developed (WHO 1999, WHO, 2009, ISO 2003, ANSI 2005, US FTA, 2006), as described in the following sections.

2.5 Percent Highly Annoyed

High annoyance with noise is a reliable and widely accepted indicator of human health effects due to environmental noise (ISO 2003, ANSI 2005, U.S. FTA 2006, Michaud et al 2008). The change in %HA is frequently used as a measure of community response to noise and addresses the potential change in the fraction of people that would be highly annoyed. Evaluation of annoyance as a major health effect tends to capture other health effects as well, including sleep disturbance and speech interference, since these also increase an individual's perception of being highly annoyed.

The change in %HA is quantified by the difference in %HA calculated for the existing condition versus the %HA calculated after consideration of a project's noise contribution. The change in %HA is considered an appropriate indicator of noise-induced human health effects for the Project construction noise (long-term) and operation phase noise exposure. The %HA is calculated using the following equation as described elsewhere (ISO 2003, ANSI 2005, Michaud et al. 2008):

$$\%HA = \frac{100}{1 + \exp[10.4 - 0.132 * RL]}$$

In this equation, the rating level (RL) is typically an adjusted L_{dn} , with adjustments made depending on the type of noise source and source characteristics (for example, tonality).

The FTA published *Transit Noise and Vibration Impact Assessment* (U.S. FTA 2006) for use in characterizing impacts for all mass transit projects, including rapid, light or commuter rail, diesel/electric buses and their storage and maintenance yards. The FTA adopted a 6.5% increase in %HA as the guideline for a severe noise impact and this criterion is widely used in environmental assessments to indicate the potential severity of project noise impacts (Michaud et al 2008).

2.6 Sleep Impairment

Uninterrupted sleep is known to be a prerequisite for good physiological and mental functioning of healthy persons, while sleep disturbance is considered to be an environmental noise effect. Potential health effects related to continuous noise at night may present as sleep impairment. This can be manifested as either increases in sleep disturbance, or sleep awakenings, depending on the noise level.

Sleep disturbance as an effect of noise typically includes difficulty falling asleep, increased body movements (motility) during sleep alterations of sleep stages or depth, curtailed sleep duration and increased awakenings (WHO 1999, 2009). For continuous community noise, the WHO (1999) guidelines present an indoor L_n of 30 dBA for sleep disturbance. Because an outdoor-to-indoor transmission loss with windows at least partially open is roughly 15 dBA, an outdoor L_n of 45 dBA as a guideline for sleep disturbance is appropriate.

For intermittent noise, the WHO (1999) indicates that indoor sound levels should not exceed 45 dBA maximum A-weighted sound pressure level (L_{Amax}) more than 10 to 15 times per night (corresponds to an outdoor level of 60 dBA L_{Amax}). These guidelines have been adopted for the assessment.

With regard to sleep awakenings, the data presented by WHO (2009) show that at sound levels above L_n 55 dBA there is a measurable increase in the number of actual sleep awakenings. Since sleep awakenings is a direct measure of sleep impairment, a L_n threshold value of 55 dBA for continuous noise was adopted as the appropriate threshold that can contribute to adverse health effects.

Additionally, to calculate the number of individuals, of those exposed to L_n levels of 55 dBA, who are highly sleep disturbed (%HSD) the following algorithm developed by Miedema et al. (2001) was adopted:

$$\text{Road traffic: } \% \text{ HSD} = 20.8 - 1.05 (L_{\text{night}}) + 0.01486(L_{\text{night}})^2$$

This algorithm was derived based on a meta-analysis of epidemiological data and considers L_n in the range of 45 to 65 dBA, which spans the range of L_n levels predicted for the LAA. The %HSD was used to estimate the number of individuals that may experience sleep impairment within the LAA at levels that can adversely affect health.

For intermittent noise such as impulsive and transient noise, the WHO (1999) suggests that indoor sound pressure levels should not exceed 45 dBA maximum A-weighted sound pressure level (L_{max}) more than 10 to 15 times per night (or 1.1 to 1.7 times per hour). This corresponds to an outdoor level of 60 dBA L_{max} , based on a 15 dBA outdoor to indoor attenuation factor for sound penetration through partially opened windows. This value was adopted as an appropriate threshold for determining the potential for increased sleep disturbance due to intermittent noise.

2.7 Interference with Speech Comprehension

Noise interference with speech comprehension can result in a number of personal disabilities, handicaps, and behavioural changes. WHO (1999) advises that background indoor sound levels for continuous noise be maintained below 35 dBA to sustain adequate speech comprehension at sensitive receptor locations such as schools. This threshold was adopted for the assessment and is equivalent to an outdoor noise level of 50 dBA based on a 15 dBA outdoor to indoor sound attenuation factor for windows partially opened.

For effective outdoor speech comprehension, WHO (1999) advises that background outdoor sound levels be kept below 55 dBA for continuous noise. The higher recommended outdoor sound level was adopted for this assessment based on (i) people's tendency to speak in a louder voice when outdoors (where the separation between speakers is typically larger than indoors) and (ii) outdoor interferences such as wind and urban environment sounds may cause background noise levels to be raised.

2.8 Ground-Borne Vibration

Ground-borne vibration can be a concern for nearby neighbours of a transit system route or maintenance facility as it can cause buildings to shake and audible rumbling sounds. Some common sources of ground-borne vibration are trains, buses on rough roads, heavy trucks, and construction activities such as blasting, pile-driving, and operating heavy earth-moving

equipment (U.S. FTA 2006). Ground-borne vibration information within the U.S. FTA (2006) guidance document has been used in this HHRA to evaluate potential ground-borne vibration effects on the noise-sensitive receptors nearest to the new bridge approach piers.

The background vibration level in residential areas is typically 78 VdB or lower, while the threshold of perception for humans is roughly 93 VdB (U.S. FTA 2006). A vibration level of 103 VdB is the approximate dividing line between barely perceptible and distinctly perceptible. The range of interest for ground-borne vibration levels from a human and structural (building) perspective is from approximately 78 VdB (ambient) to 128 VdB, which is the general threshold where minor damage can occur in fragile buildings. The human and structural response to different levels of ground-borne vibration is summarized in **Table 1**.

Table 1 Human and Structural Response to Various Levels of Ground-borne Vibration

| Vibration Velocity Level (VdB) | Human / Structural Response |
|--------------------------------|---|
| 78 | Typical background vibration level in residential areas. |
| 93 | Approximate threshold for human perception of vibration. |
| 103 | Approximate dividing line between barely perceptible and distinctly perceptible. |
| 113 | Vibration acceptable only if there is an infrequent number of events per day (<30 vibration events of the same source per day). |
| 128 | Threshold where minor damage can occur to fragile buildings. |

The U.S. FTA (2006) guidance document also includes a set of threshold criteria for ground-borne vibration during transit operations (**Table 2**). The threshold criteria are based on past experiences with human sensitivity and community responses to ground-borne vibration. The U.S. FTA-developed criteria for environmental impact of ground-borne vibration from transit operations are based on the maximum level for a single event. The impact criteria are used to determine whether a project would result in ground-borne vibration impacts (i.e., human annoyance). The criteria are specified for three separate land use categories, as described in **Table 2**.

Table 2 Ground-borne Vibration Impact Criteria for General Assessment

| Land Use Category | Ground-borne Vibration Levels (VdB) | | |
|--|-------------------------------------|----------------------------------|----------------------------------|
| | Frequent Events ⁽¹⁾ | Occasional Events ⁽²⁾ | Infrequent Events ⁽³⁾ |
| 1: Buildings where vibration would interfere with interior operations. | 93 | 93 | 93 |
| 2: Residences and buildings where people normally sleep. | 100 | 103 | 108 |
| 3: Institutional land uses with primarily daytime use. | 103 | 106 | 111 |

Notes:

1. Frequent events = more than 70 vibration events from the same source per day. Most rapid transit projects fall into this category.
2. Occasional events = between 30 and 70 vibration events from the same source per day. Most commuter trunk lines have this many operations.
3. Infrequent events = fewer than 30 vibration events from the same source per day. This category includes most commuter rail branch lines.

The impact thresholds presented in **Table 2** are based on experience with vibration from rail transit systems rather than from construction equipment; however, they have been used in the past to assess human annoyance associated with vibration from construction equipment since no specific impact criteria exist for this purpose. As a conservative approach, the ground-borne vibration impact criteria of 100 VdB (i.e., Category 2 and more than 70 vibration events per day) is applied herein at the sensitive receptor locations for evaluation of human annoyance. It is anticipated that human annoyance due to ground-borne vibration will only occur during construction activities that involve pile driving, and that only those receptors nearest to the new bridge approach piers may be affected.

2.9 Summary of Noise and Vibration Guidelines for Project

The following summarizes the noise and vibration guidelines described above and used to assess the potential noise and vibration effects from the Project:

- *Sleep Impairment:* For continuous noise, an outdoor L_n of 45 dBA as a guideline for increased sleep disturbance and an outdoor L_n of 55 dBA as a guideline for increased sleep awakenings. For intermittent noise, outdoor sound pressure levels should not exceed 60 dBA L_{Amax} , more than 10 to 15 times per night, or 1.1 to 1.7 times per hour.
- *Speech Comprehension:* For sensitive receptors (e.g., schools, daycares), indoor L_d should not exceed 50 dBA and for outdoor spaces the L_d should not exceed 55 dBA in order to maintain adequate speech comprehension.

- *% Highly Annoyed*: The maximum allowed increase for change in %HA is 6.5%, taking into consideration noise source characteristics such as impulsiveness, tonality, and frequency.
- *Vibration Annoyance*: A maximum ground-borne vibration level of 100 VdB to prevent human annoyance at sensitive receptor locations.

The above guidelines apply to both the construction and operation phases of the Project. If any of the guidelines above are exceeded, the significance of the effects was considered and mitigation measures considered, as required.

3.0 Risk Characterization

Risk characterization involved comparing the modelled noise and ground-borne vibration results to the guidelines adopted for the assessment. If the predicted noise and vibration levels were less than the adopted guidelines, then adverse health effects are not expected and the noise or vibration effect was considered acceptable. If levels were above the guidelines, mitigation measures to reduce the modelled noise or vibration effect until it is compliant with the guidelines were identified.

3.1 Construction Phase Effects

3.1.1 Noise during Construction Phase

There will be increased noise levels associated with construction activities compared with existing conditions. The potential for health effects were evaluated by comparing the predicted construction phase noise levels with the applicable thresholds adopted for the assessment, as presented in **Table 3**.

The results indicate that the noise thresholds for % Highly Annoyed, sleep impairment (disturbance and awakenings) and speech comprehension are likely to be exceeded at many locations during construction. Also, the change in predicted noise level due to construction activities will be of sufficient magnitude that they will be perceived at several sensitive receptor locations.

The health effects thresholds used to interpret the predicted construction noise, have generally been developed for predictions of health effects based on long-term (or chronic) noise exposures. The available epidemiological data and associated conclusions about the implications of % Highly Annoyed for rates of hypertensive diseases is based on communities and populations that were experiencing chronic noise exposures, over many months and years. Similarly, those studies that have suggested a linkage between sleep disturbance and cardiovascular diseases or other human illness have been conducted on populations that were experiencing chronic exposures.

It is important to consider the potential exposure duration to construction noise when comparing predicted noise levels to the previously discussed thresholds of health effects. Adverse health effects associated with annoyance or sleep disturbance over shorter durations of days to weeks are unlikely, whereas noise exposures over many months could result in chronic health effects.

Table 3 Construction Phase Compliance with Noise Limits

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|---|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 2 | 22 Capella Garden, 9731 Capella Drive, Richmond, B.C. | Residential | 72.2 | - | 64.5 | 76 | 81 | 71 | 76 | 70 | 75 | - | - | 27.7 | Yes | Yes | Yes | No |
| 3 | 10168 Caithcart Road, Richmond, B.C. | Residential | 69.7 | - | 61.4 | 70 | 75 | 64 | 69 | 63 | 68 | - | - | 14.6 | Yes | Yes | Yes | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|---|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 4 | 9 Florence Estates, 10411 Hall Avenue, Richmond, B.C. | Residential | 72 | - | 63.8 | 78 | 83 | 72 | 77 | 72 | 77 | - | - | 34.6 | Yes | Yes | Yes | No |
| 4a | Richmond Estates, 10511, Kilby Drive, Richmond, B.C. | Residential | 70.1 | - | 63 | 77 | 82 | 72 | 77 | 71 | 76 | - | - | 36.3 | Yes | Yes | Yes | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|--------------------------------------|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 4b | 10333 Bryson Drive, Richmond, B.C. | Residential | 68.8 | - | 58.1 | 79 | 84 | 74 | 79 | 73 | 78 | - | - | 45.4 | Yes | Yes | Yes | No |
| 5 | 4591 Dallyn Road, Richmond, B.C. | Residential | 68.7 | - | 60.8 | 74 | 79 | 68 | 73 | 68 | 73 | - | - | 29.8 | Yes | Yes | Yes | Yes |
| 6 | 11600 Dewsbury Drive, Richmond, B.C. | Residential | 74.1 | - | 67.1 | 75 | 80 | 69 | 74 | 69 | 74 | - | - | 19.0 | Yes | Yes | Yes | Yes |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|---|----------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 7 | 12260 Old Westminster Highway, Richmond, B.C. | Residential | 67 | 63.7 | 59.9 | 71 | 76 | 66 | 71 | 65 | 70 | - | - | 23.5 | Yes | Yes | Yes | Yes |
| 7a | Richmond Nature Park, 11851 Westminster Highway, Richmond, B.C. | Municipal-park | - | 58 | - | - | - | 51 | 56 | - | - | - | - | - | - | - | Yes ² | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|---|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 8 | 12250 Old Westminster Highway, Richmond, B.C. | Residential | 64.2 | 61.1 | 56.9 | 69 | 74 | 63 | 68 | 62 | 67 | - | - | 22.0 | Yes | Yes | Yes | No |
| 9 | 12431 Blundell Road, Richmond, B.C. | Daycare | 72.5 | 66.9 | 65.9 | 74 | 79 | 68 | 73 | 68 | 73 | - | - | 20.3 | Yes | Yes | Yes | No |
| 9 | 12431 Blundell Road, Richmond, B.C. | Daycare | 70.4 | 67.8 | 62.8 | 74 | 79 | 68 | 73 | 68 | 73 | - | - | 25.9 | Yes | Yes | Yes | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|---|----------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 10 | 12280 Blundell Road, Richmond, B.C. | Daycare | 67.3 | 64.5 | 59.9 | 73 | 78 | 68 | 73 | 67 | 72 | - | - | 29.4 | Yes | Yes | Yes | No |
| 10 a | Mosque, 12300 Blundell Road, Richmond, B.C. | Worship | - | 71.8 | - | - | - | 71 | 76 | - | - | - | - | - | - | - | Yes | No |
| 10 b | School, 12300 Blundell Road Richmond, B.C. | School | - | 71 | - | - | - | 69 | 74 | - | - | - | - | - | - | - | Yes | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|--|-----------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 10c | Ling Yen Mountain Temple, 10060 No. 5 Road, Richmond, B.C. | Worship | - | 61.7 | - | - | - | 57 | 62 | - | - | - | - | - | - | - | Yes | No |
| 11 | 10640 No. 5 Road, Richmond, B.C. | Residential | 65.7 | 62.6 | 58.3 | 71 | 76 | 65 | 70 | 65 | 70 | - | - | 25.8 | Yes | Yes | Yes | Yes |
| 11a | 11551 Dyke Road, Richmond, B.C. | Municipal -park | - | 46.4 | - | - | - | 32 | 37 | - | - | - | - | - | - | - | No | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|-----------------|---|--------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 12 | 12900 Steveston Highway, Richmond, B.C. | Commercial | - | 67.7 | - | - | - | 58 | 63 | - | - | - | - | - | - | - | Yes | Yes |
| 12 ^a | 13060 Steveston Highway, Richmond, B.C. | Residential | 59.3 | 59.2 | 49.4 | 52 | 57 | 46 | 51 | 46 | 51 | - | - | -1.8 | No | Yes | Yes | No |
| 13 | 103-14100 Riverport Way, Richmond, B.C. | Multi-family | 61.9 | 58.4 | 54.5 | 34 | 39 | 28 | 33 | 28 | 33 | 48 | 52 | -9.2 | No | No | No | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|--|--------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 14 | 12951 Rice Mill Road, Richmond, B.C. | Residential | 63.1 | 57.5 | 56.5 | 69 | 74 | 63 | 68 | 62 | 67 | 50 | 78 | 23.5 | Yes | Yes | Yes | Yes |
| 15 | 12 River Woods, 6105 River Road, Delta, B.C. | Multi-family | 68.4 | 64.2 | 61.5 | 75 | 80 | 69 | 74 | 68 | 73 | 47 | 86 | 33.7 | Yes | Yes | Yes | Yes |
| 15a | Central, Deas Island Regional Park Delta, B.C. | Reg. Park | - | 53.9 | - | - | - | 64 | 69 | - | - | - | - | - | - | - | Yes | Yes |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|--|--------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 15 b | River Watch, 6251 River Road Delta, B.C. | Multi-family | 59.7 | 56.7 | 52.3 | 59 | 64 | 53 | 58 | 52 | 57 | 52 | 72 | 5.0 | No | Yes | Yes | Yes |
| 15 c | Town & Country Inn, 6005 Highway 17A, Delta, B.C. | Hotel | 70.1 | 65.6 | 63.2 | 74 | 79 | 68 | 73 | 67 | 72 | 49 | 86 | 26.6 | Yes | Yes | Yes | Yes |
| 16 | 37 Woodward's Landing, 5300 Admiral Way, Delta, B.C. | Multi-family | 57.6 | 53.6 | 50.6 | 50 | 55 | 44 | 49 | 43 | 48 | 47 | 61 | -1.6 | No | Yes ² | No | Yes |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|---|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 17 | 5954 River Road, Delta B.C. | Residential | 67.6 | 64.4 | 60.3 | 70 | 75 | 64 | 69 | 63 | 68 | 52 | 78 | 19.2 | Yes | Yes | Yes | Yes |
| 17 a | Burr House, Deas Island Regional Park, Delta, B.C | Reg. Park | - | 46.7 | - | - | - | 32 | 37 | - | - | 49 | 52 | - | - | - | No | No |
| 16 a | East of Parking, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 46.4 | - | - | - | 37 | 42 | - | - | 52 | 57 | - | - | - | No | Yes |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|---------|---|--------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 16 b | Captain's Cove Marina, 6100 Ferry Road, Delta, B.C. | Multi-family | 66.8 | 61.8 | 60.1 | 75 | 80 | 69 | 74 | 69 | 74 | 45 | 77 | 36.9 | Yes | Yes | Yes | Yes |
| 17 b | First Fork, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 45.9 | - | - | - | 49 | 54 | - | - | 54 | 65 | - | - | - | No | Yes |
| 17 c | Second Fork, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 46 | - | - | - | 48 | 53 | - | - | - | - | - | - | - | No | Yes |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|--|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 18 | Ernie Burnett Park, 5400 Ferry Road, Delta, B.C. | Residential | 51.5 | 51.7 | 41.3 | 36 | 41 | 31 | 36 | 30 | 35 | - | - | -2.0 | No | No | No | No |
| 19 | 5631 64th Street, Delta, B.C | Residential | 57.4 | 56.3 | 48.7 | 68 | 73 | 62 | 67 | 62 | 67 | - | - | 26.2 | Yes | Yes | Yes | No |
| 20 | 8640 Ladner Trunk Road, Delta, B.C. | Residential | 67.5 | 65.2 | 59.8 | 71 | 76 | 65 | 70 | 64 | 69 | - | - | 22.5 | Yes | Yes | Yes | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|-----------------|--|--------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 20 _a | 4714 96 Street, Delta, B.C. | Residential | 53.6 | 52.8 | 44.6 | 62 | 67 | 57 | 62 | 56 | 61 | - | - | 13.9 | Yes | Yes | Yes | No |
| 21 | Delta View Life Enrichment Centre, Delta, B.C. | Multi-family | 75 | 71.8 | 67.8 | 78 | 83 | 72 | 77 | 71 | 76 | - | - | 25.8 | Yes | Yes | Yes | No |
| 22 | Delta View Life Enrichment Centre, Delta, B.C. | Multi-family | 74.5 | 70.4 | 67.4 | 78 | 83 | 72 | 77 | 71 | 76 | - | - | 27.3 | Yes | Yes | Yes | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|--------|-----------------------------------|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 23 | 4779 104th Street, Delta, B.C. | Residential | 69.1 | - | 61.7 | 75 | 80 | 69 | 74 | 69 | 74 | - | - | 32.2 | Yes | Yes | Yes | No |
| 24 | 4949 112th Street, Delta, B.C. | Residential | 73.7 | - | 67.3 | 70 | 75 | 64 | 69 | 63 | 68 | - | - | 3.9 | No | Yes | Yes | No |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | | ¹ Change in %HA Associated with L_{DN} | Exceeds Change in %HA Limit of 6.5% | L_n Exceeds Sleep Change Threshold of 45 dBA (Disturbance) or 55 dBA (Awakening) | L_D Exceeds Speech Comprehension of 35 dBA (indoor) or 55 dBA (outdoor) | Chronic health thresholds applicable? |
|---------|-----------------------------------|-------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|---|-------------------------------------|--|---|---------------------------------------|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max | | | | | |
| | | | | | | min | max | min | max | min | max | | | | | | | |
| 24 a | 5054 112th Street, Delta, B.C. | Residential | 75.5 | - | 69.7 | 55 | 60 | 49 | 54 | 48 | 53 | - | - | 31.6 | No | Yes | No | No |

- 1) Calculated from maximum predicted values
- 2) Exceeded for maximum predicted value only

"-" = value not estimated.

For this reason, the last column in **Table 3** indicates those sites that may experience increased construction noise for shorter duration near at-surface highway areas or interchanges in contrast with sites near the bridge that could experience noise from pile-driving or other activities for many months.

3.1.2 Ground-borne Vibration during Construction Phase

Construction activities may result in ground-borne vibration levels that can cause increased annoyance, especially at receptor locations located near the replacement bridge approach piers. Ground-borne vibration levels were estimated using a model adopted by the US FTA (2006) and the results are presented in **Table 4**. For a given receptor, the estimated range of vibration levels corresponds to lowest (minimum) vibration level from the most distant piling site to the highest (maximum) level from the closest piling site on the receptor side of Highway 99. Ground-borne vibration levels were compared with the annoyance criterion of 100 VdB, as previously discussed.

Table 4 Compliance with Ground-borne Vibration Criterion

| Site No. | Representative Receptor Location | Land Use | Ground-borne Vibration Level (VdB) | | Ground-borne Vibration Impact Criterion (VdB) |
|----------|--|--------------|------------------------------------|---------|---|
| | | | Minimum | Maximum | |
| 13 | 103 -14100 Riverport Way, Richmond | Multi-family | 77 | 83 | 100 |
| 14 | 12951 Rice Mill Road, Richmond | Residential | 86 | 98 | 100 |
| 15 | 12 River Woods, 6105 River Road, Delta | Multi-family | 90 | 127 | 100 |
| 15a | Central 1, Deas Island Regional Park, Delta | Reg. Park | 89 | 123 | 100 |
| 15b | River Watch, 6251 River Road, Delta | Multi-family | 90 | 101 | 100 |
| 15c | Town & Country Inn, 6005 Highway 17A, Delta | Hotel | 82 | 124 | 100 |
| 16 | 37 Woodward Landing, 5300 Admiral Way, Delta | Multi-family | 92 | 97 | 100 |
| 17 | 5954 River Road, Ladner, B.C. | Residential | 88 | 116 | 100 |

| Site No. | Representative Receptor Location | Land Use | Ground-borne Vibration Level (VdB) | | Ground-borne Vibration Impact Criterion (VdB) |
|----------|---|--------------|------------------------------------|---------|---|
| | | | Minimum | Maximum | |
| 17a | Burr House, Deas Island Regional Park, Delta | Reg. Park | 83 | 86 | 100 |
| 16a | East of Parking, Deas Island Regional Park, Delta | Reg. Park | 88 | 93 | 100 |
| 17b | First Fork, Deas Island Regional Park, Delta | Reg. Park | 89 | 104 | 100 |
| 17c | Second Fork, Deas Island Regional Park, Delta | Reg. Park | 87 | 103 | 100 |
| 16b | Captain's Cove Marina, 6100 Ferry Road, Ladner | Multi-family | 92 | 126 | 100 |

Table 4 shows that the minimum predicted ground-borne vibration levels at the receptor locations associated with pile driving during construction all satisfy the applicable impact criterion. However, the maximum predicted ground-borne vibration levels exceed the criterion at four residential and one hotel receptor locations. As such, individuals residing nearest to the new bridge approach piers may experience annoyance during Project construction.

While ground-borne vibration effects are also predicted for the regional park areas considered, these are not expected to contribute to increased annoyance among park users.

Annoyance due to ground-borne vibration will primarily occur during construction activities that involve pile driving, and that only those receptors nearest to the new bridge approach piers may be affected. Receptors at greater distances from the pile driving activities are not anticipated to be affected by ground-borne vibration since ground-borne vibration levels decrease with distance.

3.2 Operation Phase Effects

3.2.1 Noise during Operation Phase (No Mitigation)

Without mitigation, there will be increased noise levels associated with routine operation phase traffic compared with existing conditions. The potential for health effects were evaluated by comparing the predicted unmitigated operation phase (2031) noise levels with the noise guidelines adopted for the assessment. The results are presented in **Table 5**.

Table 5 2013 Baseline Noise Levels versus Future (2031) Noise Levels at Noise-Sensitive Receptors

| Site # | Location | 2013 Baseline Noise Levels (dBA) | | | Change in L _{dn} or L _d (dBA) | Total Post-Project (2031) Noise Levels (dBA) | | | Total Post-Project Change in % HA |
|------------------|---|----------------------------------|-----------------|----------------------|---|--|----------------|----------------|-----------------------------------|
| | | L _{dn} | L _d | L _n | | L _{dn} | L _d | L _n | |
| Effect Threshold | | 55 ¹ | 55 ¹ | 45 / 55 ² | | 55 | 55 | 45 / 55 | 6.5 |
| 2 | 22 Capella Garden, 9731 Capella Drive, Richmond | 72.2 | - | 64.5 | 1.9 | 74.1 | - | 66.4 | 5.5 |
| 3 | 10168 Caithcart Road, Richmond | 69.7 | - | 61.4 | 1.9 | 71.6 | - | 63.3 | 4.8 |
| 4 | 9 Florence Estates, 10411 Hall Avenue, Richmond, | 72.0 | - | 63.8 | 0.7 | 72.7 | - | 64.5 | 1.9 |
| 4a | Richmond Estates, 10511, Kilby Drive, Richmond | 70.1 | - | 63 | 1.2 | 71.3 | - | 64.2 | 3.0 |
| 4b | 10333 Bryson Drive, Richmond | 68.8 | - | 58.1 | 1.2 | 70.0 | - | 59.3 | 2.8 |
| 5 | 4591 Dallyn Road, Richmond | 68.7 | - | 60.8 | 1.6 | 70.3 | - | 62.4 | 3.7 |
| 6 | 11600 Dewsbury Drive, Richmond | 74.1 | - | 67.1 | 1.8 | 75.9 | - | 68.9 | 5.6 |
| 7 | 12260 Old Westminster Highway | 67 | - | 59.9 | 4.1 | 71.1 | - | 64 | 9.2 |
| 7a | Richmond Nature Park, 11851 Westminster Hwy, Richmond | - | 58 | - | 3.7 | - | 61.7 | - | - |
| 8 | 12250 Old Westminster Highway, Richmond | 64.2 | - | 56.9 | 3.4 | 67.6 | - | 60.3 | 5.9 |
| 9 | 12431 Blundell Road, Richmond | 72.5 | - | 65.9 | 4.1 | 76.6 | - | 70.0 | 12.5 |
| 10 | 12280 Blundell Road, Richmond | 67.3 | - | 62.8 | 3.0 | 70.3 | - | 62.9 | 6.6 |

| Site # | Location | 2013 Baseline Noise Levels (dBA) | | | Change in L _{dn} or L _d (dBA) | Total Post-Project (2031) Noise Levels (dBA) | | | Total Post-Project Change in % HA |
|--------|--|----------------------------------|----------------|----------------|---|--|----------------|----------------|-----------------------------------|
| | | L _{dn} | L _d | L _n | | L _{dn} | L _d | L _n | |
| 10a | Mosque, 12300 Blundell Road Richmond | - | 71.8 | 59.9 | 3.4 | - | 75.2 | - | - |
| 10b | School, 12300 Blundell Road Richmond | - | 71 | - | 3.5 | - | 74.5 | - | - |
| 10c | Ling Yen Mountain Temple, 10060 No. 5 Road, Richmond | - | 61.7 | - | 3.6 | - | 65.3 | - | - |
| 11 | 10640 No. 5 Road, Richmond, | 65.7 | - | 58.3 | 4.9 | 70.6 | - | 63.2 | 10.2 |
| 11a | 11551 Dyke Road, Richmond, | - | 46.4 | - | Modeled | - | 49.5 | 61.4 | - |
| 12 | 12900 Steveston Highway, Richmond, B.C. | 69.5 | - | - | Modeled | 68.8 | - | - | -1.6 |
| 12a | 13060 Steveston Highway, Richmond, B.C. | 59.3 | - | 49.4 | Modeled | 61.5 | - | 51.6 | 2.2 |
| 13 | 103-14100 Riverport Way, Richmond, B.C. | 61.9 | - | 54.5 | Modeled | 62.0 | - | 54.6 | 0.1 |
| 14 | 12951 Rice Mill Road, Richmond, B.C. | 63.1 | - | 56.5 | Modeled | 65.2 | - | 58.9 | 3.1 |
| 15 | 12 River Woods, 6105 River Road, Delta, B.C. | 68.4 | - | 61.5 | Modeled | 67.5 | - | 60.6 | -1.9 |
| 15a | Central, Deas Island Regional Park Delta, B.C. | - | 53.9 | - | Modeled | omit | omit | omit | - |
| 15b | River Watch, 6251 River Road Delta, B.C. | 59.7 | - | 52.3 | Modeled | 61.5 | - | 54.1 | 1.8 |

| Site # | Location | 2013 Baseline Noise Levels (dBA) | | | Change in L _{dn} or L _d (dBA) | Total Post-Project (2031) Noise Levels (dBA) | | | Total Post-Project Change in % HA |
|--------|--|----------------------------------|----------------|----------------|---|--|----------------|----------------|-----------------------------------|
| | | L _{dn} | L _d | L _n | | L _{dn} | L _d | L _n | |
| 15c | Town & Country Inn, 6005 Highway 17A Delta, B.C. | 70.1 | - | 63.2 | Modeled | 69.4 | - | 62.5 | -1.6 |
| 16 | 37 Woodwards Landing, 5300 Admiral Way Delta, B.C. | 57.6 | - | 50.6 | Modeled | 57.4 | - | 50.4 | -0.1 |
| 16a | East of Parking, Deas Island Regional Park Delta, B.C. | - | 46.4 | - | Modeled | - | 53.4 | - | 0 |
| 16b | Captain's Cove Marina, 6100 Ferry Road Ladner, B.C. | 66.8 | - | 60.1 | Modeled | 67.9 | - | 61.2 | 2.2 |
| 17 | 5954 River Road, Ladner B.C. | 67.6 | - | 60.3 | Modeled | 65.9 | - | 58.6 | -3.2 |
| 17a | Burr House, Deas Island Regional Park Delta, B.C | - | 46.7 | - | Modeled | - | 50.8 | - | - |
| 17b | First Fork, Deas Island Regional Park Delta, B.C. | - | 45.9 | - | Modeled | - | 56.7 | - | - |
| 17c | Second Fork, Deas Island Regional Park Delta, B.C. | - | 46 | - | Modeled | - | 56.4 | - | - |
| 18 | Ernie Burnett Park, 5400 Ferry Road, Ladner, B.C. | 51.5 | - | 41.3 | Modeled | 52.5 | - | 42.3 | 0.4 |
| 19 | 5631 64 th Street, Delta, B.C | 57.4 | - | 48.7 | 2.1 | 59.5 | - | 50.8 | 1.7 |

| Site # | Location | 2013 Baseline Noise Levels (dBA) | | | Change in L _{dn} or L _d (dBA) | Total Post-Project (2031) Noise Levels (dBA) | | | Total Post-Project Change in % HA |
|--------|--|----------------------------------|----------------|----------------|---|--|----------------|----------------|-----------------------------------|
| | | L _{dn} | L _d | L _n | | L _{dn} | L _d | L _n | |
| 20 | 8640 Ladner Trunk Road, Delta | 67.5 | - | 59.8 | 2.3 | 69.8 | - | 62.1 | 5.0 |
| 20a | 4714 96 Street, Delta | 53.6 | - | 44.6 | 2.5 | 56.1 | - | 47.1 | 1.3 |
| 21 | Delta View Life Enrichment Centre, Delta | 75 | - | 67.8 | 2.3 | 77.3 | - | 70.1 | 7.4 |
| 22 | Delta View Life Enrichment Centre, Delta | 74.5 | - | 67.4 | 2.7 | 77.2 | - | 69.7 | 8.6 |
| 23 | 4779 104 th Street, Surrey | 69.1 | - | 61.7 | 1.9 | 71.0 | - | 63.6 | 4.6 |
| 24 | 4949 112 th Street, Surrey Newton | 73.7 | - | 61.9 | - | - | - | - | - |
| 24a | 5054 112 th Street, Surrey Newton | 75.5 | - | 61.9 | - | - | - | - | - |

Notes: 1. Speech interference threshold. 2. Sleep impairment thresholds (45 dBA for sleep disturbance, 55 dBA for sleep awakenings).

As presented in **Table 6** and summarized in **Table 7**, the thresholds for all three health indicators considered are currently (2013) being exceeded at most of the receptor locations evaluated. A summary of the results for each health indicator is provided below.

Percent Highly Annoyed

The predicted change in L_{dn} noise levels (unmitigated) ranges from -1.7 to 4.9 dBA compared with current (2013) levels. Based on these increases, six additional receptors locations are predicted to exceed the 6.5 %HA threshold and four locations are expected to have a lower %HA than current conditions. Individuals at the six locations where the 6.5 %HA is predicted to be exceeded may become highly annoyed.

Sleep Impairment

For nighttime noise, the total unmitigated Project L_n levels are predicted to range from 42.3 to 70.1 dB, which are -1.7 to 4.9 dBA higher than current (2013) levels. The change in nighttime noise levels with the Project will be perceptible at approximately 50 percent of the receptor locations based on a noise perception threshold of 3 dBA. Individuals living at receptor locations where L_n levels are predicted to increase may experience increased sleep impairment compared with existing conditions.

Speech Interference

Unmitigated outdoor daytime (L_d) noise levels are predicted to increase from 3.1 to 10.8 dBA. These noise increases will result in two additional receptor locations at Deas Island Regional Park exceeding the outdoor speech interference threshold of 55 dBA. Also, the 50 dBA threshold for sensitive indoor spaces (e.g., schools) was exceeded at one additional receptor location, but this location was at an outdoor space (Deas Island Regional Park).

It is important to consider that the incremental increases in noise levels (L_d , L_{dn} , L_n) during operation are expected to increase at many of the representative receptor locations considered by less than 3 dBA, which is the typical increase in noise levels needed to be perceptible by most individuals. This is important because humans are more likely to adapt (acclimate) if the increased levels of noise are not perceptible. Thus, potential health effects may be lower than predicted where noise level increases are less than 3 dBA, but not at the 14 receptor locations (approximately 35% of the total locations considered) where noise levels are predicted to increase by more than 3 dBA.

Table 6 Summary of Exceedances of Health-Based Noise Guidelines with Current (2013) Noise Levels

| Site # | Current Land Use | Do Current (2013) Noise Levels Exceed the Applicable Guidelines? | | | Do Future (2031) Mitigated Noise Levels Exceed the Applicable Guidelines? | | |
|--------|------------------|--|---------------------|--|---|---------------------|--|
| | | %HA | Speech Interference | Sleep Impairment | %HA | Speech Interference | Sleep Impairment |
| 2 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 3 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 4 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 4a | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 4b | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |

| Site # | Current Land Use | Do Current (2013) Noise Levels Exceed the Applicable Guidelines? | | | Do Future (2031) Mitigated Noise Levels Exceed the Applicable Guidelines? | | |
|--------|-----------------------|--|---------------------|--|---|---------------------|--|
| | | %HA | Speech Interference | Sleep Impairment | %HA | Speech Interference | Sleep Impairment |
| 5 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 6 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 7 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 7a | Park | | Yes | | | Yes | |
| 8 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 9 | Daycare/ Residence | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 10 | Daycare/ Residence | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |

| Site # | Current Land Use | Do Current (2013) Noise Levels Exceed the Applicable Guidelines? | | | Do Future (2031) Mitigated Noise Levels Exceed the Applicable Guidelines? | | |
|--------|------------------|--|---------------------|---|---|---------------------|--|
| | | %HA | Speech Interference | Sleep Impairment | %HA | Speech Interference | Sleep Impairment |
| 10a | Worship | Yes | Yes | - | Yes | Yes | |
| 10b | School | Yes | Yes | - | Yes | Yes | |
| 10c | Worship | Yes | Yes | - | Yes | Yes | |
| 11 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 11a | Park | | No | | | No | |
| 12 | Commercial | Yes | Yes | | Yes | Yes | |
| 12a | Residential | Yes | - | Yes for sleep disturbance, No for sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 13 | Multi-family | Yes | - | Yes for sleep disturbance, No for sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 14 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |

| Site # | Current Land Use | Do Current (2013) Noise Levels Exceed the Applicable Guidelines? | | | Do Future (2031) Mitigated Noise Levels Exceed the Applicable Guidelines? | | |
|--------|------------------|--|---------------------|--|---|---------------------|--|
| | | %HA | Speech Interference | Sleep Impairment | %HA | Speech Interference | Sleep Impairment |
| 15 | Multi-family | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 15a | Park | | No | - | - | - | |
| 15b | Multi-family | Yes | - | Yes for sleep disturbance, No for sleep awakenings | No | - | Yes for sleep disturbance No for sleep awakenings |
| 15c | Hotel | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 16 | Multi-family | No | - | Yes for sleep disturbance, No for sleep awakenings | No | - | Yes for sleep disturbance No for sleep awakenings |
| 16a | Park | | No | | | No | |
| 16b | Multi-family | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 17 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | No | Yes |
| 17a | Park | | No | - | - | No | |
| 17b | Park | | No | - | - | No | |

| Site # | Current Land Use | Do Current (2013) Noise Levels Exceed the Applicable Guidelines? | | | Do Future (2031) Mitigated Noise Levels Exceed the Applicable Guidelines? | | |
|--------|------------------|--|---------------------|---|---|---------------------|--|
| | | %HA | Speech Interference | Sleep Impairment | %HA | Speech Interference | Sleep Impairment |
| 17c | Park | | No | - | - | - | |
| 18 | Residential | No | - | No | No | - | No |
| 19 | Residential | No | - | Yes for sleep disturbance, No for sleep awakenings | No | - | No |
| 20 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes for sleep disturbance No for sleep awakenings |
| 20a | Residential | No | - | No | No | - | Yes for sleep disturbance No for sleep awakenings |
| 21 | Multi-family | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 22 | Multi-family | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |
| 23 | Residential | Yes | - | Yes for sleep disturbance and sleep awakenings | Yes | - | Yes |

3.2.2 Noise during Operation Phase (With Mitigation)

With mitigation, the Project is anticipated to reduce noise levels by 4 to 8 dBA below current (2013) levels at most receptor locations. This will improve the overall sound environment within the study area and reduce the likelihood and severity of any health effects that may currently be associated with existing noise levels. The predicted changes in health indicators with the Project and mitigation measures are described below.

Percent Highly Annoyed

The estimated change in the %HA based on the algorithm described in **Section 2.5** using current (2013) and future mitigated noise levels is presented in **Table 7**. The %HA will be reduced at all receptor location compared with (2013) conditions. The predicted decrease in %HA with mitigation varies from approximately 2 to 20 %HA, with most receptors predicted to have reductions of 10 to 20 %HA. Collectively, the results indicate that there will be a significant reduction in the number of people who are highly annoyed compared with existing conditions.

Table 7 Estimated Percent Highly Annoyed Based on Current (2013) and Future (2031) Noise Levels at Noise-Sensitive Receptors

| Site # | Location | Current (2013) %HA | Future (2031) Mitigated %HA | Decrease in %HA with Mitigation Compared with Current (2013) Conditions |
|--------|-----------------------|--------------------|-----------------------------|---|
| 2 | Residential | 29.5 | 12.6 | 17.0 |
| 3 | Residential | 23.2 | 9.4 | 13.8 |
| 4 | Residential | 29.0 | 10.7 | 18.3 |
| 4a | Residential | 24.1 | 9.0 | 15.1 |
| 4b | Residential | 21.1 | 7.7 | 13.4 |
| 5 | Residential | 20.9 | 8.0 | 12.9 |
| 6 | Residential | 35.0 | 15.4 | 19.6 |
| 7 | Residential | 17.4 | 8.8 | 8.6 |
| 8 | Residential | 12.7 | 6.9 | 5.8 |
| 9 | Daycare/ Residence | 30.4 | 19.6 | 10.8 |
| 10 | Daycare/ Residence | 18.0 | 8.0 | 10.0 |
| 11 | Residential | 15.1 | 9.9 | 5.1 |
| 12 | Commercial | 22.7 | 0.0 | 22.7 |
| 12a | Residential | 7.1 | 0.0 | 7.1 |

| Site # | Location | Current (2013) %HA | Future (2031) Mitigated %HA | Decrease in %HA with Mitigation Compared with Current (2013) Conditions |
|--------|--------------|--------------------|-----------------------------|---|
| 13 | Multi-family | 9.7 | 0.0 | 9.7 |
| 14 | Residential | 11.2 | 7.9 | 3.3 |
| 15 | Multi-family | 20.2 | 11.1 | 9.2 |
| 15b | Multi-family | 7.4 | 6.0 | 1.4 |
| 15c | Hotel | 24.1 | 0.0 | 24.1 |
| 16 | Multi-family | 5.7 | 3.6 | 2.1 |
| 16b | Multi-family | 17.0 | 10.9 | 6.1 |
| 17 | Residential | 18.6 | 10.3 | 8.3 |
| 18 | Residential | 2.7 | 0.0 | 2.7 |
| 19 | Residential | 5.6 | 5.5 | 0.1 |
| 20 | Residential | 18.4 | 10.8 | 7.6 |
| 20a | Residential | 3.5 | 0.0 | 3.5 |
| 21 | Multi-family | 37.8 | 18.0 | 19.8 |
| 22 | Multi-family | 36.2 | 17.8 | 18.4 |
| 23 | Residential | 21.8 | 12.4 | 9.3 |

Shaded cells represent %HA increases greater than 6.5%.

Sleep Impairment

Even with mitigation, the sleep disturbance threshold of Ln 45 dBA will be exceeded at many receptor locations. However, mitigation is predicted to reduce Ln noise levels by 3 to 10 dBA below existing levels depending upon the type of mitigation and receptor location. This will significantly improve the nighttime noise environment and reduce Ln noise levels to below the 55 dBA sleep awakening threshold at a number of residences compared with existing conditions.

Speech Interference

With mitigation, there will be two receptor locations (places of worship) that are predicted to exceed the outdoor speech comprehension threshold of Ld 55 dBA. Additionally, one school is predicted to have Ld levels higher than the Ld 50 dBA threshold for learning environments. However, mitigation is predicted to reduce outdoor daytime (Ld) sound levels by approximately 1 to 9 dBA depending upon the type of mitigation and receptor location compared with existing noise levels. This will reduce the level of speech interference at all receptor locations to levels below existing conditions.

3.2.3 Ground-borne Vibration during Operation Phase

After completion of the construction phase, the Project is not anticipated to substantially affect ground-borne vibration levels experienced by sensitive human receptors. Before and during Project operation, ground-borne vibration levels are expected to be dominated by road traffic along Highway 99. In the future, ground-borne vibration levels within the study area will change, even without the Project, largely due to increases in road traffic volumes.

3.3 Uncertainty Analysis

Uncertainties associated with this HHRA for atmospheric noise are presented in **Table 8**, which provides an evaluation of each uncertainty and an opinion as to whether the uncertainty is acceptable.

Table 8 **Uncertainties of the Human Health Risk Assessment for Noise and Vibration**

| Risk Assessment Assumption | Justification | Analysis Likely to Over or Under Estimate Risk? | Assumption Acceptable? |
|---|---|---|------------------------|
| 1. The noise data (measured and modelled) provided for the HHRA are accurate, precise, and representative. | Noise monitoring and modelling was conducted in accordance with standard practice. Also, QA/QC measures were implemented to ensure that data was accurate, precise and representative. | Neutral | Yes |
| 2. The noise measurement locations selected reflect areas where noise levels are highest and are representative of all sensitive receptors within the study area. | The noise monitoring sites were selected based on site-specific information (e.g., receptor type, proximity to noise source, intervening surface, elevation of receptor relative to noise source), and therefore it is expected that the receptor locations with the highest noise levels have been identified. | Neutral | Yes |
| 3. The most current guideline values available have been used (i.e., ISO, ANSI, WHO, Health Canada, U.S. FTA). | This approach is in accordance with standard practice, and provides the most current scientific basis with which to conduct a risk assessment. | Neutral | Yes |

4.0 Conclusions

Four different endpoints were assessed to determine whether human health may be affected as a result of exposure to noise and vibration at representative noise-sensitive receptor locations affected by the Project. The endpoints considered were percent highly annoyed (%HA), sleep impairment, interference with speech comprehension, and annoyance associated with ground-borne vibration and the thresholds for each endpoint were selected from recognized international organizations including the ISO (change in %HA), the WHO (sleep impairment), the U.S. EPA (speech comprehension), and the U.S. FTA (ground-borne vibration).

4.1 Construction Phase

During Project construction without mitigation, the noise guidelines for speech comprehension and sleep impairment are predicted to be exceeded at the majority of the representative receptor locations. The % HA threshold is predicted to be exceeded at 14 of 24 locations, the sleep impairment threshold is predicted to be exceeded at 17 of 34 locations and the speech comprehension threshold is predicted to be exceeded at 24 of 34 locations. It is noted that many of these receptor locations currently have existing noise levels above the thresholds, but construction noise will generally increase noise levels by 5 to 20 dBA at many receptor locations. With mitigation, the %HA due to increased noise is predicted to be exceeded at 13 of 24 locations, which is only one receptor location less than without mitigation. However, the %HA will decrease at locations where mitigation has been considered, even though the %HA exceeds the 6.5% threshold.

Construction activities may result in ground-borne vibration levels that can cause annoyance at sensitive receptor locations. The most intense ground-borne vibrations are anticipated to be created by pile driving and dynamic sand compaction activities. The minimum predicted ground-borne vibration levels (associated with pile driving during construction) at sensitive receptor locations all satisfied the applicable impact criterion; however, the maximum predicted ground-borne vibration levels exceeded the 100 VdB impact criterion at 8 of the 13 receptor locations evaluated. As such, it is possible that individuals residing nearest to the new bridge approach piers may experience annoyance during Project construction. Receptors at greater setback distances from the pile driving activities are not anticipated to be affected by ground-borne vibration as ground-borne vibration levels attenuate with distance. Ground-borne vibration effects will be temporary and are only expected to be noticed during pile driving activities and periods of peak fill compaction.

Collectively, the results indicate that even with the use of mitigation measures to reduce noise levels during Project construction, individuals living at several locations within the study area may experience increased annoyance (% HA), increased sleep impairment and reduced speech comprehension. These effects will be reduced, but not eliminated, with proposed mitigation measures. The effects will be temporary and be most prevalent during peak construction periods/phases and will last for the duration of Project construction.

4.2 Operation Phase (2031) with Mitigation

With mitigation, the Project is anticipated to reduce noise levels below current (2013) levels at most receptor locations.

The %HA will be reduced at residential and institutional receptor locations compared with (2013) conditions. There will be a substantial reduction in the number of people who are highly annoyed compared with existing conditions.

In conclusion, with the implementation of Project-related mitigation, noise conditions in the study areas will improve relative to the existing condition. As such, the predicted reductions in noise levels compared with existing levels will reduce the likelihood and severity of any health effects that may currently be associated with existing noise levels.

5.0 References

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8.0 Accidents and Malfunctions

This section identifies potential accidents and malfunctions that could occur during Project construction or operation, and discusses potential effects of such incidents on VCs considered in this Application. An overview of mitigation measures, including design and contract specifications to avoid or minimize environmental effects is also provided. Further detail on mitigation measures and best practices that will be implemented during design, construction, and operation to minimize the potential for accidents and malfunctions to occur is included in **Section 12.0 Management Plans**.

During construction, adherence to the practices and procedures contained in the Construction Environmental Management Plan (CEMP) will minimize the potential for accidents and malfunctions to occur. As described in **Section 12.0 Management Plans**, the CEMP will be developed prior to commencement of Project construction. Preparation of such a CEMP, which would include an Emergency Response and Spill Contingency Plan that describes measures to be taken in the event of an environmental emergency, is a standard Ministry requirement prior to road and structure construction (the Ministry's *2013 Design Build Standard Specifications for Highway Construction* (B.C. MOTI 2013)).

The Project will be designed and built in accordance with the *BC Supplement to TAC Geometric Design Guide, 2007 edition* (B.C. MOT 2007), the Ministry's *2013 Design Build Standard Specifications for Highway Construction* (B.C. MOTI 2013), CSA S6-14 Canadian Highway Bridge Design Code and Bridge Standards and Procedures Manual Volume 1 – Supplement to CHBDC S6-06. In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.

8.1 Potential Accidents and Malfunctions Scenarios

For this assessment, accidents and malfunctions are defined as follows:

- An accident is an unexpected occurrence, unplanned event, or unintended action that can result in an adverse effect.
- A malfunction is the failure of a piece of equipment, device, or system that can result in an adverse effect.

Potential accidents or malfunctions that could occur during Project construction or operations that could affect the environment are listed below.

Project Construction

- Incidents resulting in release of contaminants/hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete) from marine or land-based vehicles, machinery, or equipment to the environment.
- Structural failure of a culvert, ditch, detention pond, or sediment containment measure resulting in localized flooding, erosion, sedimentation, or discharge of deleterious material into the aquatic environment.
- Damage to utilities (e.g., buried natural gas pipes, water mains) resulting in release of deleterious material into the aquatic environment.
- Marine vehicle collision resulting in obstruction of navigation.

Project Operation

Potential accidents and malfunctions during highway operations and maintenance that could adversely affect the environment include:

- Incidents resulting in the release of contaminants/hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete) to the environment during maintenance activities.
- Structural failure of a culvert or ditch resulting in localized flooding or erosion, sedimentation, or discharge of deleterious materials to the aquatic environment.
- Failure of a Project component.

A key goal of the Project is to improve safety for all users of the corridor, including vehicle operators and passengers, cyclists, and pedestrians. Widening of the highway to extend transit/HOV lanes, reducing congestion at the Fraser River crossing, and improving cyclist and pedestrian access and facilities help in achieving this goal. Reduced congestion will also improve access for emergency response vehicles in the event of an accident or incident.

Accidents and other types of emergencies will be managed in accordance with the Ministry's *Maintenance Specifications* (MOT, 2003) and related standards. Emergency responder access to the highway will be improved due to the additional capacity, reduction in traffic congestion, and improved emergency vehicle access to incidents. Given these considerations, traffic-related accidents and malfunctions during Project operations are not included in the assessment.

8.2 Assessment Methods and Interactions

8.2.1 Methodology

The matrix presented in **Section 8.2.3** shows the potential interactions between accidents and malfunctions and VCs based on review of relevant literature, other environmental assessments, and professional judgment. Interactions between an accident or malfunction and VC resulting in a potential effect are carried forward in this assessment.

For each accident or malfunction considered, the following steps were taken to assess the potential risk:

1. The accident or malfunction scenario is described.
2. Measures to reduce the likelihood and consequence of the accident or malfunction on a VC are identified.
3. The likelihood of the accident or malfunction to occur post-mitigation is determined.
4. The consequence of the accident or malfunction (post-mitigation) is assessed by characterizing the magnitude, frequency, geographic extent, and reversibility of the consequence on the VC.
5. The potential risk is determined based on the risk evaluation matrix (i.e., likelihood multiplied by consequence).

8.2.2 Risk Evaluation Methods and Definitions

Likelihood is the probability of the event actually occurring while consequence is a measure of the severity and magnitude of the potential adverse effects. Likelihood and consequence are each qualitatively ranked. Definitions for ranks and levels are provided in **Table 8.2-1**.

Likelihood ranges from remote to very high; consequence ranges from very low to very high.

Table 8.2-1 Definitions for Categories of Likelihood and Consequence

| | Category | Description |
|------------------------------------|-----------|--|
| Likelihood Post-Mitigation | Remote | Event could occur only under exceptional circumstances. |
| | Low | Event not likely to occur under normal circumstances. |
| | Moderate | Event could occur at some point under normal circumstances. |
| | High | Event will probably occur in most circumstances. |
| | Very high | Event is expected to occur in most circumstances and has a history of occurrence. |
| Consequence Post-Mitigation | Very low | Effects are localized and short-term in duration. Recovery is anticipated within days or weeks of incident occurring. |
| | Low | Effects are localized and short-term in duration. Recovery is anticipated within one to two years of incident occurring. |
| | Moderate | Effects are widespread. Recovery is anticipated within two to five years of incident occurring. |
| | High | Effects are widespread. Recovery is not anticipated within five to ten years of incident occurring. |
| | Very high | Effects cause a loss of a considerable portion of a VC. Recovery is not expected. |

Risk was determined using a risk evaluation matrix (**Table 8.2-2**), adapted for the Project from the Risk Management Guideline for the BC Public Sector document (Province of British Columbia Risk Management Branch and Government Security Office 2012).

Table 8.2-2 Risk Evaluation Matrix

| | | Consequence Post Mitigation | | | | |
|-----------------------------------|------------------|-----------------------------|--------|----------|-----------|-----------|
| | | Very low | Low | Moderate | High | Very high |
| Likelihood Post Mitigation | Very High | Low | Medium | High | Very High | Very High |
| | High | Low | Medium | High | High | Very High |
| | Moderate | Low | Low | Medium | High | High |
| | Low | Low | Low | Medium | Medium | Medium |
| | Remote | Low | Low | Low | Low | Medium |

Reference: Adapted from Province of British Columbia Risk Management Branch and Government Security Office, 2012

8.2.3 Potential Interactions with Valued Components

Potential interactions of a Project-specific accident or malfunction with each VC are summarized in **Table 8.2-3**. A check mark indicates that an interaction could occur, in which case it is assessed in the subsequent sections.

Table 8.2-3 Potential Interactions of Project Accidents and Malfunctions with Valued Components

| Accidents and Malfunctions Scenario | Fish and Fish Habitat | Marine Mammals | Vegetation | At-risk Amphibians | Wildlife | Marine Use | Land Use | Agricultural Use | Visual Quality | Human Health | Heritage Resources |
|--|-----------------------|----------------|------------|--------------------|----------|------------|----------|------------------|----------------|--------------|--------------------|
| Release of toxic or hazardous materials (e.g., hydrocarbon fuels, lubricants, concrete) into the environment during construction or maintenance. | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | ✓ | - | ✓ | - |
| Structural failure of a culvert, ditch, detention pond, or sediment containment measure resulting in localized flooding, erosion, sedimentation, or discharge of deleterious material into the aquatic environment during construction or maintenance. | ✓ | ✓ | ✓ | ✓ | - | - | - | ✓ | - | - | - |
| Damage to utilities (e.g., buried natural gas pipes, water mains) resulting in release of deleterious material into the aquatic environment during construction or maintenance or loss of water, sewage, or power service. | ✓ | ✓ | - | ✓ | ✓ | ✓ | ✓ | ✓ | - | - | - |
| Marine vehicle collision and unintended obstruction of navigation during construction | ✓ | ✓ | - | - | - | ✓ | - | - | - | - | - |
| Potential failure of a Project component during project operation. | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ | - | ✓ | - |

8.3 Likelihood, Consequence, and Risk of Potential Accidents and Malfunctions

A description of the potential Project-related accident or malfunction scenarios identified in **Section 8.1**, and a discussion on their likelihood and consequence is presented below. Mitigation measures to minimize the likelihood of accidents or malfunctions and their consequence are identified, and a conclusion on the potential risk of the accident or malfunction is provided.

8.3.1 Release or Spill of Contaminants or Hazardous Materials

For the purposes of this assessment, a spill is considered to be any release or discharge into the environment, not authorized under the provincial *Environmental Management Act*, of a substance in an amount equal to or greater than the amount specified in the *Spill Reporting Regulation* (Government of BC 2008). The Project assessment considers spills reportable under the *Spill Reporting Regulation*, and spills that would not meet reporting criteria under this regulation. Spills of a contaminant or hazardous material are considered for the construction and operation (restructured to maintenance activities) phases of the Project.

Sources of spills during construction are generally associated with storage and use of fuel and machinery, with less likely spills associated with vehicle or vessel collision. During construction and Tunnel decommissioning, there is potential for minor spills involving release of hydrocarbon fuels, lubricants, uncured concrete, concrete-affected waters, or other materials into the aquatic environment. Spills of toxic or hazardous substances into the environment could result in temporary degradation of watercourses or terrestrial areas.

The most likely spill scenario is the spill of relatively small amounts of fuels, lubricants, or other equipment fluids which may occur through refueling or leaks from machinery. The volume of these spills would be minor (less than a few litres), localized, limited to the required on-site containment areas, and readily cleaned up. Onsite storage and use of hazardous materials will comply with all relevant regulations, and secondary containment measures will make an uncontained spill unlikely.

Mitigation Measures

Mitigation measures to reduce the likelihood and consequence of an accidental spill into the environment will include the following:

- Training construction and maintenance personnel on spill prevention and management.
- Training construction and maintenance personnel on environmentally sensitive areas within the Project alignment.
- Maintaining equipment and machinery and regularly inspecting them for leaks.
- Development and implementation of EMPs, describing best practices for management and clean-up of hazardous spills.
- Storing spill abatement equipment onsite.
- Secondary containment for all hazardous materials.
- Locating refuelling and maintenance areas a minimum of 30 m from any water bodies or sensitive areas.
- Development and implementation of reporting and monitoring requirements for any spill of toxic or hazardous material to the Ministry and, when applicable, to the provincial Environmental Emergency Program, under the *Environmental Management Act*, S.B.C. 2003, c. 53, Spill Reporting Regulation, B.C. Reg. 263/90.

These measures will be specified in more detail in the Emergency Response and Spill Contingency Plan component of the CEMP and OEMP developed for the Project (see **Section 12.0 Management Plans**).

In addition to the above, measures will be in place to reduce the likelihood and consequence of spills from collisions involving construction vehicles, vessels, or machinery, and general traffic moving near or through the construction site.

A Construction Traffic Management Plan and a Marine Access Management Plan will be developed prior to the start of construction. These plans will describe mitigation measures to be implemented to prevent or manage potential land- and marine-related traffic hazards during construction, such as:

- Mitigation measures that may include barriers, speed limits, compliance with transport and storage of dangerous goods in accordance with the *Transportation of Dangerous Goods Act*, R.S.B.C. 1996, c. 458, and specific provisions for worker safety.
- Measures to promote safety and security of onsite personnel and all users of the corridor including the public, minimizing the potential for vehicle-related accidents.

- Procedures for coordination with emergency responders (police, ambulance, fire) and immediate measures for managing spills.
- Specifications, that in the event of a vehicle-related accident, waste materials will be disposed of in accordance the emergency response measures described in **Section 12.1.5 Emergency Response and Spill Contingency Plan.**
- Mitigation measures to minimize the potential for vessel-related accidents including communications protocols and emergency procedures.
- Specifications that navigational clearances for the new bridge will be incorporated into the Project design in accordance with the requirements of Transport Canada Navigation Protection Program, pursuant to the *Navigation Protection Act*, R.S.C., 1985, c. N-22. The proposed navigational clearances are described in **Section 5.2 Marine Use.**

Likelihood

The potential of a spill of contaminants or hazardous materials entering the environment and resulting in an adverse effect to terrestrial or aquatic wildlife, agricultural use, land use, or human health is unlikely to occur post-mitigation. The mitigation measures described above will be implemented to avoid or minimize the potential for a spill to occur, and to mitigate and manage the potential effect in the event of a spill occurring. With mitigation in place, the likelihood of a spill of hazardous materials reaching the environment and having an adverse effect on VCs is considered to be low.

Consequence

The geographic extent of a spill would depend on the quantity of the material spilled and location where it was spilled. With the implementation of appropriate spill response procedures and the mitigation measures described above, it is anticipated that a spill would be localized in geographic extent. The frequency of a spill into the environment is considered to be uncommon. The effect is anticipated to be reversible, with baseline conditions naturally restored after the disturbance has ceased and appropriate remediation measures have been applied.

The magnitude and duration of any potential effects of a hazardous material spill would depend on the quantity spilled, the location of the spill, and (potentially) the time of year in which the incident occurs.

Spill response procedures will be developed to contain and manage a spilled product in a localized area, thus limiting potential interaction with the receiving environment. For example, re-fueling will not be permitted near at-risk vegetation communities, within 30 m of watercourses, or near important habitat for species of conservation concern.

The consequence of spill of contaminants or hazardous materials resulting in adverse effects to VCs is assessed to be very low given that effects would be localized and short-term in duration, and recovery would be within days or weeks of incident occurring.

Risk Conclusion

The mitigation measures outlined above are standard practice in the industry and have been proven effective in reducing the likelihood of a spill to occur. The implementation of spill contingency and cleanup measures are well-tested and effective means of reducing the consequences of spills. The confidence in this assessment is high, since the assessment is based on well-documented cause-effect relationships.

With the implementation of the mitigation measures described, a spill has a low likelihood of occurring and resulting in an adverse effect to VCs. Although it is possible that spills may occur during construction; even with the preventative mitigation measures applied, the implementation of spill contingency and cleanup measures are expected to reduce the consequence of an adverse effect to receptor VCs in the event that a spill did occur.

The consequence of a spill ranges from very low to low, depending on the size of the spill, type of material, location, and circumstances.

Given the low likelihood and very low to low consequence of a spill of contaminants or hazardous material resulting in an adverse effect on VCs, using the risk evaluation matrix, the risk is determined to be low.

A summary of residual effects resulting from a spill of contaminants or hazardous materials is presented in **Table 8.3-1** for those VCs where an interaction may occur. The more detailed VC-specific definitions for magnitude, extent, duration, frequency, and reversibility are presented in **Section 4.0 Environmental Effects Assessment** to **Section 7.0 Health Effects Assessment**, and are used in cases where they are relevant for both the Project effects assessment and for the accident or malfunction effects assessment.

Table 8.3-1 Residual Effects of Spills

| Valued Component | Residual Effects Criteria | | | | | | Consequence | Likelihood | Risk |
|-----------------------|---------------------------|-----------|--------|------------|-----------|---------------|-------------|------------|------|
| | Direction | Magnitude | Extent | Duration | Frequency | Reversibility | | | |
| Fish and Fish Habitat | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| At-risk Amphibians | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| Marine Mammals | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| Vegetation | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| Terrestrial Wildlife | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| Land Use | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| Agricultural Use | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| Human Health | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |

8.3.2 Structural Failure of Containment Structures

Structural failure of a containment structure is considered to include failure of a culvert, ditch, detention pond, or sediment containment structure resulting in localized flooding, erosion, sedimentation, or discharge of sediment-laden water into the aquatic environment during Project construction or operation.

Sediment and erosion control structures will be installed during Project construction and operational maintenance activities for work in and around riparian zones and waterbodies. Under unexpectedly severe weather conditions or calamitous events, it is possible that structures could fail, potentially releasing sediment-laden water into road-side ditches or watercourses. Failure of a culvert may result in increased or concentrated overland flow, increased erosion and sediment transport, and potentially accidental release of sediment-laden water into the receiving environment.

Depending on the extent and duration of the incident, accidental release of sediment or sediment-laden water into a watercourse may result in degradation of water quality, potentially affecting fish and fish habitat, at-risk amphibians, and marine mammals. In addition to impacts to aquatic organisms, elevated sediment levels may block, damage, or overwhelm drainage infrastructure or culverts resulting in damage to or malfunction of irrigation and drainage equipment.

Mitigation Measures

In the event that a culvert, ditch, or sediment containment structure fails, mitigation will be applied to address the potential for erosion or sedimentation to affect receiving aquatic or terrestrial environments. As discussed in **Section 12.0 Management Plans**, an Erosion and Sediment Control Plan will be developed as part of the CEMP. The primary objective of the plan will be to ensure that, during Project construction, water from the site that is discharged into the receiving environment will meet suspended sediment requirements outlined in the Canadian Council of Ministers of the Environment (2002) and the B.C. (B.C. MOE 2006) water quality guidelines.

Mitigation measures and best practices to address the potential for release of deleterious substances into the environment will be incorporated into the Project design, and will be implemented during construction (as described in **Part B – Assessment of Environmental, Economic, Social, Heritage, and Health Effects** of the Application), minimizing the potential for adverse environmental effects from the Project.

Sediment and erosion control will be a primary focus during Project construction activities occurring near the Fraser River South Arm, Green and Deas Sloughs, and roadside ditches/waterbodies within the Project alignment. Culverts, ditches, and sediment containment structures will be designed in accordance with the Ministry's *2013 Design Build Standard Specifications for Highway Construction* (B.C. MOTI 2013).

During Project operation, temporary erosion control measures may be required in the event of a large natural event (see **Section 9.0 Effects of the Environment on the Project**), or during activities involving maintenance of stormwater or drainage infrastructure.

Mitigation and best practices that will be implemented to mitigate potential erosion or sedimentation resulting from structural failure of a culvert, ditch, or sediment containment structure will be included in the Erosion and Sediment Control Plan component of the CEMP and OEMP and will include measures to:

- Develop temporary drainage systems to receive, filter, and direct stormwater and runoff during construction
- Store waste material and soil to prevent possible entry into the aquatic environment

- Install silt fences or other appropriate mitigation
- Reduce the extent and duration of ground disturbance during construction
- Protect exposed soil
- Install temporary and permanent erosion control measures and bio-filtration ponds/marshes and revegetation of slopes
- Establish an erosion and sediment control inspection and maintenance program

More information on the mitigation measures that will be implemented to manage potential sediment release or erosion is provided in **Section 12.0 Management Plans**.

Likelihood

The likelihood of erosion or sedimentation resulting from structural failure of a culvert, ditch, or sediment containment structure during construction is considered to be low. With implementation of mitigation measures, such events are anticipated to be avoided.

Consequence

In the unlikely scenario that sediment-laden water reaches the aquatic environment (e.g., the Fraser River or a road side ditch) as a result of failure of a culvert, ditch, or sediment containment structure, water quality could be affected. Such changes could subsequently affect fish, marine mammals, or at-risk amphibians directly, or through change in quality of habitat, or, human health.

If sediment-laden water reached the aquatic environment, the geographic extent of the effect would depend on the quantity of sediment-laden water released relative to the size of the receiving body, and potential for dispersion. With the implementation of the mitigation measures described above, the volume of sediment that could be released into the aquatic environment would likely be low and the extent of the effect would likely be local.

The magnitude of the effects of a low-volume sediment release is anticipated to be low. The release of a low volume of sediment-laden water into watercourses within the Project alignment would not be expected to result in a noticeable effect over baseline conditions, given the natural variability of suspended sediment with the river seasonally and annually (**Section 4.1 River Hydraulics and River Morphology**), and the quality of the upland watercourses.

The duration of the effect is anticipated to be short-term as sediment that may be released during Project construction or maintenance activities would be expected to be contained or dissipated quickly. The frequency of a release of sediment-laden water is anticipated to be uncommon. Considering the existing variability of sediment levels in the Fraser River and the

unlikely disturbance of CRA fish habitat or at-risk amphibians in road side ditches after mitigation measures have been applied, the effect is anticipated to be reversible, with baseline conditions naturally restored after the disturbance has ceased.

The consequence of the failure of a culvert, ditch, or containment structure is low given that the effects are predicted to be localized, low in magnitude, and reversible over the short-term.

Risk Conclusion

The likelihood and consequence of a sediment release into the environment is anticipated to be low given the controls and preventative measures that are required to be in place. The mitigation measures outlined are well-established industry standards that have been proven effective at managing localized flooding, erosion, sedimentation, or discharge of deleterious materials into the aquatic environment. With the implementation of mitigation, the likelihood and consequence of residual adverse effects is considered to be low. Therefore, the potential event is considered to be of low risk.

A summary of residual effects resulting from localized flooding, erosion, sedimentation, or discharge of deleterious materials into the environment is presented in **Table 8.3-2** for those VCs where an interaction may occur. The more detailed VC-specific definitions for magnitude, extent, duration, frequency, and reversibility are presented in **Section 4.0 Environmental Effects Assessment** to **Section 7.0 Health Effects Assessment**, and are used in cases where they are relevant for both the Project effects assessment and for the accident or malfunction effects assessment.

Table 8.3-2 Effects of Failure of Containment Structures

| Valued Component | Residual Effects Criteria | | | | | | Consequence | Likelihood | Risk |
|-----------------------|---------------------------|-----------|--------|------------|-----------|---------------|-------------|------------|------|
| | Direction | Magnitude | Extent | Duration | Frequency | Reversibility | | | |
| Fish and Fish Habitat | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| At-risk Amphibians | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |
| Marine Mammals | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |

8.3.3 Damage to Utilities

The Project alignment accommodates a number of underground utilities such as electricity, sewage, water, natural gas, jet fuel or telecommunications, and there is a potential for accidental damage of these utilities during Project construction or maintenance activities involving ground disturbance (e.g. excavating, trenching, pile driving, ground improvements). Damage of utilities may cause disruption of municipal services for residential, commercial, or industrial users. Utility damage involving a spill of waste water or chlorinated water could also affect fish and fish habitat, marine mammals, or at-risk amphibians if such spills enter the aquatic environment. An accidental breach in the integrity of a natural gas pipeline could have potential health and safety implications.

Mitigation Measures

Prior to the start of construction or maintenance activities involving ground disturbance, underground utilities within the Project alignment will be located and mapped. Locating and mapping underground utilities on detailed design drawings will minimize the likelihood of unexpected disruption.

Contractors will be required to contact BC One Call, a central agency that helps identify buried underground utilities and facilities, in advance of any ground works.

In the event of a disruption to underground utilities, the municipality and the relevant utility will be contacted immediately and response will proceed as set out in the CEMP.

Likelihood

Due to the standard nature of construction methods envisaged and the use of appropriate mitigation measures, including the proper identification and protection of utilities prior to construction, the likelihood of accidental damage to utilities resulting in adverse effects to VCs is considered remote.

Consequence

Any disruption of utilities is expected to be addressed in an effective, timely manner through the implementation of the CEMP. This will ensure that potential effects of such incidents are localized in extent, temporary in duration, and minimal in consequence. The consequence of accidental damage to a utility is anticipated to be low to moderate, depending on the type of utility damaged and the extent of the damage.

Risk Conclusion

Proposed mitigation measures are anticipated to reduce the likelihood of utility damage during construction and maintenance, and the consequence of any unlikely incident. With mitigation, the likelihood of residual adverse effects is considered remote. The potential consequence of damaging utilities during construction is likely to be low after implementation of proposed mitigation. The potential risk associated with accidental damage of utilities during Project construction and maintenance is considered to be low. Given the low risk involved, and the remote nature of likelihood of such and effect occurring, an assessment of potential effects of an accident or malfunction involving utility disruption is not considered necessary.

8.3.4 Marine Vessel Collision

During construction of the Project, there will be marine vessels and marine-based equipment stationed near the Project and travelling to and from the Project, depending on location of staging areas. A marine-based vessel or equipment collision with another marine-based vessel or equipment (Project-related or non-Project-related) during construction has the potential to disturb navigation in and around the area of the incident.

The potential for a marine vessel collision during operations is very rare and would require marine-based maintenance activities to be occurring such that the location, timing, and duration could affect other vessels or equipment. Navigational clearances for the proposed new bridge have been developed in accordance with the requirements of Transport Canada (Navigable Waters Protection Division). Proposed vertical and horizontal navigational clearances are described in **Section 1.1 Description of Proposed Project**. Project maintenance will be primarily land or structure-based; the potential for marine based maintenance activities to occur during Project operations is considered very rare and therefore not discussed further.

Mitigation Measures

Mitigation measures to reduce the likelihood and consequence of disturbance to marine use and navigation will include the following:

- Training will be mandatory for all contractors and equipment operators to understand and adhere to a Marine Access Management Plan during construction activities to avoid collision or interference with other marine users, marine vehicles, and marine equipment related and unrelated to the Project.

- Signage requirements will be determined and will be described in the Marine Access Management Plan, prior to commencement of marine-based activities.
- Avoiding work during adverse marine conditions (e.g., fog) where possible, and include speed restrictions during inclement weather, for inclusion in the Marine Access Management Plan.

Likelihood

The potential of a marine vessel collision resulting in obstruction to navigation is considered low given the mitigation measures in place, including operator training, and high-visibility marking of construction areas.

Consequence

In the unlikely scenario of a marine vessel collision resulting in obstruction to navigation, marine use could be affected. The geographic extent of the effect is anticipated to be local. The magnitude and duration of obstruction to navigation due to a marine vessel collision would likely be of low magnitude, and over short duration, given the mitigation measures in place.

The frequency of a marine vessel collision resulting in unintended obstruction to navigation is anticipated to be uncommon given implementation of the Marine Access Management Plan, including operator training, high-visibility marking of navigation and construction areas.

The effect is anticipated to be reversible after the disturbance has ceased. The consequence of a marine vehicle collision resulting in unintended obstruction to navigation is assessed to be low given that the effects are predicted to be low in magnitude, localized, temporary in duration, and reversible over the short-term. Any disturbance to marine use is expected to be addressed in an effective, timely manner through the implementation of the Construction Traffic Management Plan.

Risk Conclusion

The mitigation measures outlined above are standard practice in the industry and have been proven effective. The Construction Traffic Management Plan will include a communication program informing marine users of activities and schedules of construction within (and to/from) the Project. This is expected to effectively reduce the likelihood and consequence of disturbance to marine use from a marine vessel collision resulting in obstruction to navigation. The confidence in this assessment is high, since the assessment is based on well-documented cause-effect relationships.

It is unlikely that a marine vessel collision will disturb marine use. Given the implementation of mitigation measures, the consequence of such an accident is anticipated to be low, resulting in a risk rating of low.

A summary of residual effects resulting from marine vessel collision resulting in obstruction to navigation and the potential interactions with VCs is presented in **Table 8.3-3**. The more detailed VC-specific definitions for magnitude, extent, duration, frequency, and reversibility are presented in **Section 5.0 Socio-economic Effects Assessment**, and are used in cases where they are relevant for both the Project effects assessment and for the accidents and malfunction effects assessment.

Table 8.3-3 Effects of Marine Vehicle Collision and Unintended Obstruction to Navigation

| Valued Component | Residual Effects Criteria | | | | | | Consequence | Likelihood | Risk |
|------------------|---------------------------|-----------|--------|------------|-----------|---------------|-------------|------------|------|
| | Direction | Magnitude | Extent | Duration | Frequency | Reversibility | | | |
| Marine Use | Adverse | Low | Local | Short-term | Uncommon | Reversible | Low | Low | Low |

8.3.5 Structural Failure of Project Components

The new bridge, interchanges, and associated infrastructure will be designed and built to withstand collision from vehicles without sustaining structural damage. Parapets and railings will be designed to prevent vehicles from leaving the roadway, as set out in *CSA S6-14 Canadian Highway Bridge Design Code* and the *Ministry's Bridge Standards and Procedures Manual–Volume 1, Supplement to CHBDC S6-06*. The potential for Project malfunctions resulting from structural failure during Project operations is therefore considered remote. An overview of measures that will be implemented to ensure that potential structural failure is avoided, and resulting consequences are minimized is presented below, along with a discussion on associated risk.

Mitigation Measures

The Project will be designed and constructed in accordance with federal and provincial standards to minimize the potential for damage resulting from structure failure, including the *CSA S6-14 Canadian Highway Bridge Design Code* and the Ministry's *Bridge Standards and Procedures Manual–Volume 1, Supplement to CHBDC S6-06*.

The Ministry's maintenance contractors are required to respond to structural damage as set out in Chapter 7-800 (Structure Damage Response) of the Ministry's *Maintenance Specifications*. In general, the objective of the response is to ensure the safety of highway users, to restore all affected structures to their original condition, and to maximize their functional life (B.C. MOT 2003). Where the safety of highway users is affected, the Ministry maintenance contractors must immediately notify the Ministry so a Bridge Structural Engineer may make an inspection. If determined that there is a risk of structural failure under loading, the bridge may be load restricted or closed to all traffic or uses, and the bridge repaired to a safe and stable condition.

In the event of a structural failure, priority will be given to ensuring the stability of the highway and the safety of highway users. Once public safety is assured, Ministry contractors are required to take the necessary steps to reduce the risk posed by debris or other materials to the drainage system, riparian areas, and watercourses. The removal of such debris will commence as soon as possible, in consultation with Ministry of Environment, Ministry of Forests, Lands and Natural Resource Operations, and Department of Fisheries and Oceans, as applicable. During debris removal activities, measures will be implemented to prevent sediment and other deleterious materials from entering road drains and watercourses.

Likelihood

The likelihood of a structural failure involving Project components is considered remote, given the strict regulation and standards that apply to the design, construction, and operation of major infrastructure.

Consequence

Design standards and the mitigation measures discussed above are expected to ensure that potential consequences of any structural failure are minimized. Potential consequence to human health and safety in an unlikely event involving structural failure of a Project component is considered to be low, given the design, construction, and maintenance specifications and requirements of the proposed structures. The potential consequence of the failure of a Project component to VCs is considered to be low to medium.

Risk Conclusion

Based on the remote likelihood of an accident or malfunction resulting in the structural failure of a Project component during Project operations, and the low to medium consequence of such an incident on VCs, the risk associated with structural failure during operations is determined to be low. Given the low risk involved, and the remote nature of the likelihood of such an effect occurring, an assessment of potential effects of an accident or malfunction involving failure of a Project component during operations is not considered necessary.

8.4 Summary

During construction, adherence to the practices and procedures contained in the CEMP and sub-plans will minimize the potential for accidents and malfunctions to occur. As described in **Section 12.0 Management Plans**, the CEMP will be developed prior to Project construction and will include measures to be taken in the event of an environmental incident, in accordance with the Ministry's *2012 Standard Specifications for Highway Construction* (B.C. MOTI 2012). An Operation Environmental Management Plan (OEMP) will be developed upon Project completion, prior to commencement of the operation phase.

One of the key objectives of the Project is to improve safety within the Highway 99 corridor. The improvements in traffic and transportation conditions that are anticipated to result from the Project are expected to lower the potential for accidents or malfunctions to occur during Project operation, compared to existing conditions.

The preventative measures that will be in place to avoid or mitigate potential environmental effects resulting from an accident or malfunction during Project construction and operation have been outlined in this section. More prescriptive response efforts and activities that will be implemented in the event that an accident or malfunction occurs, despite the preventative actions taken, will be described in the applicable management plans that will be developed prior to construction.

The likelihood, consequence, and risk for each event described, with implementation of the design and management objectives and mitigation measures described in the preceding sections are summarized in **Table 8.4-1**.

Implementation of effective Project design and management specifications and mitigation measures is expected to minimize the likelihood, and avoid or reduce the consequence of potential accidents and malfunctions that could occur during Project construction and operation. Potential risks associated with all potential Project-related accident or malfunction scenarios are expected to be low.

Table 8.4-1 Summary of Risk for Accidents and Malfunctions

| Section | Accident or Malfunction Scenario | Project Phase ¹ | Likelihood | Consequence | Risk ² (after mitigation) |
|---------|--|----------------------------|------------|-----------------|--------------------------------------|
| 8.3.1 | Release or spill of toxic or hazardous materials | C O | Low | Low | Low |
| 8.3.2 | Structural failure of containment structures | C O | Low | Low | Low |
| 8.3.3 | Damage to utilities | C O | Remote | Low to Moderate | Low |
| 8.3.4 | Marine vehicle collisions | C | Low | Low | Low |
| 8.3.5 | Structural failure of Project components | O | Remote | Low to Moderate | Low |

Notes: ¹C = construction phase; O = operation phase, which includes maintenance

² Risk evaluation considers the interaction of likelihood and consequence as described in **Section 8.2.2.**

8.5 References

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9.0 Effects of the Environment on the Project

This section presents the results of a review of environmental factors deemed to have possible consequences for the Project. The following factors were considered in this review: extreme weather, seismic events, erosion and scour, fire, extreme flood events, and climate change. Effects that may be caused by these factors, and their likelihood and consequence for relevant VCs, are described. Practical mitigation measures, including design strategies and environmental management plans, to avoid or minimize the likelihood and consequence of the effects of the environment on the Project are identified and a conclusion on the potential risk of an effect of the environment on the Project and to relevant VCs is provided.

Likelihood and Consequence

Likelihood is the probability of the event actually occurring while consequence is a measure of the severity and magnitude of the potential effects. Likelihood and consequence are each qualitatively ranked. Definitions for ranks and levels are provided in **Table 9-1**. Likelihood ranges from remote to very high; consequence ranges from very low to very high.

Table 9-1 Definitions for Categories of Likelihood and Consequence

| | Category | Description |
|------------------------------------|-----------|--|
| Likelihood Post-Mitigation | Remote | Event could occur only in exceptional circumstances. |
| | Low | Event not likely to occur in normal circumstances. Expected to occur less than once every five years. |
| | Moderate | Event could occur at some point. Expected to occur once in every three to five years. |
| | High | Event will probably occur in most circumstances. Expected to occur once in one to three years. |
| | Very high | Event is expected to occur in most circumstances and has a history of occurrence. Expected to occur once or more per year. |
| Consequence Post-Mitigation | Very low | Effects are localized and short-term in duration. Recovery is anticipated within days or weeks. |
| | Low | Effects are localized and short-term in duration. Recovery is anticipated within 20 years of occurrence. |
| | Moderate | Effects are widespread. Recovery is anticipated within 20 years of occurrence. |
| | High | Effects are widespread. Recovery is not anticipated within 20 years of occurrence. |
| | Very high | Effects cause a loss of a considerable portion of a VC. |

Risk

Risk was determined using a risk evaluation matrix (**Table 9-2**), adapted for the Project from the Risk Management Guideline for the B.C. Public Sector document (B.C. Risk Management Branch and Government Security Office 2012). The level of risk associated with an event depends on the potential consequence and the likelihood of occurrence (see **Table 9-2**). For example, an event is considered very high risk if the likelihood and the consequence of the event post-mitigation are very high.

Table 9-2 Risk Evaluation Matrix

| Likelihood Post- Mitigation | Consequence Post-Mitigation | | | | |
|-----------------------------|-----------------------------|--------|----------|-----------|-----------|
| | Very low | Low | Moderate | High | Very high |
| Very High | Low | Medium | High | Very High | Very High |
| High | Low | Medium | High | High | Very High |
| Moderate | Low | Low | Medium | High | High |
| Low | Low | Low | Medium | Medium | Medium |
| Remote | Low | Low | Low | Low | Medium |

Reference: Adapted from B.C. Risk Management Branch and Government Security Office, 2012

9.1 Extreme Weather

The Project is located within the Coastal Western Hemlock dry maritime biogeoclimatic sub-zone (CWHdm), which is characterized by warm summers and moist, mild winters with rare cases of snow (Green and Klinka 1994). Although the climate is generally consistent among seasons, there are rare cases of climate extremes. Severe climatic events that may affect the Project include heavy precipitation including snow, ice, high winds, and extreme temperatures.

The average and extreme precipitation data, collected from Environment Canada’s Richmond Nature Park Climate Station and the Delta Tsawwassen Beach Climate Station from 1981 to 2010, are summarized on **Table 9.1-1**. These climate stations have been selected to represent the extreme weather scenarios that could occur in and around the Project. The majority of the annual precipitation within the Project area is rain, which occurs regularly between October to March, along with occasional, short-duration snow events.

Table 9.1-1 Average and Extreme Weather Data from 1981 to 2010

| Parameter | Richmond Nature Park Climate Station | Delta Tsawwassen Beach Climate Station |
|----------------------------------|--------------------------------------|--|
| Average temperature (°C) | 10.6 | 11.1 |
| Extreme maximum temperature (°C) | 34.5 (1983) | 31 (1988) |
| Extreme minimum temperature (°C) | -16.5 (1978) | -12.0 (1989) |
| Annual rainfall (mm) | 1227.8 | 899.9 |
| Extreme daily rainfall (mm) | 93.8 (2003) | 88.2 (2003) |
| Annual total snowfall (cm) | 24 | 28 |
| Median snow depth (cm) | 0 | 0 |
| Extreme daily snowfall (cm) | 24 (1998) | 39 (1996) |

Source: Environment Canada (2014)

Higher-than-average precipitation levels could increase flood potential (**Section 9.5 Extreme Flood Events**) and cause erosion (**Section 9.3 Erosion and Scour**) within the Project alignment during construction or operation.

Wind data from the climate station at the Vancouver International Airport was used to represent local conditions. Over the course of a typical year, wind speeds vary from 0 km/h to 42 km/h (light air to moderate breeze), rarely exceeding 52 km/h (high wind).

Potential Effects on the Project and Valued Components

Potential effects of extreme weather events on the Project include the following:

- From heavy precipitation events, increased erosion potential, flooding, and decreased slope stability.
- Damage to roads, structures, and drainage facilities from high winds and heavy rain, resulting in untreated runoff and debris entering watercourses or terrestrial habitat.
- Accidents and malfunctions, triggered by extreme weather events, resulting in release of deleterious or toxic substances into terrestrial or aquatic habitats (**Section 8.0 Accidents and Malfunctions**).
- Adverse driving conditions, leading to increased potential for accidents during heavy rain, snow, fog, and high-wind events, potentially resulting in spills or release of toxic substances into terrestrial or aquatic habitats.

Effects of extreme weather events on the Project, as listed above, could have the following implications for valued components:

- Fish and fish habitat and at-risk amphibians may be affected by untreated runoff and debris entering watercourses.
- Fish and fish habitat, at-risk amphibians, marine mammals, and terrestrial wildlife may be affected by the release or spill of deleterious or toxic substances.
- Marine use may be affected by debris entering the Fraser River.
- Land use may be affected by flooding.

Mitigation Measures

The Project will be designed and constructed in accordance with federal and provincial standards to minimize the potential for structural damage resulting from extreme weather. Applicable design standards and directives include the *Canadian Highway Bridge Design Code* (CSA 2010), the Ministry's *Bridge Standards and Procedures Manual* (B.C. MOT 2007), the Ministry's 2012 *Standard Specifications for Highway Construction* (B.C. MOTI 2012) and the Ministry's Technical Circular T-06/15 Climate Change and Extreme Weather Event Preparedness and Resilience in Engineering Infrastructure Design.

Specifically, the following measures will be in place to reduce the likelihood and mitigate the consequence of effects of extreme weather events:

- The river bank will be enhanced or reinforced where required to support Project components, providing protection against extreme weather events, erosion, and flooding.
- The Project will be designed to withstand extreme rainfall through stormwater management and drainage infrastructure.
- Upland drainage ditches will be designed to withstand storm events adjusted for climate change.
- The new bridge will be designed to mitigate potential functionality issues that could occur during snow and ice events.
- The Project will be designed to withstand maximum wind conditions.

Likelihood and Consequence of Potential Effects

Weather in the Project area is stable through most of the year with rare occurrences of extreme conditions. The Project will be designed and constructed to withstand extreme events, and provide safe movement of vehicles across the new bridge and along the upgraded highway during extreme weather conditions.

With mitigation applied to prevent, avoid, or reduce extreme weather effects, including design, construction, operation, and maintenance standards, the likelihood and consequence of an extreme weather-related effect is considered to be very low. Appropriate maintenance and management procedures will be in place to avoid or minimize environmental consequences of extreme weather events on valued components.

Conclusions on Potential Risk

Potential effects of extreme weather events on the Project will be considered during design, construction, and operation of the Project. Mitigation measures will be designed and implemented to avoid or reduce potential adverse effects of the environment on the Project, and subsequent effects on valued components. The overall risk to the Project from extreme weather events, during either construction or operation, is considered to be very low.

9.2 Seismic Events

The Lower Mainland is within one of the most seismically active areas of Canada. Approximately 4,000 earthquakes are recorded each year in Canada, half of which occur off the coast of B.C. (NRC 2011). Seismic activity occurs when tectonic plates move apart, slide past one another, or collide. This activity results in small earthquakes (occurring daily), larger, potentially damaging earthquakes (occurring decades apart), and some of the world's largest earthquakes (occurring centuries apart).

The largest earthquakes that have occurred in the region in the past several decades include a magnitude 6.8 event in Washington State in 2001, a magnitude 6.5 event near Seattle-Tacoma, Washington in 1965, and a magnitude 7.3 event near Campbell River, B.C. in 1946. Geological evidence indicates that great (magnitude 8 to 9) earthquakes strike the B.C. coast every 200 to 850 years. The most recent great event occurred over 300 years ago (January 26, 1700).

Potential Effects on the Project and Valued Components

Depending on the distance from the Project, a large earthquake could result in structural damage to the Project, which may include:

- Ground deformations, embankment approach fill deformation, structural change to the new bridge and soil liquefaction, resulting in structural damage to the new bridge, roads, banks, and dikes.
- Increased potential for erosion, scour, or flooding (**Sections 9.1 Extreme Weather and 9.5 Extreme Flood Events**).
- Increased potential for accidents and malfunctions, resulting in debris and toxic or deleterious substances entering a watercourse (**Section 8.0 Accidents and Malfunctions**).

Effects of a seismic event on the Project, as listed above, could have the following implications for valued components:

- The bridge may be temporarily out of service.
- Traffic may be affected by delays in movement or change in accessibility of traffic routes
- Marine use may be affected by debris entering the Fraser River.
- Fish and fish habitat, at-risk amphibians, marine mammals, and wildlife may be affected by toxic or deleterious substances entering watercourses.
- Land use may be affected by ground deformations, soil liquefaction, erosion, scour, or flooding.

Mitigation Measures

One of the key objectives of the Project is to improve safety within the Highway 99 corridor. The Project will be designed, constructed, and operated in accordance with the latest *Canadian Highway Bridge Design Code* (CSA 56-14), and other applicable and current seismic design codes from the United States and Europe. These design codes serve as models to help provincial and territorial authorities ensure that structures are engineered to the level of earthquake hazard for the applicable seismic zone. The Project will result in a safer travel corridor that will withstand seismic activity in an improved capacity compared to existing conditions (i.e., the Tunnel). Specifically, the following measures will avoid or minimize the likelihood and consequence of potential effects of seismic events on the Project:

- Ground improvements will be undertaken prior to construction, allowing the Project components, including the new bridge, to be built on densified ground, which is less susceptible to liquefaction in the event of seismic activity.
- The new bridge will be constructed as a Lifeline Structure. In the event of an earthquake, a Lifeline Structure will:
 - Sustain no damage and remain open to all traffic following an earthquake with a 1-in-475-year return period seismic event.
 - Sustain minimal damage following a 1-in-975-year return period seismic event.
 - Sustain repairable damage resulting in limited service following a 1-in-2,475-year return period seismic event.

Likelihood and Consequence of Potential Effects

The likelihood that a seismic event could affect Project infrastructure resulting in adverse effects to the environment is remote, given the design of the new bridge as a Lifeline Structure. The consequence of the effects of a major (i.e., 7 magnitude or greater) seismic event could be high, depending on the scale of the event and associated damage.

Public safety, emergency routes and access, and structure stability will be improved compared to the current situation within the Highway 99 corridor. Specifically, the new bridge will be safer in the unlikely event of a large-scale earthquake, and will be designed to better withstand a seismic event.

Conclusions on Potential Risk

Large-scale seismic events could potentially affect the Project; however, the likelihood of such events occurring is remote. In addition, the potential consequence of the event will be mitigated through Project design which will improve public safety, emergency routes and access, and structure stability compared to the current situation within the Highway 99 corridor. The overall risk to the Project is considered to be very low.

9.3 Erosion and Scour

Erosion occurs when flowing water removes soil particles or a mass of material from the bank of a waterbody. Waterbodies within the Project alignment include the Fraser River South Arm, Deas Slough, Green Slough, and smaller roadside waterbodies/ditches along the Highway 99 corridor. The banks along Fraser River South Arm are well established and support the existing water and sediment flows.

Scour refers to lowering of a channel bed below its normal level. Bathymetric survey data collected for the Fraser River South Arm in 2014 (**Section 4.1 River Hydraulics and River Morphology**) show the areas of periodic scour and subsequent fill that currently occur within the river channel.

Potential Effects on the Project and Valued Components

Potential effects of erosion and scour on the Project and the subsequent effect on the environment include decreased slope stability or bank failure at bridge support areas, resulting in sediment entering a watercourse and temporary effects to water quality.

These erosion and scour effects could cause changes to the following valued components:

- Fish and fish habitat through temporary changes in water quality
- Marine use through debris entering the Fraser River

Mitigation Measures

The Project will be designed, constructed, and operated in a manner that anticipates and addresses potential adverse effects of erosion and scour on the Project. The following measures will be taken to avoid or minimize the likelihood and consequence of scour and erosion on Project components:

- The new bridge will be a clear span; bridge piers will not be located within the Fraser River South Arm.
- Banks within the Project alignment will be reinforced and protected where required to support construction and operation of the new bridge, reducing the potential for erosion to occur.
- Upland drainage ditches will be designed to withstand storm events adjusted for climate change, minimizing the potential for runoff to result in erosion of roadside watercourses and the river banks.
- River banks and dikes that are altered or otherwise affected by Project components will be re-established or stabilized to meet provincial and municipal requirements.
- The Project's CEMP and OEMP (**Section 12.0 Management Plans**) will be implemented to mitigate likelihood and manage the consequence of erosion and sediment control events.

Likelihood and Consequence of Potential Effects

There are no Project components that, even if subject to scour or erosion, could release potentially deleterious substances or otherwise affect the environment or human health. In this context, the likelihood that scour or erosion could affect Project infrastructure resulting in adverse environmental effects is considered to be remote.

Appropriate maintenance and management procedures will be in place to avoid or minimize environmental consequences of the effect of erosion and scour on the Project valued components, including fish and fish habitat. With the implementation of the design and construction mitigation, the consequence of the effects of erosion and scour on the Project affecting the environment is considered to be very low.

Conclusions on Potential Risk

The potential effects of erosion and scour on the Project will be considered during design, construction, operation, and maintenance of the Project. Mitigation measures will be implemented to avoid or reduce adverse effects of the environment on the Project and potential subsequent effects on valued components. The overall risk to the Project from erosion and scour events, during construction or operation, is considered to be very low.

9.4 Fire

The Project is located in an urban setting with a high percentage of impermeable surfaces and waterbodies (i.e., the Fraser River). Vegetated areas within the Project alignment are limited and include mowed and maintained strips adjacent to the Highway 99 corridor, Deas Island Regional Park, and the Richmond Nature Reserve. Metro Vancouver manages Deas Island Regional Park and imposes use and activity restrictions based on fire rating advisories, which reduces the potential for a wildfire to occur.

Potential Effects on the Project and Valued Components

The probability of a wildfire occurring within the Project alignment, remaining unaddressed, and becoming of a magnitude great enough to result in structural damage to the Project, is extremely unlikely. Potential effects of this scenario resulting in adverse effects to valued components are not expected. Emergency response measures that will be developed for implementation during Project construction and operation are described in **Section 12.0 Management Plans**.

Likelihood and Consequence of Potential Effects

Given its setting within a fully developed urban area in the vicinity of the Fraser River, the likelihood of an uncontrolled fire occurring within the Project alignment and resulting in damage to the Project and subsequent effects on the environment is considered to be remote. The consequences associated with the event are considered to be very low.

Conclusions on Potential Risk

The overall risk to the Project from wildfire, during either construction or operation, is considered to be low.

9.5 Extreme Flood Events

The Project is located within the City of Richmond and the Corporation of Delta. Richmond is situated within a river delta featuring rich, alluvial soils, and is only one metre above sea level, making it susceptible to flooding during high tide or a high spring freshet (City of Richmond 2013). Delta is similarly susceptible to flooding. It is less than 1.5 m above mean sea level, occupies part of the alluvial deposit created by the Fraser River, and is bordered by water on three sides (the Fraser River South Arm to the north, the Strait of Georgia to the west, and Boundary Bay to the south).

Floods can occur during spring freshet, extreme weather events, or a combination of both. Flooding during spring freshet occurs when higher-than-normal snow packs combine with warmer-than-normal weather, resulting in a rise in river discharge. Historically, the highest Fraser River freshets occurred in 1894, 1948, and 1972 (Environment Canada 2014).

Richmond and Delta are surrounded by dikes that have been built higher than the highest-ever-recorded water level at this location on the Fraser Basin (which occurred in 1894) and are designed to withstand a 1-in-200-year flood event.

Richmond has a dike network that extends over 49 km, protecting more than 12,000 ha from flooding (City of Richmond 2013). Over 60 km of sea dikes and riverbank dikes surround the entire lowland area of Delta, protecting the community from high water levels along the Fraser River, the Strait of Georgia, and Boundary Bay (Corporation of Delta 2014).

In addition to the dike networks protecting these communities, Richmond and Delta have extensive ditch, drainage, canal, culvert, and sewer networks that manage the high volumes of water experienced during times of extreme precipitation. These systems are designed to accommodate a 1-in-100-year storm event. Elevated roads and highways such as Deltaport Way, Highway 17, and Highway 99 also provide secondary flood protection. Flooding as a result of climate change and sea-level rise is discussed in more detail in **9.6 Climate Change**.

Potential Effects on the Project and Valued Components

The potential effects of an extreme flood event on the Project and the subsequent environmental effects that may result include:

- Decreased slope stability due to erosion, washout, or dike breach, resulting in runoff and debris entering watercourses or terrestrial habitat.
- Damage to roads, structures, and drainage and stormwater facilities, resulting in untreated runoff and debris entering watercourses or terrestrial habitat.

These flood event effects could cause changes to the following valued components:

- Fish and fish habitat and at-risk amphibians may be affected by changes in water quality.
- Agricultural use may be affected by untreated runoff.

Mitigation Measures

Mitigation measures proposed to reduce the likelihood and consequence of flood events on the Project include the following:

- Incorporate dike reinforcement and bank protection where required into the Project design, to maintain the integrity of the dike and to reduce the potential for erosion at the new bridge footings and support components.
- Upland drainage ditches will be designed to withstand storm events adjusted for climate change.
- Develop a CEMP and an OEMP, which will include an Emergency Response and Spill Contingency Plan and an Erosion and Sediment Control Plan. These plans will describe the mitigation to be implemented to protect the Project in the event of a structural failure of a Project component, and sedimentation and runoff management.

Likelihood and Consequence of Potential Effects

The existing dike system within the Project alignment has been designed to withstand extreme flood events, and the Project will be designed to incorporate bank reinforcement and protection. The likelihood of an extreme flood event resulting in damage to the Project and subsequent effects on the environment is considered to be remote. In addition, the Project design will include elements that minimize the effects of extreme flooding on Project components, including increased erosion and stormwater runoff. With the implementation of the design and construction measures, the consequence of an extreme flood is anticipated to be very low.

Conclusions on Potential Risk

The potential effects of extreme flooding on the Project will be considered during design, construction, operation, and maintenance of the Project. Mitigation measures will be implemented to avoid or reduce adverse effects of the environment on the Project and potential subsequent effects on valued components. The overall risk to the Project from an extreme flood, during either construction or operation, is considered to be very low.

9.6 Climate Change

The general effects of climate change that could affect the Project include temperature rise, increased precipitation, more intense storms, and sea-level rise. The following sections discuss the forecasted effects of climate change and the potential effect of climate change on the Project.

Temperature Rise

Historical temperature data for the south coast of B.C., as analyzed by the Pacific Climate Impacts Consortium (PCIC), indicates that a rise of approximately one degree Celsius ($^{\circ}\text{C}$) has occurred within the 20th century, in all seasons (PCIC 2013). By the 2050s, a mean temperature rise of 1.7°C from the 1961 to 1990 baseline has been predicted. Summer temperatures are projected to rise slightly more than other seasons, at 2°C by the 2050s, and 3.1°C by the 2080s (PCIC 2013).

Precipitation

The mean seasonal precipitation for the regional area peaks at approximately 440 mm during the winter months (PCIC 2013). A modest increase of 10% in precipitation was projected by the 2080s by PCIC for all seasons except for the summer months, in which a 10% decrease was predicted. By the 2050s, snowfall is predicted to be reduced by half in the spring and by 24% during the winter (PCIC 2013).

Higher intensities of precipitation could lead to increased flooding, particularly in areas that are already vulnerable to flooding. Recent studies conducted by B.C. Ministry of Environment have indicated that the 1-in-200-year to 1-in-500-year size flood may occur as often as every 50 years (B.C. MOE 2014a). More information on potential effects of extreme precipitation or flooding is provided in **Sections 9.1 Extreme Weather** and **9.5 Extreme Flood Events**.

Sea-level Rise

By 2100, sea-level rise at the Fraser River delta is predicted to range from 50 cm to a possible extreme level of 120 cm in some areas (B.C. MOE 2008, 2014a, b). With higher sea levels, storm surges can reach greater heights and potentially spread further inland (ICF International 2010). Coupled with more intense storm surges and flooding events in the Fraser River delta, higher sea levels could result in higher potential for erosion or washout of road bases, overwhelming of stormwater infrastructure, and reduction in clearance under the bridge (ICF International 2010).

Potential Effects on the Project and Valued Components

The primary potential effects of climate change that could influence the Project are storm intensity and flooding associated with sea-level rise, coupled with high river flows or high tides in the Fraser River. Additionally, increased occurrences of extreme weather events may lead to more severe, extreme precipitation and drought, resulting in alterations in watercourse flows, thereby potentially affecting Project infrastructure.

These climate change-related effects could in turn affect valued components as follows:

- Fish and fish habitat, marine mammals, or at-risk amphibians may be affected by changes in water quality.
- Agricultural use and land use may be affected by flooding.
- Marine use may be affected by debris entering the Fraser River.

Mitigation Measures

The Project will be designed and constructed in accordance with federal and provincial standards and directives to minimize the potential for structural damage resulting from extreme weather, including the *Canadian Highway Bridge Design Code* (CSA 56-14), the Ministry's *Bridge Standards and Procedures Manual* (B.C. MOT 2007), and the Ministry's 2012 *Standard Specifications for Highway Construction* (B.C. MOTI 2012) and the design will be based in accordance with the Ministry's T-06/15 Circular on climate change (see **Section 1.1.6 Project Design Considerations** for more details). The Project incorporates several design requirements that account for climate change. For example the new bridge design incorporates the provincially recommended additional clearance of one metre to account for the anticipated effects of sea level rise. Additionally, potential increases in storm intensity due to climate change will be reflected in ditch, culvert, and retention pond design. The Project will result in a safer travel corridor that will better withstand extreme weather compared to existing conditions. The mitigation described in **Sections 9.1 Extreme Weather, 9.3 Erosion and Scour, and Section 9.5 Extreme Flood Events** above address the potential effects of erosion and scour, extreme weather, and flood events on the Project, which would also apply to the potential effects of temperature rise, increased precipitation, and sea-level rise on the Project. Moreover, the vessel navigational clearance requirements for the new bridge will include consideration of potential sea level rise resulting from climate change.

Likelihood and Consequence of Potential Effects

The likelihood of climate change affecting the Project and resulting in an adverse effect on the environment is low. Appropriate maintenance and management procedures will be in place to avoid or minimize environmental consequences of climate change on the Project valued components. With the implementation of the design, construction, and operation phase measures, the consequence of the effects of climate change on the Project affecting the environment is considered to be very low.

Conclusions on Potential Risk

The potential effects of climate change on the Project will be considered during design, construction, operation, and maintenance of the Project. Mitigation measures will be implemented to avoid or reduce adverse effects of the environment on the Project and potential subsequent effects on valued components. The overall risk to the Project from climate change, during either construction or operation, is considered to be very low.

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Part C – Aboriginal Consultation

10.0 Aboriginal Consultation

- Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor.
- Potential effects on Aboriginal Interests were described through consideration of four indicators:
 - Access to preferred locations for the exercise of Aboriginal Interests;
 - Availability of preferred resources for the exercise of Aboriginal Interests;
 - Quality of preferred resources for the exercise of Aboriginal Interests; and
 - Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.
- Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective.
- Potential effects on the exercise of Aboriginal Interests are predicted to be negligible following mitigation to address potential effects on ICs and VCs except for:
 - Potential temporary effect on access related to instream construction activities for some groups and a potential effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access
 - Potential temporary effect during construction on quality of experience related to construction-related noise and quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to sensory disturbance
 - Potential effect on quality of experience (i.e., cultural heritage) during operations tied to traditional uses due to visual and noise disturbance to the cultural landscape

Additional measures have been identified to address potential residual effects on Aboriginal Interests include:

- Ongoing consultation regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of an Archaeological and Heritage Resources Management Plan.

With the implementation of mitigation proposed to address potential effects on ICs and VCs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no residual effects on the exercise of Aboriginal Interests as a result of the Project, are expected.

10.0 Aboriginal Consultation

Aboriginal Interests, defined in the section 11 Order as asserted or determined Aboriginal rights, including title, and treaty rights, are discussed in **Section 10.1 Aboriginal Interests**. Issues raised by Aboriginal Groups that do not directly relate to Aboriginal Interests, such as those pertaining to potential adverse social, economic, heritage, or health effects, and proposed measures to address those effects, are presented in **Section 10.2 Other Matters of Concern to Aboriginal Groups**. The results of **Section 10.1.3 Aboriginal Interests Assessment** and **Section 10.2** are summarized in **Section 10.3 Issue Summary Table**.

Any statements in this Application regarding Aboriginal Groups are based on information provided by those Aboriginal Groups in the context of consultation on the Project, or as available in publicly available sources, and do not constitute admissions, acknowledgments or endorsements of the claims, positions, or accuracy of the information by the Province of British Columbia.

10.1 Aboriginal Interests

As set out in the section 11 Order for the proposed Project, issued by the Environmental Assessment Office (EAO) on March 7, 2016, the following Aboriginal Groups were identified as requiring consultation and invited to participate on the Working Group, and placed on Schedule B of that order (Schedule B Aboriginal Groups):

- Cowichan Tribes
- Halalt First Nation
- Katzie First Nation
- Kwantlen First Nation
- Lake Cowichan First Nation
- Lyackson First Nation
- Musqueam Indian Band
- Penelakut Tribe
- Hwlitsum¹
- Semiahmoo First Nation

¹ The section 11 Order states, in Schedule B: “EAO’s reference to the Hwlitsum is not intended to signify any change in the position that the Province may have taken in other contexts in relation to the duty to consult with this group.”

- Squamish Nation
- Stz'uminus First Nation
- Tsawwassen First Nation
- Tsleil-Waututh Nation

Four of the Aboriginal Groups named above – Cowichan Tribes, Halalt First Nation, Penelakut Tribe, and Stz'uminus First Nation – are affiliated as the Cowichan Nation Alliance.

The following Aboriginal Groups were identified in the section 11 Order as requiring notification, and placed on Schedule C of that order (Schedule C Aboriginal Groups):

- People of the River Referrals Office

Prior to the section 11 Order, the Ministry had received a deferral from the People of the River Referrals Office, which handles referrals for some member nations of the Stó:lō Tribal Council and Stó:lō Nation, as well as the six member nations of the Ts'elxweyeqw Tribe.

Structure of Section 10.1

Descriptions of each Schedule B Aboriginal Group's population, reserves or treaty lands and areas, traditional territory, land use planning and governance, and economic interests, are provided in **Section 10.1.1 Background Information**. Maps of Indian Reserves, Aboriginal communities, and traditional territories of Schedule B Aboriginal Groups relative to the Project area are presented in **Appendix 10-A**.

Consultation activities undertaken by the Ministry with each Schedule B Aboriginal Group during the pre-Application phase are described in **Section 10.1.2 Consultation Activities**.

As available from Schedule B Aboriginal Groups or publicly available sources, **Section 10.1.3 Aboriginal Interests Assessment** summarizes, for each Schedule B Aboriginal Group (and the Cowichan Nation Alliance collectively), relevant past, present, or desired future use information of pertinence to the exercise of identified Aboriginal Interests in the proposed Project area. An assessment of potential adverse effects of the proposed Project on the exercise of Aboriginal Interests of each Schedule B Aboriginal Group is also presented in **Section 10.1.3**, with full consideration of the findings of the IC and VC chapters in Part B of the Application that are relevant to Aboriginal Interests, including cumulative effects and follow up strategies.

Provided by the Ministry to each Schedule B Aboriginal Group for review and comment prior to the submission of the Application were: the background summaries for these groups presented in **Section 10.1.1.1** through **10.1.1.11**; maps of traditional territories presented in **Appendix 10-A**; and the baseline (“existing conditions”) summaries relating to past, present, and desired future use of Schedule B Aboriginal Groups presented in **Section 10.1.3**. The subsections for each Aboriginal Group note whether or not comments on these sections of the Application were received from that Aboriginal Group prior to submission.

10.1.1 Background Information

Aboriginal Regional Setting

The ancestral languages of the Schedule B First Nations—Halkomelem Salish, Northern Straits Salish, and Squamish Salish—belong to the Coast Salish language family, and more specifically the Central Coast Salish branch of that family.

There are three dialects of Halkomelem Salish -- Downriver, Upriver, and Island. Two of these dialects – Downriver and Island – are associated with Schedule B Aboriginal Groups, while the third, Upriver dialect is associated with Schedule C First Nations. Specifically, the Downriver dialect of Halkomelem, or *Həŋqəmihəŋm*, is the ancestral language of nations based on the Lower Mainland, and associated with Fraser River from its mouth to the Stave River – i.e., present-day Tsawwassen First Nation, Musqueam Indian Band, Tsleil-Waututh Nation, Katzie First Nation, and Kwantlen First Nation (FPHLCC 2016). The Island dialect of Halkomelem, or *Hul’q’umi’num*, is the ancestral language of nations based on southeastern Vancouver Island from north of Mill Bay to Qualicum, including Cowichan Tribes, Halalt, Lake Cowichan, Lyackson, Penelakut, and Stz’uminus (FPHLCC 2016); these groups are also associated with the Fraser River. The Upriver dialect of Halkomelem, or *Halq’eméylem*, is the ancestral language of the Stó:lō nations associated with the Fraser River from the Stave River to the lower Fraser Canyon (FPHLCC 2016), some of which are represented by the People of the River Referrals Office (i.e., Schedule C First Nations). Downriver and Upriver dialects have been collectively described as Mainland Halkomelem.

To the south of Halkomelem-speaking nations are speakers of Northern Straits Salish, including the Semiahmoo, who are associated with the *SEMYOME* dialect. Northern Straits Salish is sometimes referred to as *SENĆOTEN* or Sencot’en, which is the dialect now spoken by most Northern Straits speakers (FPHLCC 2016). To the north and west of Halkomelem-speaking nations, are speakers of Squamish Salish, or *Skwxwú7mesh sníchim*, spoken only by the Squamish Nation (FPHLCC 2016).

Central Coast Salish ties to the South Arm of the Fraser River and adjacent upland areas are reflected in, for example, named places, origin stories, transformation sites (where, long ago, ancestors were transformed into animals and natural features of the landscape), and life histories. Some of the place names in the vicinity of the Project area, along with variations in spelling based on Halkomelem dialect differences (with approximate orthography), are listed in **Table 10.1-1** and shown in **Appendix 10-A, Figure 10-1 Halkomelem Place Names along the Fraser River South Arm**. The variations in spelling may not be exhaustive for any given place name, and place names reported below may not reflect the full range of named places in the vicinity of the Project known to Aboriginal Groups.

Table 10.1-1 Halkomelem Place Names in the Vicinity of the Project

| Name | Meaning | Location | Reference |
|--|---|--|--|
| Not reported | Not reported | Bog in central Lulu Island | VAFFC 2011 |
| <i>Zuqtinus</i> <i>λ'eqtines</i> <i>λ'eqətines</i> <i>Tl'ektines</i> <i>Tl'uqtinus</i> <i>λ'eqtinəs</i> | "long chest" "long beach" "long river-bank" "long shore" | South shore of Lulu Island, spanning from opposite Deas Island to Tilbury Island, and potentially extending from Woodward's Landing (at the foot of No. 5 Road) to Ewen's Cannery (on the west end of Lion Island), in the area of the Tunnel crossing | MIB 1976, MBC1984, Suttles 2004, TFN et al. 2009b, HTG 2005a, Rozen 1985, TWN 2015, PMV 2015, CNA 2016 |
| <i>puʔxun'é-w'mux^w</i> <i>Pulhxuneewmuhw</i> <i>Pətxənéməx</i> <i>pətxəneməx^w</i> | "meadow flat" "meadow land" | South shore of Fraser River, just above Ladner, on or adjacent to the western aspect of Deas Island, in the vicinity of the Tunnel crossing | MIB 1976, MBC 1984, Suttles 2004, HTG 2005b, Rozen 1985, TWN 2015, PMV 2015 |
| <i>q^wəq^wəʔápətp</i> | "crabapple trees" | Site of St. Mungo's Cannery, on the south shore of the Fraser River, across from Annacis Island | MIB 1976, MBC 1984, Suttles 2004 |
| <i>suwq^weqsun'</i> <i>səw'q^wéqsən</i> <i>Suwqw'eqsun</i> | "drifting away point" | Southwestern side of Annacis Island | MIB 1976, Suttles 2004, HTG 2005b |
| <i>Ma'q^wem</i> | Not reported | Burns Bog | TFN et al. 2009b |

| Name | Meaning | Location | Reference |
|--|---|---|--|
| <i>spuʔxun</i> <i>Spu'xun</i> <i>spəʔxən</i> | "meadow" | Upland Delta area | MIB 1976, MBC 1984, Suttles 2004, Rozen 1985. TWN 2015, PMV 2015 |
| <i>scúlux^wqun</i> <i>sc'ələx^wqən'</i> <i>čičilex^wqen</i> <i>Sts'uluhwqun</i> <i>sčələx^wqəń</i> <i>Sčələxwqəń</i> | "go upstream" and "throat" | Ladner area / Ladner Reach / Ladner Landing | MIB 1976, MBC 1984, Suttles 2004, TFN et al. 2009b, HTG 2005b, TWN 2015, PMV 2015 |
| <i>q^wʔé'yum</i> <i>q^wíáy'əm</i> <i>Qwlheyum</i> <i>q^wʔəy'əm</i> <i>q'é'yum</i> | "driftwood place" "driftwood log" | South shore of Lulu Island, across from Shady Island | MIB 1976, MBC 1984, Suttles 2004, HTG 2005b, TWN 2015, PMV 2015 |
| <i>kwy-yowka</i> | Not reported | South shore of Lulu Island at Steveston, across from Shady Island | TWN 2015, PMV 2015 |
| <i>q^wúya'x^w</i> <i>q^wweyaʔx^w</i> <i>Qw'eya'xw</i> | "boiling water" | Garry Point, on the southwestern tip of Lulu Island, at the mouth of the main channel of the Fraser River | MIB 1976, MBC 1984, Suttles 2004, HTG 2005b, VAFFC 2011, PMV 2015 |
| <i>q^wúya'x^w stáləw</i> <i>q^wweyaʔx^w staləw</i> | "river" (<i>stalew</i>) | Main channel of the Fraser River at Steveston | MIB 1976, MBC 1984, Suttles 2004, PMV 2015 |
| <i>uléqsun</i> <i>ʔələqsən</i> <i>Uleksen</i> <i>ʔəleqsən</i> | "point" | Westham Island (perhaps northwestern point or other specific points thereon) | MIB 1976, MBC 1984, Suttles 2004, HTG 2005b, TWN 2015, PMV 2015 |
| <i>x^wʔicum</i> <i>x^wíic'əm</i> <i>X^wlic'em</i> <i>Xwulit'sum</i> <i>xwlhits'em</i> <i>Hwlhits'um</i> <i>šx^wíicəm</i> | "cut inside out" "place for cutting [cat-tails]" (deriving from the practice of cutting rushes to let salmon pass through) | Brunswick Point / Canoe Pass | MIB 1976, MBC 1984, Suttles 2004, HTG 2005a, HTG 2005b, Rozen 1985, TWN 2015, PMV 2015 |

Schedule B Aboriginal Groups

10.1.1.1 Cowichan Tribes

Cowichan Tribes, along with Halalt First Nation, Penelakut Tribe, and Stz'uminus First Nation, have engaged directly with the Ministry on this Project and also collectively as member First Nations of the Cowichan Nation Alliance.

Cowichan Tribes is governed by a chief and council with a two-year term under an *Indian Act* electoral system. Cowichan Tribes has a 13-member council, with the current term expiring in December 2017 (AANDC 2016).

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round (PMV 2015), Cowichan Tribe's main present-day community is located in Cowichan, on southeast Vancouver Island. The largest First Nation in British Columbia, Cowichan Tribes has 2,455 of its total membership of 4,755 living on reserve. (AANDC 2016). The Project area does not overlap Cowichan Tribes' current or former reserve lands.

Cowichan Tribes is, or has been, affiliated with the Hul'qumi'num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the "Island" dialect of Halkomelem (*Hul'q'umi'num*), and have referred to themselves collectively as *Hul'qumi'num Mustimuhw* (HTG 2005).

The Hul'qumi'num Treaty Group member bands collectively assert a core territory or "title lands" and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to "the south arm of the Fraser River, including Canoe Pass, up to and including Douglas Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the Fraser River along Canoe Pass up to Deas Island" (BCTC 2004). This area is subsumed within the broader marine or fishing territory. The core territory of the Hul'qumi'num Treaty Group overlaps the Project area at the Tunnel crossing (**Appendix 10-A, Figure 10-2**).

Cowichan Tribes, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia (MARR 2014). The territorial maps attached to these agreements typically include areas on the western side of the Strait of Georgia only.

Locations along the South Arm of the Fraser River of importance to Cowichan Tribes, along with the other Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl'uq̓tinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island (CNA 2016), and *Hwlh̓its'um* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands, including Cowichan Tribes, as ancestral village and resource sites. A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uq̓tinus* for residential and/or commercial purposes (CNA 2016a,b, SFN 2013). Cowichan Nation Alliance's *Tl'uq̓tinus* claim area is shown in Section 10.1.3.2 (Existing Conditions) in Plate 1: Lands of *Tl'uq̓tinus* Claim Area (CNA 2016a).

10.1.1.2 Halalt First Nation

Halalt First Nation, along with Cowichan Tribes, Penelakut Tribe, and Stz'uminus First Nation, have engaged directly with the Ministry on this Project and also collectively as member First Nations of the Cowichan Nation Alliance.

Halalt First Nation is governed by a chief and council with a two-year term under an *Indian Act* electoral system. Halalt has a three-member council, with the current term expiring in April 2017 (AANDC 2016).

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round (PMV 2015), Halalt's main present-day community is located in Chemainus on southeast Vancouver Island. Of 212 registered members, 84 live on reserve (AANDC 2016). The Project area does not overlap any of Halalt's current or former reserve lands.

Halalt is, or has been, affiliated with the Hul'qumi'num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the "Island" dialect of Halkomelem (*Hul'q'umi'num*), and have referred to themselves collectively as *Hul'qumi'num Mustimuhw* (HTG 2005).

The Hul'qumi'num Treaty Group member bands collectively assert a core territory or "title lands" and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to "the south arm of the Fraser River, including Canoe Pass, up to and including Douglas Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the

Fraser River along Canoe Pass up to Deas Island” (BCTC 2004). This area is subsumed within the broader marine or fishing territory. The core territory of the Hul’qumi’num Treaty Group overlaps the Project area at the Tunnel crossing (**Appendix 10-A, Figure 10-2**).

Halalt, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia (MARR 2014). The territorial maps attached to these agreements typically include areas on the western side of the Strait of Georgia only.

Locations along the South Arm of the Fraser River of importance to Halalt, along with the Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl’uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island (CNA 2016), and *Hwlhitsu’um* or *Xwulit’sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites. A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl’uqtinus* for residential and/or commercial purposes (CNA 2016a,b, SFN 2013). Cowichan Nation Alliance's *Tl’uqtinus* claim area is shown in Section 10.1.3.2 (Existing Conditions) in Plate 1: Lands of *Tl’uqtinus* Claim Area (CNA 2016a).

10.1.1.3 Katzie First Nation

Katzie First Nation is governed by a chief and council with two-year terms under a custom electoral system. The current term for the four-member council expires in March 2018 (AANDC 2016).

The main Katzie First Nation community resides on Katzie 1, on the north bank of the Fraser River, west of Port Hammond, and south of the town of Pitt Meadows (AANDC 2016, Katzie First Nation 2016a). Katzie First Nation has four other reserves: Katzie 2, on the south bank of the Fraser River, upstream of Katzie 1 and opposite Port Hammond; Barnston Island 3, on the south shore of Barnston Island, which lies within the Fraser River; Pitt Lake 4, at the lower end of Pitt Lake; and Graveyard 5, the Katzie cemetery south of Lougheed Highway (AANDC 2016, Katzie First Nation 2016a). Of 570 registered Katzie members, 315 live on reserve (AANDC 2016). Katzie is working toward finalizing a land code that would apply to Katzie reserve lands pursuant to the federal *Framework Agreement on First Nation Land Management* and the *First Nations Land Management Act* (Katzie First Nation 2016b). The Project area does not overlap any current or former Katzie reserve lands.

Katzie’s ancestral language is *Hə́n̓q̓əmi̓n̓əh̓*, and Katzie reports that they are among the most inland speakers of this “downriver” dialect of Mainland Halkomelem (Katzie First Nation 2016a). Katzie have described their traditional territory as “extending south from the headwaters of the Pitt River to encompass Pitt Lake, Pitt Polder, a portion of the Fraser River, and south east to encompass the Nicomekl and Serpentine Rivers” (Katzie First Nation 2016a). In the east, this territory takes in Alouette Lake, Rolley Lake, portions of Fort Langley and Hazelmere, while in the west, the territory follows the height of land north along the mountain range through Pinecone-Burke Mountain Provincial Park to encompass all tributaries of the Pitt River system (Katzie First Nation 2016a). The Project area overlaps the southwestern portion of Katzie First Nation territory (**Appendix 10-A, Figure 10-4**).

Katzie First Nation owns and operates Katzie Development Limited Partnership, a cultural and environmental management services firm established in 2006 (KDC 2016). Other economic interests of the Katzie First Nation include a three-year Forest and Range Consultation and Revenue Sharing Agreement with the Province of British Columbia, signed in 2014 (Katzie First Nation and BC 2014).

10.1.1.4 Kwantlen First Nation

Kwantlen First Nation is governed by a chief and council under a custom electoral system. The current chief and two councillors were appointed in November 1993 (AANDC 2016).

The main community of the Kwantlen First Nation resides on McMillan Island 6, in the Fraser River to the north of Fort Langley. Of 269 registered members, 70 live on reserve, of which the Kwantlen have six, including McMillan Island 6, all centered on the area of confluence between the Stave River and the Fraser River. Kwantlen also share the *Pekw’Xe:yles* (Peckquaylis) reserve, approximately 2 km upstream of the Mission Bridge, with 20 Stó:lō nations (AANDC 2016). None of these reserves overlap the proposed Project area.

Kwantlen traditional territory has been previously shown to extend from the watershed of the Stave River in the north to the international border in the south, taking in the northeastern part of Boundary Bay, the Serpentine, Nicomekl, and Salmon Rivers, as well as the Fraser River upstream of Tilbury Island to the Nicomen Slough, near Chilliwack (Kwantlen First Nation and BC 2012). This territory overlaps the portion of the Project area at its westernmost extent (i.e., between Highway 17 and Highway 91), but does not overlap the Project area at or north of the Fraser River (**Appendix 10-A, Figure 10-5**). A map recently provided by Kwantlen shows “Kwantlen Territory 2015” as extending further westward along the Fraser River, taking in Deas Island and all of Lulu Island, and therefore overlapping all of the Project area (Kwantlen First Nation 2015).

Kwantlen, while ancestrally a *Həŋqəmiŋəm*-speaking nation (Kwantlen First Nation 2015, FPHLCC 2014), has been affiliated with the Stó:lō Tribal Council since 2005, when the organization formed out of a separation from the Stó:lō Nation. The Stó:lō speak the “Upriver” form of Halkomelem or *Halq'eméylem* (FPHLCC 2014). Kwantlen First Nation consults on Kwantlen interests independently of the Stó:lō Tribal Council, under the leadership of a Hereditary Chief and two-member appointed council that has been in place since 1993 (AANDC 2016). Like other members of the Stó:lō Tribal Council, Kwantlen is not currently involved in treaty negotiations; however, in March 2012, the Nation reached a three-year agreement with the Province on forest resource consultation and revenue-sharing (Kwantlen First Nation and BC 2012).

Since 2011, the economic arm of the Kwantlen First Nation has operated as Seyem' Qwantlen Business Group, representing five limited partnerships owned by the Nation, and providing services principally in the areas of contracting (construction, excavation, and earthworks), on and off reserve land development, and resource management (fisheries, forestry, archaeology) (SQBG 2014).

10.1.1.5 Lake Cowichan First Nation

Lake Cowichan First Nation is governed by a four-member council under a custom electoral system. The late Chief Cyril Livingstone and one councillor were appointed in October 1977, while two other councillors were appointed in March 1999 (AANDC 2016).

Lake Cowichan First Nation membership takes descent from both Ditidaht (Nuu-chah-nulth) ancestors and *Hul'qumi'num'* ancestors known as the Somenos (or Saumni, Samena, Saumina and other variations), one of seven village groups comprising the Cowichan Tribes (Rozen 1985). The community is based on a single reserve on the northeastern shore of Cowichan Lake, approximately 30 km west of Duncan (on the east coast of Vancouver Island), and less than 20 km east of Nitinat Lake (on the west coast of Vancouver Island). In 1860, the community was significantly affected by a smallpox epidemic (Rozen 1985, VAFFC 2011); the population has remained small, with only 12 of 20 registered members living on reserve (AANDC 2016). The Project area does not overlap any current or former Lake Cowichan reserve lands.

Lake Cowichan First Nation have stated that Cowichan Lake has always been their primary home, and that their traditional territory is centred on the lake, taking in surrounding lands, streams, and other waters, including the uppermost part of the Cowichan River. They have also stated that their use of this territory has continued to the present day (LCFN 2014). A three-year Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia, dated 2011, identifies this Vancouver Island-based territory (LCFN and BC 2011).

Based on their affiliation with the Hul'qumi'num Treaty Group, the Lake Cowichan First Nation has also been associated with a larger, collective traditional territory with the other member First Nations of that group. The core territory of the Hul'qumi'num Treaty Group overlaps the Project area at the Tunnel crossing (**Appendix 10-A, Figure 10-2**). The other members of the Hul'qumi'num Treaty Group – namely, Cowichan Tribes, Halalt First Nation, Penelakut Tribe, and Stz'uminus First Nation – are working jointly on their Fraser River interests through the Cowichan Nation Alliance (BC and PMV 2012). Lake Cowichan First Nation is engaging with the Ministry on the Project separately from the Cowichan Nation Alliance.

10.1.1.6 Lyackson First Nation

Lyackson First Nation is governed by a chief and council under a custom electoral system. The chief of the four-member council was appointed in April 2006. The other three councillors are elected for four-year terms, with the current term expiring in June 2018 (AANDC 2016).

The Lyackson First Nation has three reserves, all on Valdes Island (*Le'eyqsun*), which lies approximately 45 km west of the Project area on the east side of the Strait of Georgia, directly opposite the mouth of the Fraser River. Over 90% of Lyackson First Nation's registered membership lives off reserve, principally on southeastern Vancouver Island (AANDC 2016). The Project area does not overlap any current or former Lyackson First Nation reserve lands.

The Lyackson First Nation has described *Le'eyqsun* as their homeland and ancestral territory, one in which they continue to engage in traditional practices on a seasonal basis (LFN 2015).

Based on their affiliation with the Hul'qumi'num Treaty Group, the Lyackson First Nation has been associated with a collective traditional territory with the other member First Nations of that group. The core territory of the Hul'qumi'num Treaty Group overlaps the Project area at the Tunnel crossing (**Appendix 10-A, Figure 10-2**). The other members of the Hul'qumi'num Treaty Group – namely, Cowichan Tribes, Halalt First Nation, Penelakut Tribe, and Stz'uminus First Nation – are working jointly on their Fraser River interests through the Cowichan Nation Alliance (BC and PMV 2012). Lyackson First Nation is engaging with the Ministry separately from the Cowichan Nation Alliance.

10.1.1.7 Musqueam Indian Band

Musqueam Indian Band is governed by a chief and council with two-year terms under an *Indian Act* electoral system. The current term for the 11-member council expires in January 2017 (AANDC 2016).

The main community of the Musqueam is based at the mouth of the North Arm of the Fraser River, within the limits of the City of Vancouver, where 671 of 1337 registered members reside (AANDC 2016). A second reserve is located across the river from this location, on Sea Island, within the City of Richmond, while a third reserve is located in Ladner, near Canoe Pass, off the South Arm of the Fraser River. At one time, the Musqueam had a fourth reserve (the first reserve set aside for them) further up the Fraser River at *Qiqéyt* (Brownsville), on the south shore of the Fraser River, across from New Westminster, adjacent to a reserve for the Kwantlen (Crockford 2010, MIB 1976, MBC 1984). The Project area does not overlap any current or former Musqueam Indian Band reserve lands.

The Musqueam Indian Band's traditional territory has been described as follows:

The lands, lakes and streams defined and included by a line commencing at Harvey Creek in Howe Sound and proceeding Eastward to the height of land and continuing on the height of land around the entire watershed draining into English Bay, Burrard Inlet and Indian Arm; South along the height of land between Coquitlam River and Brunette River to the Fraser River, across to the South or left bank of the Fraser River and proceeding downstream taking in the left bank of the main stream and the South Arm to the sea, including all those intervening lands, islands and waters back along the shore to Harvey Creek, AND, the sea, its reefs, flats, tidal lands and islands adjacent to the above described land and out to the centre of Georgia Strait (MIB 1976).

The Project area falls almost entirely within the boundaries described above (**Appendix 10-A, Figure 10-6**); these boundaries are consistent with Musqueam Indian Band's Statement of Intent, filed with the British Columbia Treaty Commission (BCTC 1993). The Project area is also situated approximately 4 km upstream of Canoe Pass, where Musqueam Indian Band have an established Aboriginal right to fish for food, social, and ceremonial purposes pursuant to the Supreme Court of Canada's decision in *R. v. Sparrow* [1990], 1 S.C.R. 1075 (SCC 1990). The Ministry understands the Musqueam take the view that their established right extends to areas beyond Canoe Pass. Musqueam territory was described in the *Sparrow* decision "as extending from the north arm of Burrard Inlet to the south shore of the main channel of the Fraser River including the waters of Burrard Inlet, the North Arm, the Middle Arm, the Main Channel, Canoe Pass (or passage) and Ladner Reach" (MIB 2015).

In 2008, Musqueam and the Province of British Columbia entered into a Reconciliation, Settlement and Benefits Agreement, which transferred several land parcels to the Musqueam in fee simple, including but not limited to areas in Pacific Spirit Regional Park and the University Golf Course in Point Grey, and along Bridgeport Road in Richmond, at the confluence of the

North and Middle Arms of the Fraser River, known as the “Bridgepoint Lands” (MARR 2014). The Bridgepoint Lands are immediately to the west of the south end of the Oak Street Bridge, at the northern end of the Highway 99 corridor, approximately 1 km northwest of the Project. Musqueam produced a comprehensive community development plan in 2011 that, in part, guides decision-making for the Nation’s reserve and fee simple lands (MFN 2011).

10.1.1.8 Penelakut Tribe

Penelakut Tribe, along with Cowichan Tribes, Halalt First Nation, and Stz’uminus First Nation, have engaged directly with the Ministry on this Project *and also collectively as member First Nations of the Cowichan Nation Alliance*.

Penelakut Tribe is governed by a chief and council with a two-year term under an *Indian Act* electoral system. Penelakut has a 13-member council, with the current term expiring in February 2018 (AANDC 2016).

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round (PMV 2015), Penelakut’s primary village (Penelakut IR 7) is on Penelakut Island, to the east of Chemainus on southeast Vancouver Island. Penelakut members also reside on Kuper, Tent and Galiano islands. Of Penelakut’s 952 registered members, 525 live on reserve. (AANDC 2016). The Project area does not overlap any of Penelakut’s current or former reserve lands.

Penelakut is, or has been, affiliated with the Hul’qumi’num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the “Island” dialect of Halkomelem (*Hul’q’umi’num’*), and have referred to themselves collectively as *Hul’qumi’num Mustimuhw* (HTG 2005).

The Hul’qumi’num Treaty Group member bands collectively assert a core territory or “title lands” and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to “the south arm of the Fraser River, including Canoe Pass, up to and including Douglas Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the Fraser River along Canoe Pass up to Deas Island” (BCTC 2004). This area is subsumed within the broader marine or fishing territory. The core territory of the Hul’qumi’num Treaty Group overlaps the Project area at the Tunnel crossing (**Appendix 10-A, Figure 10-2**).

Penelakut, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia (MARR 2014). The territorial maps attached to these agreements typically include areas on the western side of the Strait of Georgia only.

Locations along the South Arm of the Fraser River of importance to Penelakut, along with the Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island (CNA 2016), and *Hwlhitsu'm* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites. A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uqtinus* for residential and/or commercial purposes (CNA 2016a,b, SFN 2013). Cowichan Nation Alliance's *Tl'uqtinus* claim area is shown in Section 10.1.3.2 (Existing Conditions) in Plate 1: Lands of *Tl'uqtinus* Claim Area (CNA 2016a).

10.1.1.9 Semiahmoo First Nation

Semiahmoo First Nation is governed by a chief and council with two-year terms under an *Indian Act* electoral system. The current term for the three-member council expires in December 2016 (AANDC 2016).

The ancestral language of the Semiahmoo First Nation is *SEMYOME*, one of six dialects of Northern Straits Salish (FPHLCC 2014). Semiahmoo First Nation has one reserve, fronting Semiahmoo Bay (part of Boundary Bay) at the Canada-United States border, about 1 km southeast of White Rock. The reserve, covering 129.10 ha, is home to 51 of the nation's 97 registered members (AANDC 2016). Originally 158.64 ha, portions of the reserve have been successively taken up for public purposes, including for the construction of Highway 99 in 1962. While the Highway 99 corridor runs adjacent to the eastern border of the reserve, the Project area does not include that section of the corridor.

Semiahmoo First Nation traditional territory has been previously represented as centred on Boundary Bay, taking in eastern portions of the Point Roberts peninsula, Mud Bay, and the lands and waters in and around the Serpentine, Nicomekl, and Campbell rivers (MOT 2006). Semiahmoo First Nation has recently presented a more extensive territory that, still centred on Boundary Bay, takes in the Lower Fraser River and adjacent lands downstream of the confluence with the Sumas River, all of the Gulf Islands south of Gabriola Island, the San Juan Islands, most of Bellingham Bay, and the Nooksack River (SFN 2011a). The boundaries of this territory largely take in almost the entire Project area (**Appendix 10-A, Figure 10-7**).

Semiahmoo First Nation is not currently participating in the British Columbia Treaty Commission process.

10.1.1.10 Squamish Nation

The *Skwxwú7mesh Úxwumíxw* (Squamish Nation) describe themselves as the descendants of Coast Salish ancestors that lived in what are now known as the Greater Vancouver area, Gibson's Landing, and Squamish River watershed (SN 2016a). The ancestral language of the Squamish Nation is *Sḵwxwú7mesh sníchim* (FPHLCC 2016, SN 2016b).

Squamish Nation is governed by a 16-member council with four-year terms under a custom electoral system. The current term for the two chiefs and 14 councillors expires in December 2017 (AANDC 2016).

Squamish Nation has 24 reserves, with 2,232 of 4,176 registered members residing on Squamish Nation's reserve lands (AANDC 2016). The largest proportion of these on-reserve members live on the Squamish Nation's several urban reserves in the cities of Vancouver, North Vancouver, and West Vancouver, and the District of Squamish (SN 2016c), with the most populated reserve being Mission 1, on the north shore of Burrard Inlet, bounded on the north and east by the City of North Vancouver (AANDC 2016). The Project area does not overlap any current or former Squamish Nation reserve lands.

Squamish Nation traditional territory, as described in their Statement of Intent filed with the British Columbia Treaty Commission, takes in the area from Point Grey in the south to Roberts Creek in the west; then north along the height of land to the Elaho River headwaters including all the islands and drainages in Howe Sound; then southeast to the confluence of the Soo and Green rivers north from Whistler; then south along the height of land to the Port Moody area including the entire Mamquam River and Indian Arm drainages; then west along the height of land to Point Grey (BCTC 2016). This territorial boundary, as updated from time to time, is asserted by Squamish Nation to extend farther south than described above, and specifically to the South Arm of the Fraser River, taking in all of Lulu Island. This area overlaps the northern half of the Project corridor, including the Tunnel crossing (**Appendix 10-A, Figure 10-8**).

Xay Temíxw (sacred land), the Squamish Nation's Land Use Plan, describes the Squamish Nation's vision for the future of the forests and wilderness of their traditional territory, with the stated objective to ensure the land is protected and managed for the benefit of present and future generations. *Xay Temíxw* has established four land use zones: a forest stewardship zone, sensitive areas, restoration areas, and *Kwa kwayx welh-aynexws* (wild spirit places). *Xay Temíxw* has also set management objectives that define how the lands, waters, and territory

must be managed. Squamish Nation report that they are also undertaking planning for traditional fishing areas, but, due to the sensitivity of the information, may not be mapped or described in the plan (SN 2016d).

The Squamish Nation owns and operates several businesses, including the Mosquito Creek Marina, Lynnwood Marina, Marina Grill, North Vancouver Smoke Shop at Mosquito Creek, Squamish Valley Gas LP, Superstore Gas Bar, North Vancouver, Capilano River RV Park, West Vancouver, and the Northwest Squamish Forestry LP. In addition to revenue generated from existing leases and businesses, the Squamish Nation plans to develop various parcels of lands, including proposed developments at Seymour, Capilano, Kitsilano, Chekwelp and Stawamus (SN 2016a). The Squamish Nation also currently generates revenue from a three-year Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia, signed in March 2015 (BC 2016).

10.1.1.11 Stz'uminus First Nation

Stz'uminus First Nation, along with Cowichan Tribes, Halalt First Nation, and Penelakut Tribe have engaged directly with the Ministry on this Project *and also collectively as member First Nations of the Cowichan Nation Alliance*.

Stz'uminus is governed by a chief and council, but under a custom electoral system, with the current three-year term for the ten-member council expiring in April 2017 (AANDC 2016).

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round (PMV 2015), Stz'uminus' main present-day community is located in Ladysmith on southeast Vancouver Island. Of 1,296 registered members, 712 live on reserve (AANDC 2016). The Project area does not overlap any of Stz'uminus' current or former reserve lands.

Stz'uminus is, or has been, affiliated with the Hul'qumi'num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the "Island" dialect of Halkomelem (*Hul'q'umi'num'*), and have referred to themselves collectively as *Hul'qumi'num Mustimuhw* (HTG 2005).

The Hul'qumi'num Treaty Group member bands collectively assert a core territory or "title lands" and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to "the south arm of the Fraser River, including Canoe Pass, up to and including Douglas

Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the Fraser River along Canoe Pass up to Deas Island” (BCTC 2004). This area is subsumed within the broader marine or fishing territory. The core territory of the Hul’qumi’num Treaty Group overlaps the Project area at the Tunnel crossing (**Appendix 10-A, Figure 10-2**).

Stz’uminus, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia (MARR 2014). In the map for the Stz’uminus’ 2013 agreement, the territory depicted is equivalent to the collective core territory of the Hul’qumi’num Treaty Group.

Locations along the South Arm of the Fraser River of importance to Stz’uminus, along with the Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl’uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island (CNA 2016), and *Hwlhitsu’um* or *Xwulit’sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites. A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl’uqtinus* for residential and/or commercial purposes (CNA 2016a,b, SFN 2013). Cowichan Nation Alliance’s *Tl’uqtinus* claim area is shown in Section 10.1.3.2 (Existing Conditions) in Plate 1: Lands of *Tl’uqtinus* Claim Area (CNA 2016a).

10.1.1.12 Tsawwassen First Nation

The Tsawwassen First Nation is based on the southern aspect of Fraser River delta, on the west side of the peninsula that separates Boundary Bay from the Strait of Georgia. Pursuant to the Tsawwassen First Nation Final Agreement (TFNFA), which came into effect on April 3, 2009, the Tsawwassen First Nation is a self-governing community led by a chief and council that are elected every three years. The current three-year term for the five-member council expires in April 2019 (AANDC 2016).

Under the TFNFA, the Tsawwassen First Nation acquired 724 ha of treaty settlement lands, including 290 ha of former reserves and 372 ha of former Provincial Crown Land (TFN et al. 2009a). These 662 ha of Tsawwassen Lands, located on the upland areas between the ferry terminal at Tsawwassen and the container port at Roberts Bank, are owned by and under the jurisdiction of the Tsawwassen First Nation, and are guided by the Tsawwassen First Nation Land Use Plan (see **Section 5.3 Land Use**). An additional 62 ha of fee simple land near Boundary Bay and on the Fraser River (along Canoe Pass) are owned by the Tsawwassen First Nation, but are under the jurisdiction of the Corporation of Delta (TFN et al. 2009a). Roughly

half (184) of the Tsawwassen First Nation's registered population (365) reside on Tsawwassen Lands (AANDC 2016). The Project area does not overlap any of the treaty settlement lands of the Tsawwassen First Nation (**Appendix 10-A, Figure 10-9**).

In addition to fee simple interests, the TFNFA secures harvesting rights to the Tsawwassen First Nation in areas located within Tsawwassen Territory, which is defined in the TFNFA as the area of land that Tsawwassen First Nation identified in its Statement of Intent to the British Columbia Treaty Commission, and included as a map in Appendix A to the agreement (TFN et al. 2009b). This territory extends from the southern Gulf Islands to the area around Pitt Lake. Rights under the TFNFA are limited by measures necessary for conservation, public health, or public safety (TFN et al. 2009a).

The Project area lies within Tsawwassen Territory, and is situated in or near several harvesting areas defined in the TFNFA relating to fishing, wildlife and migratory bird harvesting, and plant gathering (TFN et al. 2009a,b). These areas also appear on **Appendix 10-A, Figure 12-9** and are further described in **Section 10.1.3 Aboriginal Interests Assessment**.

10.1.1.13 Tsleil-Waututh Nation

Tsleil-Waututh Nation is governed by a chief and council with two-year terms under an *Indian Act* electoral system. The current term for the six-member council expires in March 2017 (AANDC 2016).

The main Tsleil-Waututh community is located in North Vancouver, on the shore of Burrard Inlet, approximately 2 km east of the north end of the Second Narrows Bridge, on Burrard Inlet 3 (AANDC 2016). Two other reserves, Inlailawatash 4 and Inlailawatash 4A, are located on Indian Arm. Of 578 registered members, 287 reside on Tsleil-Waututh reserves (AANDC 2016). The Project area does not overlap any current or former reserve lands of the Tsleil-Waututh Nation.

Tsleil-Waututh's Consultation Area extends from the vicinity of Mount Garibaldi in the north to the 49th parallel (and beyond) in the south, Gibsons in the west, and Coquitlam Lake in the east (TWN 2008, TWN 2016). Tsleil-Waututh Nation report that this Consultation Area encompasses all the waters and lands used by Tsleil-Waututh during extensive seasonal rounds of travel and resource harvest, and includes both areas exclusively occupied and governed by Tsleil-Waututh and areas to which Tsleil-Waututh is granted access according to Coast Salish protocols (TWN 2016). The Project area lies fully within this Consultation Area (**Appendix 10-A, Figure 10-10**).

The Tseil-Waututh established an Economic Development Department in 1992. The Nation owns and operates several businesses, including Takaya Developments Ltd. (real estate development), Takaya Tours (cultural tourism), TWN Wind Power Inc. (small wind turbine distribution), Inlailawatash Forestry Limited Partnership (natural and cultural resources consulting service), Salish Seas Limited (a partnership between Tseil-Waututh Nation, Sliammon First Nation, and Musqueam Indian Band), TWN and Aquilini Group, and SPAL General Constructors, a project management company co-owned with Tsawwassen First Nation (TWN 2014, TWN 2016). Other important related Tseil-Waututh organizations and agreements of include the First Nations Legacy Society (also involving Katzie First Nation, Kwantlen First Nation, Kwikwetlem First Nation, Musqueam Indian Band, and Tsawwassen First Nation) and the MST Land Protocol (TWN 2016).

10.1.1.14 Hwlitsum

Members of the Hwlitsum community, who consider themselves descendants of the Lamalchi and close relatives of the Penelakut Tribe (i.e., from Kuper Island), reside in the area of Canoe Pass, and carry the Halkomelem name for this location (e.g., *Hwlhitsu'um*, *Xwulit'sum*) (HFN 2016a). While Hwlitsum community members, who number over 300, are individually registered Indians under the *Indian Act*, they are not collectively recognized as a “band” under the *Indian Act* and do not have any reserves (BC and PMV 2012). The group is represented by a chief.

Hwlitsum report that early ethnographic sources often employ the term “Cowichan” to refer to a set of linked communities that include the Hwlitsum (HFN 2016). Hwlitsum consider the “Island” dialect of Halkomelem as their ancestral language and have described themselves as related to but independent of the Cowichan Nation community (HFN 2016b).

In 2008, Hwlitsum’s Statement of Intent was accepted into the British Columbia Treaty Commission (BCTC) process. The Ministry understands that Canada and BC advised Hwlitsum at that time that they had decided to not continue negotiations to Stage 2 of that process. A representation of Hwlitsum’s traditional territory, based on Hwlitsum’s Statement of Intent boundary submitted to the BCTC (HFN 2008), is presented in relationship to the proposed Project area in **Appendix 10-A, Figure 10-3**.² Hwlitsum note that they have been recognized as a First Nation by government entities, including the BC Treaty Commission.

² Any statements in this Application regarding Hwlitsum are based on information provided by Hwlitsum in the context of consultation on the Project, or as available in publicly available sources, and do not constitute admissions, acknowledgments or endorsements of the claims, positions, or accuracy of the information by the Province of British Columbia.

10.1.2 Consultation Activities

10.1.2.1 Overview

This section provides information regarding the consultation activities that the Ministry carried out prior to submission of the Application and those planned during the remainder of the EA process with respect to Aboriginal Groups that may be affected by the Project or that have Aboriginal Interests within the Project alignment. This section also provides an overview of the Project's Aboriginal Consultation Plan and a summary of proposed changes to the Aboriginal Consultation Plan based on input from Aboriginal Groups and implementation of the Aboriginal Consultation Plan thus far. A summary and status of key issues and concerns raised by Aboriginal Groups and the Ministry's plans for addressing outstanding concerns is also presented.

Two phases of consultation are complete. To date, more than 80 meetings have taken place with Aboriginal Groups involved with the Project. The table below describes the consultation phases for the Project and the duration and status of each.

Table 10.1-2 Phases of Consultation with Aboriginal Groups

| | Consultation Phase | Overview | Duration/Status |
|---|----------------------|---|---|
| 1 | Initial Consultation | Project development and planning up to the December 16, 2015 submission of Project Description. Includes collection of baseline information, sharing of draft EA-related documents (i.e. Project Description and Areas of Study, AIR) | Start of consultation (January 2013) to December 2015 |
| 2 | Pre-application | Period from the filing of the Project Description to Application submission, including issuance of section 11 Order, AIR development and collection of baseline information (may include submission of permit applications) | December 2015 – TBD |

| | Consultation Phase | Overview | Duration/Status |
|---|--|---|-----------------|
| 3 | Application review Consultation | EAO acceptance of the Application to the end of the Application Review stage (180 days). This will be followed by the Minister’s decision (up to 45 days) with respect to in the issuance of an Environmental Assessment Certificate (EAC). | TBD |
| 4 | Post Environmental Assessment Certificate (EAC) Consultation | Post EAC issuance to the date when all permit applications have been adjudicated and permits issued | TBD |

10.1.2.2 Consultation Approach: Objectives & Principles

The primary objective of the Project’s Aboriginal consultation program is to maintain and, where possible, enhance respectful, positive and productive relationships with Aboriginal Groups while meeting all applicable legal, policy and regulatory requirements in relation to the Project. Additional objectives include providing opportunities for Aboriginal Groups to provide meaningful input for consideration in the EA and permitting processes and undertaking consultation with Aboriginal Groups in accordance with the Project’s Aboriginal Consultation Plan. Objectives of the Aboriginal Consultation Plan are presented below in **Section 10.1.2.3**.

The approach to Aboriginal consultation has been and will continue to be undertaken according to the principles outlined below.

Timeliness:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests.
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes.

Inclusiveness, responsiveness & participation:

- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes.
- Consult in accordance with the section 11 Order requirements and the Project's Aboriginal Consultation Plan and continue to work with Aboriginal Groups to revise or update, where appropriate and necessary, components of the Consultation Plan that will support a meaningful, respectful and successful process.
- Establish and maintain dialogue throughout the EA process as a means of providing opportunities to respond to outstanding concerns.
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects.
- Involve Aboriginal groups in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate Aboriginal traditional knowledge in Project components, when it is shared by Aboriginal Groups and with appropriate permission for its use and inclusion.
- Provide capacity funding to support Aboriginal Groups for the purposes of reviewing, understanding and providing input to the Project's EA and permitting processes.

Respect & relationships:

- Build and foster mutually respectful relationships with Aboriginal Groups.
- Consult with Aboriginal Groups in a respectful and appropriate manner.
- Actively explore opportunities to provide economic and non-economic benefits to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.
- Respect processes and requirements related to the use of information shared by Aboriginal groups, including keeping documents or specific information confidential as requested by communities.³

³ The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. Subject to the requirements of applicable laws, the Ministry will work with Aboriginal Groups to develop appropriate terms to protect information that is shared by Aboriginal Groups during Project consultation.

Aboriginal Consultation Plan: Overview

The Ministry is committed to positive working relationships with Aboriginal Groups and meeting legal and regulatory requirements for consultation with those Aboriginal Groups listed in Schedule B of the section 11 Order. The Ministry is also committed to meeting section 11 Order requirements pertaining to Schedule C Aboriginal Groups.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components
- Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Ministry considered the following in the development of a Draft Aboriginal Consultation Plan for Schedule B Aboriginal Groups' review and comment:

- Regulatory and legal requirements with respect to consultation with Aboriginal Groups
- Positive, respectful and productive working relationships with Aboriginal Groups
- Established working relationships with Aboriginal Groups and past consultation experience
- Specific input received during consultation meetings and discussions with Aboriginal Groups with respect to the consultation approach and activities
- Consultation activities, agreed to by both parties, specified under existing Project participation funding agreements.

10.1.2.3 Feedback and Proposed Changes to the Aboriginal Consultation Plan.

The Aboriginal Consultation Plan was provided to Aboriginal Groups in October 2015 for review and comment, revised based on input received, and approved by EAO on April 6, 2016. The Aboriginal Consultation Plan was developed with the understanding that it is a working document that may be revised should ongoing engagement with Aboriginal Groups lead to the identification of preferred alternatives or modifications to planned consultation activities. The Ministry undertook the following process in order to obtain and, where appropriate, incorporate input on the Draft Aboriginal Consultation Plan:

| | |
|-----------------------|--|
| Initial Draft Review: | Draft Aboriginal Consultation Plan was emailed to Aboriginal Groups. Follow up communications (email and phone calls) reiterated the request for Aboriginal Groups to review and comment on the document; provided an offer to meet regarding the Draft Aboriginal Consultation Plan and/or to respond to any questions; confirmed intent of Aboriginal Groups to submit comments; discussed or obtained clarification on any comments provided to the Ministry; and coordinated meetings or calls regarding the Draft Plan. |
| Revision: | Draft Aboriginal Consultation Plan was revised to reflect input received from Aboriginal Groups |
| Revised Draft Review: | Revised Draft Aboriginal Consultation Plan was emailed to Aboriginal Groups with a summary of responses and corresponding action taken by the Ministry (i.e. revision, comment "noted", request for further discussion regarding request). Follow up communication responded to questions regarding the Aboriginal Consultation Plan; confirmed receipt of revised Aboriginal Consultation Plan; and included an offer to meet. |

The approved Aboriginal Consultation Plan is inclusive of current feedback from Aboriginal Groups with respect to proposed consultation activities and approach. In an effort to ensure the objectives of the Aboriginal Consultation Plan are met, the Ministry will continuously seek input from Aboriginal Groups with respect to any suggested changes and/or challenges with respect to implementation.

Musqueam recently has identified concerns in relation to the Provincial regulatory process and how Musqueam is to be consulted on environmental assessments within Musqueam's asserted traditional territory. The Ministry is committed to support effective and meaningful consultation with Musqueam regarding the Project. Any broader discussions between Musqueam and EAO or the Province regarding the provincial regulatory process are beyond the scope of the Project.

10.1.2.4 Aboriginal Consultation Methods – Initial Consultation and Pre-Application Phases

The Ministry implemented a broad range of consultation methods to obtain information regarding Aboriginal Interests and Aboriginal Group's past, present and desired future use information as it pertains to the exercise of Aboriginal Interests within the Project area, the potential for Project-related adverse effects on Aboriginal Interests and measures to avoid, mitigate or otherwise accommodate, as appropriate, any adverse effects. These methods include, but are not limited to, the following:

- Sharing of Project-related information including focused presentations on topics of interest and/or concern to Aboriginal Groups
- Funding for participation in Project consultation activities and EA process and for traditional use or Project-related studies
- Meeting with Aboriginal Groups' leadership, staff, consultants, elders and membership
- Aboriginal Groups' review of draft EA documents such as the Project Description, Application Information Requirements (AIR), Aboriginal Consultation Plan, and Aboriginal Consultation Reports
- Response and follow up with Aboriginal Groups regarding the identification and resolution of issues

Information Distribution Methods

Aboriginal Groups were provided with Project-related information through information packages; Project fact sheets, maps and conceptual drawings; draft EA-related documents (e.g., Project Description and Key Areas of Study, Archaeological Overview Assessment and Archaeological and Heritage Resources Management Plan, Aboriginal Consultation Plan, Application Information Requirements); presentations; emails and phone calls; and meetings and updates.

Depending on the preferences of respective Schedule B Aboriginal Groups, communication activities have included, but not been limited to, meetings with Chief and/or Council and/or staff and consultants; meetings with elders; conference calls; presentations; community meetings; and site visits.

Technical Workshops and Working Group Meetings

EAO invited Aboriginal Groups identified in Schedule B of the section 11 Order to participate as members in the Working Group. During the Pre-Application stage, EAO held two Working Group meetings where the Ministry presented information on the Project and the EA process and received and responded to comments on those presentations.

10.1.2.5 Methods of Documenting Project Communications

Project-related consultation activities have been and will continue to be documented in accordance with the section 11 Order requirements and based on input from Aboriginal Groups.

The Ministry prepared formal consultation reports in accordance with the section 11 Order and as outlined in the Aboriginal Consultation Plan.

10.1.2.6 Participation Funding

Initial Consultation through to the end of the Pre-Application Phase

Requests for funding to support participation in the Project review process were made by all Schedule B Aboriginal Groups during initial Project-related discussions. In response to these requests, the Ministry provided participation funding and undertook the appropriate planning and discussions with Aboriginal Groups.

When a provincial agency is a proponent of a project going through a provincial EA, that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding.

Funding provided to date has covered consultation from the Initial Consultation Phase through to the submission of the Application. These funding agreements were aimed at clearly identifying expectations and requirements of both parties with regards to consultation and with respect to Aboriginal Groups' participation in the EA process. They outlined specific consultation activities, identified documents to be provided to Aboriginal groups for review and comment and allocated funding specifically for each Aboriginal Group to prepare/submit their own study or report. Efforts focused on finalizing these agreements, where consultation activities had been discussed and agreed to between the Ministry and each Aboriginal Group, assisted in the development of components of the draft Aboriginal Consultation Plan.

The Ministry entered into Participation Funding Agreements (covering the first two phases of consultation) with the following Aboriginal Groups:

- Cowichan Tribes
- Halalt First Nation
- Katzie First Nation
- Kwantlen First Nation
- Lake Cowichan First Nation
- Lyackson First Nation
- Musqueam Indian Band
- Penelakut Tribe
- Hwlitsum⁴
- Semiahmoo First Nation
- Squamish Nation
- Stz'uminus First Nation
- Tsawwassen First Nation
- Tseil-Waututh Nation

Participation Funding – Application acceptance by EAO through to end of Application Review Phase

The Ministry has been working with Schedule B Aboriginal Groups with respect to their needs for capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate Aboriginal Groups' participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to support Aboriginal Groups in presenting information regarding their respective Aboriginal Interests, and to ensure the consultation requirements pursuant to the section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry continues to work with Aboriginal Groups to finalize funding agreements for the Application Review phase.

⁴ The section 11 Order states, at Schedule B: "EAO's reference to the Hwlitsum is not intended to signify any change in the position that the Province may have taken in other contexts in relation to the duty to consult with this group."

10.1.2.7 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to each Schedule B Aboriginal Group specifically for the preparation and submission of a traditional use study or other mutually agreed to Project-related study. This funding was provided in response to requests from Aboriginal Groups, and in an effort to include and consider Aboriginal input and traditional knowledge in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests. To ensure that Aboriginal Groups submitted information that they considered most relevant and useful for the purposes of the EA, the Ministry worked with each Aboriginal Group to determine their preference with respect to the type of study to be provided. This was specified in the respective funding agreements along with agreed-to timelines for the submission of these studies/reports. The Ministry received several requests for extensions to the submission dates for these studies/reports and all requests were accommodated. In adherence to the specified terms and conditions of use, the Ministry reviewed these studies as part of the assessment, along with any other input provided by Aboriginal Groups, including information in relation to their past, current and desired future use of the Project area, Aboriginal Interests and potential Project-related impacts on those Interests. With the exception of the Semiahmoo First Nation, all Aboriginal Groups submitted studies. **Table 10.1-3** outlines the studies submitted by Aboriginal Groups to the Ministry.

Table 10.1-3 Traditional Use, Traditional Knowledge & Other Studies Submitted by Aboriginal Groups

| Aboriginal Group | Study |
|---|---|
| Tseil-Waututh Nation | Tseil-Waututh Knowledge Study for the George Massey Tunnel Project |
| Musqueam Indian Band | Musqueam 2015. Salmon So Thick, That You Could Walk on Water: Preliminary Scope of Musqueam Components for the Environmental Impact Assessment of the Proposed George Massey Tunnel Replacement Project. |
| Tsawwassen First Nation | George Massey Tunnel Replacement: Project Impact Study: An assessment of potential impacts of the George Massey Tunnel Replacement Project on aspects of the TFN Final Agreement, and other considerations |
| Cowichan Nation Alliance (Cowichan Tribes, Halalt, Penelakut and Stz'uminus) | Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015 George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015 Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010 |
| Hwilitsum | Hwilitsum Traditional Use and Occupancy Study 2015 |
| Lyackson First Nation | Preliminary Lyackson Use and Occupancy Mapping Study for BC MOTI's George Massey Tunnel Replacement Project |
| Lake Cowichan First Nation | Ts'uubaasatx Interest: George Massey Tunnel |
| Katzie First Nation | George Massey Tunnel Replacement: Katzie First Nation Traditional Use Study |
| Kwantlen First Nation | Kwantlen Land Use and Occupation in the Vicinity of Highway 99 |
| Squamish Nation | Review of George Massey Tunnel Project April 2016 |

The findings of the TUS listed above have supported the descriptions of existing conditions within Part B of the Application, where information provided from the TUS was applicable. The TUS also helped to identify and describe potential Project-related effects on VCs and ICs, and how an effect on a VC or IC could affect Aboriginal Interests. Potential Project-related effects on Aboriginal Interests are described in more detail in Section 10.3.1 below and summarized in **Table 10.3-1**.

Traditional knowledge shared by Aboriginal Groups supported the selection of candidate VC during early stages of the EA process as well as the descriptions of existing conditions within Part B of the Application and also informed the selection of potential mitigation measures for addressing potential Project-related effects. In particular, Traditional Knowledge related to fish and fish habitat, wildlife, vegetation, marine mammals, and marine use was shared with the Ministry and is described within these specific IC and VC assessments. The Ministry will continue to engage Aboriginal Groups on the integration of Traditional Knowledge and traditional use information through future stages of Project development.

10.1.2.8 Overview of Consultation Activities - Initial Consultation Phase

The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. Initiation of consultation with each Aboriginal Group is outlined in **Section 10.1.2.11**. During the Initial Consultation Phase, the Ministry consulted with all of the Aboriginal Groups later assigned to Schedule B of the section 11 Order.

At meetings with Aboriginal Groups during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Aboriginal Groups' use of the Project area for traditional purposes, or in the case of Tsawwassen First Nation for the exercise of treaty rights, and any concerns related to potential impacts on Aboriginal Interests. The Ministry also sought to determine community-specific preferences with respect to participation in Project consultation, EA review, and related activities. During initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

The Ministry provided Schedule B Aboriginal Groups with the following draft EA documents for review and comment:

- Project Description and Key Areas of Study
- Application Information Requirements
- Heritage Resources Overview Assessment
- Archaeological Heritage Resources Impact Assessment
- Aboriginal Consultation Plan

The Ministry considered sharing early drafts of key EA documents to Aboriginal Groups as an opportunity to:

- Acknowledge and respond, in part, to known concerns from Aboriginal groups regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Aboriginal Groups' review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g., Valued Components, studies and study area boundaries) prior to the Pre-Application Phase; and
- Allow time for meetings to be coordinated and conducted with Aboriginal Groups interested in detailed discussions regarding particular documents or aspect of the Project in advance of the Pre-Application Phase.

Meetings conducted with Schedule B Aboriginal Groups during the Initial Consultation Phase are listed in **Appendix 10-B Aboriginal Consultation Report 2**.

In addition to meetings with Chief and Council and/or Aboriginal Groups' staff, the Ministry also facilitated site visits and a community meeting; hosted a Project booth at an Aboriginal community event; and facilitated the participation of Aboriginal Groups' representatives in fieldwork.

During the Initial Consultation Phase, the Ministry also offered to meet with the Stō:Lò Nation and Stō:Lò Tribal Council. In May 2014, the Ministry received a deferral from the People of the River Office, representing member communities of the Stō:Lò Nation and Tribal Council. In January 2016, the People of the River Office advised EAO of their interest in deeper consultation given the decommissioning of the Tunnel component of the Project including the removal of sections of the Tunnel. As a result, EAO added the People of the River Office to Schedule C of the section 11 Order in March 2016.

Additional information regarding consultation activities undertaken during the Initial Consultation Phase are described in the Aboriginal Consultation Reports.

10.1.2.9 Overview of Consultation Activities - Pre-Application Phase Consultation

The Ministry met with all Schedule B Aboriginal Groups during the four month Pre-Application phase of the Project. Meetings are listed in **Appendix 10-B Aboriginal Consultation Report 2**.

Activities during this Phase included meetings with Chief and Council and/or Aboriginal groups' staff, site visits and community meetings; participation of Aboriginal Groups' representatives in fieldwork; and two Working Group meetings.

In April 2016, Schedule B Aboriginal Groups were invited to participate in river otter-related fieldwork. The objectives of this work were to document known or suspected river otter presence within the Regional Assessment Area, document and describe use of riparian areas and identify the potential for Project-related effects. This work was undertaken in response to Working Group comments raised by Musqueam in relation to the draft Application Information Requirements.

Working Group Meetings

The Ministry and Aboriginal Groups participated in two Working Group meetings during the Pre-Application Phase.

Working Group Meeting (January 21, 2016): *A one-day workshop with all members of Working Group. Discussions and presentations focused on:*

- EA Process
- Project overview and update
- Key Areas of Study
- Draft Application Information Requirements Overview
- Preliminary conclusions from study results to date

Working Group Meeting (March 10, 2016): *A one-day workshop with all members of Working Group. Discussions and presentations focused on:*

- EA Process
- List of materials available on Project website
- Review of comments received on, and resulting changes to, the draft Application Information Requirements
- Description and rationale of assessment areas

10.1.2.10 Overview of consultation with each Schedule B Aboriginal Group

The following section provides an overview of consultation activities undertaken with each Schedule B Aboriginal Group during the Initial Consultation and Pre-Application Phases. Additional information regarding consultation activities undertaken during the Initial Consultation Phase are described in Aboriginal Consultation Report #1 which is posted on EAO's website.

Cowichan Tribes

Cowichan Tribes engaged directly with the Ministry on the Project and also collectively with Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation as member nations of the Cowichan Nation Alliance. The Ministry provided information and funding directly to Cowichan Tribes. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribes represented Cowichan Nation Alliance in correspondence, meetings and fieldwork. As such, Cowichan Nation Alliance is only noted when Cowichan Tribes was not the Cowichan Nation Alliance representative.

Cowichan Tribes has actively engaged in consultation with the Ministry since early 2014.

During the Initial Consultation Phase, consultation activities included:

- Meetings with Cowichan Tribes Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Cowichan Nation Alliance Study.

During initial discussions with Cowichan Tribes, and as demonstrated in the Consultation Plan and participation funding agreement with Cowichan Tribes, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Cowichan Tribes.

In addition to meetings with Cowichan Tribes representatives during the Initial Consultation Phase, Cowichan Tribes participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, proposed plans for Deas Slough and Deas Island, and anticipated works and enhancements opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Cowichan Tribes' Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

During the Initial Consultation Phase, the Ministry sought Cowichan Tribes' input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Heritage Resources Overview Assessment
- Draft Archaeological Heritage Resources Impact Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Cowichan Tribes during this consultation Phase include:

- Introductory letter notifying Cowichan Tribes of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

With the exception of the draft Aboriginal Consultation Plan, the Ministry met with Cowichan Tribes and walked through these draft documents. Focused discussions were intended to explain the scope and content, to respond to any initial questions and to elicit input.

From the beginning of consultation, the Ministry worked with Cowichan Tribes to develop a mutually acceptable consultation approach, including the manner in which Cowichan Tribes was to be kept informed about the Project, and the means by which comments were to be communicated and addressed by the Ministry. Cowichan Tribes, representing Cowichan Nation Alliance, provided comments on the Draft Aboriginal Consultation Plan in a letter dated October 30 2015. These comments were summarized in Aboriginal Consultation Report #2.

Between early 2014 and May 2016, the Ministry and Cowichan Tribes discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. The Ministry met with Cowichan Tribes to discuss the scope of the Project, Project-related studies, Valued Components, mitigation, Project updates, EA process, Cowichan Tribes concerns, issues and Aboriginal Interests, and Project-related documents.

At meetings with Cowichan Tribes during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Cowichan Tribes' past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Cowichan Tribes's Aboriginal Interests. The Ministry also sought to determine Cowichan Tribes' preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this Phase, key topics and/or presentations covered during meetings with Cowichan Tribes included archaeology/heritage resources, wildlife, marine use, fish and fish habitat, traffic, human health (air and noise), river hydraulics and morphology, utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report, and the draft Application Information Requirements.

Documents and formal comments shared by Cowichan Tribes during this phase include:

- Ministry of Forests, Lands, and Natural Resource Operations' Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Proposed Studies (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Cowichan Tribes with funding for the submission of a traditional use study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015
- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015
- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

During the Pre-Application Phase, the Ministry met with Cowichan Tribes Chief and Council, staff and consultants; shared Project-related materials and draft documents for review and comment; and invited Cowichan Tribes to participate in fieldwork.

Cowichan Tribes shared the following documents with the Ministry:

- Environment Canada's Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Names (Working Group March 10, 2016)

During the Pre-Application Phase, the Ministry met three times with Cowichan Tribes and conducted a conference call in relation to Cowichan Tribes' interest in the procurement process and Project-related benefits and to discuss comments on the draft Part C content and Aboriginal Consultation Report 1.

During this phase, Cowichan Tribes was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Cowichan Tribes was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Cowichan Tribes reviewed and provided feedback on draft Part C content and Aboriginal Consultation Report 1. Where appropriate, revisions were made to these drafts based on the input received.

Cowichan Tribes communicated directly with EAO with respect to the EA process. EAO led two Working Group meetings noted in **Section 10.1.2.10**. Halalt represented Cowichan Nation Alliance at the first Working Group meeting. Halalt and Cowichan Tribes represented Cowichan Nation Alliance at the second Working Group meeting.

In addition, the Ministry undertook two meetings with the Cowichan Nation Alliance focused specifically on topics and content covered at each of the Working Group meetings. These were attended by Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation.

Consultation efforts to date sought to identify and address concerns and issues raised by Cowichan Nation Alliance during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Halalt First Nation

Halalt First Nation engaged directly with the Ministry on the Project and also collectively with Cowichan Tribes, Penelakut Tribe and Stz'uminus First Nation as member nations of the Cowichan Nation Alliance. The Ministry provided information and funding directly to Cowichan Tribe. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribe represented Cowichan Nation Alliance in correspondence, meetings and fieldwork.

Halalt First Nation has actively engaged in consultation with the Ministry since early 2014.

During the Initial Consultation Phase, consultation activities included:

- Meetings with Halalt First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Cowichan Nation Alliance Study.

During initial discussions with Halalt First Nation, and as demonstrated in the Consultation Plan and participation funding agreement with Halalt First Nation, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Halalt First Nation.

In addition to meetings with Halalt First Nation representatives during the Initial Consultation Phase, Halalt First Nation participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, proposed plans for Deas Slough and Deas Island, and anticipated works and enhancements opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Halalt First Nation's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

During the Initial Consultation Phase, the Ministry sought Halalt First Nation's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Heritage Resources Overview Assessment
- Draft Archaeological Heritage Resources Impact Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Halalt First Nation during this consultation Phase include:

- Introductory letter notifying Halalt First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

The Ministry met with Cowichan Nation Alliance to review all documents except the Aboriginal Consultation Plan. Focused discussions were intended to explain the scope and content, to respond to any initial questions and to elicit input.

From the beginning of consultation, the Ministry worked with Halalt First Nation to develop a mutually acceptable consultation approach, including the manner in which Halalt First Nation was to be kept informed about the Project, and the means by which comments were to be communicated and addressed by the Ministry. Cowichan Nation Alliance provided comments on the Draft Aboriginal Consultation Plan in a letter dated October 30 2015. These comments were summarized in Aboriginal Consultation Report #2.

Between early 2014 and May 2016, the Ministry and Halalt First Nation and Cowichan Nation Alliance discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. The Ministry met with Cowichan Nation Alliance to discuss the scope of the Project, Project-related studies, Valued Components, mitigation, Project updates, EA process, Halalt First Nation concerns, issues and Aboriginal Interests, and Project-related documents.

At meetings with Halalt First Nation and Cowichan Nation Alliance during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Halalt First Nation's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Halalt First Nation's Aboriginal Interests. The Ministry also sought to determine Halalt First Nation's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this Phase, key topics and/or presentations covered during meetings with Halalt First Nation included archaeology/heritage resources, wildlife, marine use, fish and fish habitat, traffic, human health (air and noise), river hydraulics and morphology, utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report, and the draft Application Information Requirements.

Documents and formal comments shared by Halalt First Nation during this phase include:

- Ministry of Forests, Lands, and Natural Resource Operations' Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Proposed Studies (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Halalt First Nation with funding for the submission of a traditional use study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015

- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015
- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

During the Pre-Application Phase, the Ministry met with Halalt First Nation Chief and Council, staff and consultants and Cowichan Nation Alliance representatives; shared Project-related materials and draft documents for review and comment; and invited Halalt First Nation to participate in fieldwork.

Halalt First Nation shared the following documents with the Ministry:

- Environment Canada's Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Names (Working Group March 10, 2016)

During the Pre-Application Phase, the Ministry met three times with Cowichan Nation Alliance. Halalt First Nation attended two of those meetings. The Ministry also conducted a conference call in relation to Halalt First Nation's interest in the procurement process and Project-related benefits and to discuss comments on the draft Part C content and Aboriginal Consultation Report 1. Cowichan Nation Alliance represented Halalt First Nation on that call.

During this phase, Halalt First Nation was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Halalt First Nation was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Cowichan Nation Alliance provided feedback on draft Part C content and Aboriginal Consultation Report 1. Where appropriate, revisions were made to these drafts based on the input received.

Halalt First Nation communicated directly with EAO with respect to the EA process. EAO led two Working Group meetings noted in **Section 10.1.2.10**. Halalt First Nation represented Cowichan Nation Alliance at the first Working Group meeting. Cowichan Tribes and Halalt First Nation represented Cowichan Nation Alliance at the second Working Group meeting.

In addition, the Ministry undertook two meetings with the Cowichan Nation Alliance focused specifically on topics and content covered at each of the Working Group meetings. These were attended by Cowichan Tribe, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation.

Consultation efforts to date sought to identify and address concerns and issues raised by Cowichan Nation Alliance during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-C Aboriginal Consultation Report 2**).

Hwlitsum

The Province is aware that Hwlitsum has asserted that it is an Aboriginal group independent of the Penelakut Tribe, and has commenced an action in the British Columbia Supreme Court in which this issue arises. The Province considers Hwlitsum to be a family group/component of the Penelakut Tribe. However, to ensure that all information that may be applicable to the Penelakut and its components is available and considered, as appropriate, EAO invited Hwlitsum to participate as a Working Group member for the EA, and directed the Ministry to consult with Hwlitsum as per the section 11 Order.

Hwlitsum has actively engaged in consultation with the Ministry since early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

Initially, Hwlitsum was affiliated with the Cowichan Nation Alliance and participated in Project consultation as a member of the Alliance. In fall 2014, Hwlitsum indicated that they would engage with the Ministry directly. Between early 2014 and May 2016, the Ministry and Hwlitsum discussed and exchanged Project-related information through emails, phone calls, letters, a community meeting and in-person meetings.

From the beginning of consultation, the Ministry worked with Hwlitsum to develop a mutually acceptable consultation approach, including the manner in which Hwlitsum was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

During initial discussions with Hwlitsum, and as demonstrated in the Consultation Plan and Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Hwlitsum.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, Hwlitsum's past, present and future desired use of the Project area for the exercise of identified Aboriginal Interests, identification of potential impacts on Hwlitsum's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

During Initial Consultation meetings, Hwlitsum identified the need for capacity funding to support Hwlitsum's involvement in Project consultation activities, review of EA-related documents and participation in the Pre-Application phase of the EA process. Hwlitsum also identified the need for funding for a Hwlitsum Study. The Ministry and Hwlitsum worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Hwlitsum's review and comment. Hwlitsum submitted a study entitled "Hwlitsum Traditional Use and Occupancy Study 2015".

At meetings with Hwlitsum during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Hwlitsum's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Hwlitsum's Aboriginal Interests. The Ministry also sought to determine Hwlitsum's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In support of consultation, the following Ministry-led activities have been undertaken with Hwlitsum during these phases:

- Meetings with Hwlitsum Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;

- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and an Hwlitsum Study.

During this period, key topics and/or presentations covered during meetings with Hwlitsum include: Archaeology/Heritage Resources, Marine Use, Fish and Fish Habitat, River Hydraulics and Morphology, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

During the Initial Consultation Phase, the Ministry sought Hwlitsum's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Hwlitsum during this consultation Phase include:

- Introductory letter notifying Hwlitsum of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

With the exception of the draft Aboriginal Consultation Plan, the Ministry met with Hwlitsum and walked through these draft documents. Focused discussions on these documents were intended to explain the scope and content, to respond to any initial questions and to elicit input. Hwlitsum submitted comments on the draft Heritage Resources Overview Assessment for the Project via letter/email dated December 12, 2014.

During the Pre-Application Phase, the Ministry held a community meeting with Hwlitsum. At the request of Hwlitsum, the Project team provided an overview of the Project (scope, components, schedule, EA process) and a focused presentation on fish and fish habitat.

During this phase, Hwlitsum was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Hwlitsum was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

The Ministry provided draft Consultation Report 1 to Hwlitsum for review and comment prior to finalization and submission to EAO indicating that feedback received by May 2, 2106, would be incorporated into the final version as appropriate. Draft Part C content was also provided. Hwlitsum provided comments on the Aboriginal Consultation Report 1 and Draft Part C content on May 10, 2016. Where appropriate, revisions were made to these drafts based on the input received.

Hwlitsum attended two EAO-led Working Group meetings and had communications directly with EAO with respect to the EA process.

Consultation efforts to date sought to identify and address concerns and issues raised by Hwlitsum raised by Hwlitsum during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Katzie First Nation

Katzie First Nation (Katzie) has actively engaged in consultation with the Ministry since early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

Between early 2014 and May 2016, the Ministry and the Katzie First Nation discussed and exchanged Project-related information through emails, phone calls, letters and meetings.

During the Initial Consultation Phase, consultation activities included:

- Meetings with Katzie First Nation Chief and Council, staff and consultants;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Katzie First Nation Study.

Letters sent to Katzie First Nation during this consultation Phase include:

- Introductory letter notifying Katzie First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

During initial discussions with Katzie, and as demonstrated in the Consultation Plan and Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Katzie.

At meetings with Katzie during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Katzie's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests and any concerns related to potential impacts on Katzie's Aboriginal Interests.

From the beginning of consultation, the Ministry worked with Katzie to develop a mutually acceptable consultation approach, including the manner in which Katzie was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

During this period, key topics and/or presentations covered during meetings with Katzie include: archaeology/heritage resources, wildlife, marine use, fish and fish habitat, traffic, human health (air and noise), river hydraulics and morphology, utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report, and the draft Application Information Requirements.

The Ministry met with Katzie and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input. Katzie First Nation submitted comments on the Draft Aboriginal Consultation Plan in a November 20, 2015 letter/email.

During the Pre-Application Phase, the Ministry met twice with Katzie. A key topic of interest was procurement and Project related benefits. EAO invited Katzie to two EAO-led Working Group meetings, but Katzie did not attend.

During this phase, Katzie was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Katzie was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report 2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Katzie reviewed draft Aboriginal Consultation Report 1 and draft Part C content and had no comments or concerns.

On May 18 2016, the Ministry received a letter from Katzie, Kwantlen and Semiahmoo First Nations expressing concern with the Project's procurement strategy and requesting further dialogue with respect to business opportunities. The Ministry will continue to work with Katzie, Kwantlen and Semiahmoo First Nations to address this and any other Project-related concerns.

Consultation efforts to date sought to identify and address concerns and issues raised by Katzie during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Kwantlen First Nation

Kwantlen First Nation (Kwantlen) has actively engaged in consultation with the Ministry since early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

Between early 2014 and May 2016, the Ministry and the Kwantlen First Nation discussed and exchanged Project-related information through emails, phone calls, letters and meetings.

During the Initial Consultation Phase, consultation activities included:

- Meetings with Kwantlen First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Kwantlen First Nation Study.

Letters sent to Kwantlen First Nation during this consultation Phase include:

- Introductory letter notifying Kwantlen First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

During initial discussions with Kwantlen First Nation, and as demonstrated in the Consultation Plan and Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Kwantlen.

During Initial Consultation meetings, Kwantlen identified the need for capacity funding to support Kwantlen's involvement in Project consultation activities, review of EA-related documents and participation in the Pre-Application phase of the EA process. Kwantlen First Nation also identified the need for funding for a Kwantlen First Nation traditional use study. The Ministry and Kwantlen worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Kwantlen's review and comment. Kwantlen submitted a Study entitled Kwantlen Land Use and Occupation in the Vicinity of Highway 99.

At meetings with Kwantlen First Nation during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Kwantlen's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests and any concerns related to potential impacts on Kwantlen's Aboriginal Interests. The Ministry also sought to determine Kwantlen's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this period, key topics and/or presentations covered during meetings with Kwantlen include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

During the Initial Consultation Phase, the Ministry sought Kwantlen's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Kwantlen First Nation during this consultation Phase include:

- Introductory letter notifying Kwantlen First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

With the exception of the Draft Consultation Plan, the Ministry met with Kwantlen and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

During the Pre-Application Phase, the Ministry met twice with Kwantlen First Nation. A key topic of interest was procurement and Project related benefits. Kwantlen First Nation has participated in two EAO-led Working Group meetings.

In April 2016, Kwantlen First Nation participated in river otter-related fieldwork. The objectives of this work were to document known or suspected river otter presence within the Regional Assessment Area, document and describe use of riparian areas and identify the potential for Project-related effects.

During this phase, Kwantlen was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Kwantlen was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report 2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Kwantlen reviewed and provided comments on Part C of the Application and draft Aboriginal Consultation Report #1. Where appropriate, revisions were made to these drafts based on the input received.

On May 18 2016, the Ministry received a letter from Kwantlen, Katzie and Semiahmoo First Nations expressing concern with the Project's procurement strategy and requesting further dialogue with respect to business opportunities. The Ministry will continue to work with Kwantlen, Katzie and Semiahmoo First Nations through the Application Review Phase to address this and any other Project-related concerns.

Consultation efforts to date sought to identify and address concerns and issues raised by Kwantlen during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Lake Cowichan First Nation

Lake Cowichan First Nation (Lake Cowichan) has actively engaged in consultation with the Ministry since early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

Between early 2014 and May 2016, the Ministry and the Lake Cowichan First Nation discussed and exchanged Project-related information through emails, phone calls, and meetings. Lyackson First Nation and Lake Cowichan First Nation have been working together on this Project and as such, the summary of meetings has been recorded to reflect this engagement approach.

In support of consultation, the following Ministry-led activities have been undertaken with Lake Cowichan First Nation:

- Meetings with Lake Cowichan First Nation Chief and Council, staff and consultants;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Lake Cowichan First Nation Study.

During initial discussions with Lake Cowichan First Nation, and as demonstrated in the Consultation Plan and Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Lake Cowichan. From the beginning of consultation, the Ministry worked with Lake Cowichan to develop a mutually acceptable consultation approach, including the manner in which Lake Cowichan was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

At meetings with Lake Cowichan First Nation during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Lake Cowichan's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests and any concerns related to potential impacts on Lake Cowichan's Aboriginal Interests. The Ministry also sought to determine Lake Cowichan's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this period, key topics and/or presentations covered during meetings with Lake Cowichan include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements

During the Initial Consultation Phase, the Ministry sought Lake Cowichan's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Lake Cowichan First Nation during this consultation Phase include:

- Introductory letter notifying Lake Cowichan First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

With the exception of the Draft Consultation Plan, the Ministry met with Lake Cowichan and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input. Lake Cowichan First Nation reviewed, but did not comment on, the Draft Aboriginal Consultation Plan.

During the Pre-Application Phase, the Ministry met three times with Lake Cowichan First Nation representatives. Lake Cowichan First Nation was invited to participate in the EAO-led Working Group, but did not attend the two meetings during this Phase.

During this phase, Lake Cowichan was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Lake Cowichan was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report 2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Lake Cowichan's feedback on Aboriginal Consultation Report #1 was provided during a meeting with Lyackson First Nation. Lake Cowichan First Nation reviewed draft Part C content and had no comments or concerns.

Consultation efforts to date sought to identify and address concerns and issues raised by Lake Cowichan during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Lyackson First Nation

Lyackson First Nation (Lyackson) has actively engaged in consultation with the Ministry since early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports. Lyackson First Nation and Lake Cowichan First Nation have worked together on this Project and this is reflected in both the summary of meetings and of the concerns/issues raised to date.

The Ministry initiated consultation with Lyackson in early 2014. Between early 2014 and May 2016, the Ministry and the Lyackson discussed and exchanged Project-related information through emails, phone calls, and meetings. In support of consultation, the following Ministry-led activities have been undertaken with Lyackson First Nation during these phases:

- Meetings with Lyackson First Nation staff and consultants;
- Two site visits (general and for Lyackson elders);
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Lyackson First Nation Study.

From the beginning of consultation, the Ministry worked with Lyackson to develop a mutually acceptable consultation approach, including the manner in which Lyackson was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

During Initial Consultation meetings, Lyackson identified the need for capacity funding to support Lyackson's involvement in Project consultation activities, review of EA-related documents and participation in the Pre-Application phase of the EA process. Lyackson First Nation also identified the need for funding for a Lyackson First Nation traditional use study. The Ministry and Lyackson worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Lyackson's review and comment. Lyackson submitted a Study entitled, Preliminary Lyackson Use and Occupancy Mapping Study for BC MOTI's George Massey Tunnel Replacement Project.

During initial discussions with Lyackson First Nation, and as demonstrated in the Consultation Plan and Lyackson/GMT Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Lyackson.

At meetings with Lyackson First Nation during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Lyackson's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests and any concerns related to potential impacts on Lyackson's Aboriginal Interests. The Ministry also sought to determine Lyackson's preferences with respect to participation in Project consultation, EA review, and related activities.

During this period, key topics and/or presentations covered during meetings with Lyackson include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

During the Initial Consultation Phase, the Ministry sought Lyackson's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment

- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Lyackson First Nation during this consultation Phase include:

- Introductory letter notifying Lyackson First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

With the exception of the Draft Consultation Plan, the Ministry met with Lyackson and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Lyackson on this matter, the Ministry is of the understanding that Lyackson First Nation has no outstanding concerns or comments with respect to the Plan.

During the Pre-Application Phase, the Ministry met three times with Lyackson First Nation. Lyackson First Nation participated in two EAO-led Working Group meetings.

In addition, Lyackson elders participated in a site visit that had been requested in the Working Group meeting. The site visit covered key Project components, provided an opportunity for mutual sharing of information and knowledge, and allowed for Lyackson representatives to ask questions about the Project.

During this phase, Lyackson was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Lyackson was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Lyackson commented on the draft Application Information Requirements through the Working Group and provided comments on the draft content of Part C during an April 27, 2016 meeting with the Ministry. Changes to Part C content were made based on Lyackson's input. Lyackson advised the Ministry that they had no comments on draft Aboriginal Consultation Report #1.

Consultation efforts to date sought to identify and address concerns and issues raised by Lyackson during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Musqueam Indian Band

The Ministry initiated consultation with Musqueam Indian Band (Musqueam) in early 2013. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

Between early 2013 and May 2016, the Ministry and Musqueam discussed and exchanged Project-related information through emails, phone calls, letters and meetings. From the beginning of consultation, the Ministry worked with Musqueam in an effort to develop a mutually acceptable consultation approach, including the manner in which Musqueam was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

During initial discussions with Musqueam, and as demonstrated in the Consultation Plan and Musqueam/GMT Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Musqueam. During Initial Consultation meetings, Musqueam identified the need for capacity funding to support Musqueam's involvement in Project consultation activities, review of EA-related documents and participation in the Pre-Application phase of the EA process. Musqueam also identified the need for funding for a Musqueam traditional use study. The Ministry and Musqueam worked together to finalize a funding agreement. The agreement specifies the Initial Consultation and Pre-Application Phase activities covered under the agreement and Project/EA-related documents for MIB's review and comment. On November 17, 2015, Musqueam submitted a study, "Salmon So Thick, That You Could Walk on Water: Preliminary Scope of Musqueam Components for the Environmental Impact Assessment of the Proposed George Massey Tunnel Replacement Project".

Consultation activities during this period were focused on the Project scope and schedule, proposed Studies/Valued Components, understanding Musqueam's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and the identification of potential impacts on Musqueam's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects. The Ministry also sought to determine Musqueam's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In support of consultation, the following Ministry-led activities have been undertaken with Musqueam during these phases:

- Meetings with Musqueam Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Project booth at Musqueam Aboriginal Day event; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Musqueam Study.

During this period, key topics and/or presentations covered during activities with Musqueam include: archaeology/heritage resources; wildlife; marine use, fish and fish habitat; traffic; human health (air and noise); river hydraulics and morphology; utilities; and the Green Slough concept.

The Ministry sought Musqueam's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Musqueam Indian Band during this consultation Phase include:

- Introductory letter notifying Musqueam Indian Band of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and

- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

With the exception of the draft Aboriginal Consultation Plan, the Ministry met with Musqueam to discuss these documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input Musqueam's comments. Musqueam provided comments on the Draft Consultation Plan via email on November 6, 2015. Where Musqueam's comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Musqueam has not responded to the Ministry's email (March 09, 2015) outlining changes to the Plan resulting from Musqueam's input or to the offer to meet to discuss the Plan.

During the Pre-Application Phase, the Ministry met twice with Musqueam. Musqueam attended two EAO-led Working Group meetings and met one-on-one with EAO with respect to the EA process.

In April 2016, Musqueam was invited to participate in river otter-related fieldwork. The objectives of this work were to document known or suspected river otter presence within the Regional Assessment Area, document and describe use of riparian areas and identify the potential for Project-related effects. This work was undertaken in response to Working Group comments raised by Musqueam in relation to the dAIR. Musqueam did not participate in this fieldwork opportunity.

During this phase, Musqueam was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Musqueam was provided Draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

The Ministry provided draft Consultation Report #1 to Musqueam for review and comment prior to finalization and submission to EAO, indicating that feedback received by May 2, 2106, would be incorporated into the final version as appropriate. Musqueam requested an extension to provide comments. Musqueam provided comments on the draft Consultation Report related to its content and format, and requested that a separate Musqueam-specific report be prepared that is reflective of Musqueam's perspective regarding the consultation undertaken to date. Aboriginal Consultation Report #2 provides Musqueam-specific content and is inclusive of Musqueam's perspective on consultation undertaken to date. Where appropriate, comments received on Report #2 will be incorporated into the revised document.

Musqueam also provided comments on draft Part C content of the Application. Based on input provided by Musqueam and where appropriate, changes to this content have been made.

During the Pre-Application Phase, Musqueam submitted a letter to the Ministry in relation to the use of Musqueam information (March 17, 2016). The Ministry responded to Musqueam in a meeting on April 13, 2016, and also via letter dated April 20, 2016 addressing questions and concerns with respect to the appropriate use of Musqueam information.

On May 19, 2016, Musqueam submitted a draft Memorandum of Understanding (MOU) to the Ministry in relation to the Project. The Ministry is committed to working with Musqueam with respect to the draft MOU, to continued consultation and to a positive, mutually respectful and productive relationship on this Project.

Consultation efforts to date have sought to identify and address concerns and issues raised by Musqueam during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Penelakut Tribe

Penelakut Tribe engaged directly with the Ministry on the Project and also collectively with Cowichan Tribes, Penelakut Tribe and Stz'uminus First Nation as member nations of the Cowichan Nation Alliance. The Ministry provided information and funding directly to Cowichan Tribe. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribe represented Cowichan Nation Alliance in correspondence, meetings and fieldwork.

Penelakut Tribe has actively engaged in consultation with the Ministry since early 2014.

During the Initial Consultation Phase, consultation activities included:

- Meetings with Penelakut Tribe Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Cowichan Nation Alliance Study.

During initial discussions with Penelakut Tribe, and as demonstrated in the Consultation Plan and participation funding agreement with Penelakut Tribe, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Penelakut Tribe.

In addition to meetings with Penelakut Tribe representatives during the Initial Consultation Phase, Penelakut Tribe participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, proposed plans for Deas Slough and Deas Island, and anticipated works and enhancements opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Penelakut Tribe's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

During the Initial Consultation Phase, the Ministry sought Penelakut Tribe's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Heritage Resources Overview Assessment
- Draft Archaeological Heritage Resources Impact Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Penelakut Tribe during this consultation Phase include:

- Introductory letter notifying Penelakut Tribe of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

The Ministry met with Cowichan Nation Alliance to review all documents except the Aboriginal Consultation Plan. Focused discussions were intended to explain the scope and content, to respond to any initial questions and to elicit input.

From the beginning of consultation, the Ministry worked with Penelakut Tribe to develop a mutually acceptable consultation approach, including the manner in which Penelakut Tribe was to be kept informed about the Project, and the means by which comments were to be communicated and addressed by the Ministry. Cowichan Nation Alliance provided comments on the Draft Aboriginal Consultation Plan in a letter dated October 30 2015. These comments were summarized in Aboriginal Consultation Report #2.

Between early 2014 and May 2016, the Ministry and Penelakut Tribe and Cowichan Nation Alliance discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. The Ministry met with Cowichan Nation Alliance to discuss the scope of the Project, Project-related studies, Valued Components, mitigation, Project updates, EA process, Penelakut Tribe concerns, issues and Aboriginal Interests, and Project-related documents.

At meetings with Penelakut Tribe and Cowichan Nation Alliance during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Penelakut Tribe's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Penelakut Tribe's Aboriginal Interests. The Ministry also sought to determine Penelakut Tribe's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this Phase, key topics and/or presentations covered during meetings with Penelakut Tribe included archaeology/heritage resources, wildlife, marine use, fish and fish habitat, traffic, human health (air and noise), river hydraulics and morphology, utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report, and the draft Application Information Requirements.

Documents and formal comments shared by Penelakut Tribe during this phase include:

- Ministry of Forests, Lands, and Natural Resource Operations' Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Proposed Studies (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Penelakut Tribe with funding for the submission of a traditional use study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015
- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015
- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

During the Pre-Application Phase, the Ministry met with Penelakut Tribe Chief and Council, staff and consultants and Cowichan Nation Alliance representatives; shared Project-related materials and draft documents for review and comment; and invited Penelakut Tribe to participate in fieldwork.

Penelakut Tribe shared the following documents with the Ministry:

- Environment Canada's Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Names (Working Group March 10, 2016)

During the Pre-Application Phase, the Ministry met three times with Cowichan Nation Alliance. Penelakut Tribe attended one of those meetings. The Ministry also conducted a conference call in relation to Penelakut Tribe's interest in the procurement process and Project-related benefits and to discuss comments on the draft Part C content and Aboriginal Consultation Report 1. Cowichan Nation Alliance represented Penelakut Tribe on that call.

During this phase, Penelakut Tribe was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Penelakut Tribe was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Cowichan Nation Alliance provided feedback on draft Part C content and Aboriginal Consultation Report 1. Where appropriate, revisions were made to these drafts based on the input received.

Penelakut Tribe communicated directly with EAO with respect to the EA process. EAO led two Working Group meetings noted in **Section 10.1.2.10**. Halalt First Nation represented Cowichan Nation Alliance at the first Working Group meeting. Cowichan Tribes and Halalt First Nation represented Cowichan Nation Alliance at the second Working Group meeting.

In addition, the Ministry undertook two meetings with the Cowichan Nation Alliance focused specifically on topics and content covered at each of the Working Group meetings. These were attended by Cowichan Tribe, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation.

Consultation efforts to date sought to identify and address concerns and issues raised by Cowichan Nation Alliance during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-C Aboriginal Consultation Report 2**).

Semiahmoo First Nation

Semiahmoo First Nation (Seamiahmoo) has actively engaged in consultation with the Ministry since early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

The Ministry initiated consultation with Semiahmoo in early 2014. In support of consultation, the following Ministry-led activities have been undertaken with Semiahmoo during these phases:

- Meetings with Semiahmoo First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Semiahmoo First Nation Study.

During initial discussions with Semiahmoo, and as demonstrated in the Consultation Plan and Semiahmoo/GMT Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Semiahmoo.

During Initial Consultation meetings, Semiahmoo identified the need for capacity funding to support Semiahmoo's involvement in Project consultation activities, review of EA-related documents and participation in the Pre-Application phase of the EA process. Semiahmoo also identified the need for funding for a Semiahmoo First Nation traditional use study and the Ministry and Semiahmoo worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Semiahmoo's review and comment. Semiahmoo did not submit a traditional use study.

Between early 2014 and May 2016, the Ministry and Semiahmoo discussed and exchanged Project-related information through emails, letters, phone calls and meetings.

At meetings with Semiahmoo during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Semiahmoo's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Semiahmoo's Aboriginal Interests. The Ministry also sought to determine Semiahmoo's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this period, key topics and/or presentations covered during activities with Semiahmoo include: archaeology/heritage resources; wildlife; marine use, fish and fish habitat; traffic; human health (air and noise); river hydraulics and morphology; utilities; and the Green Slough concept.

In addition to meetings with Semiahmoo representatives during the Initial Consultation Phase, Semiahmoo was invited to participate in a site visit which focused on key Project components, mutual sharing of information, plans for tunnel decommissioning, Deas Slough and Deas Island, and anticipated works and enhancements opportunities for Green Slough.

During the Initial Consultation Phase, the Ministry sought Semiahmoo's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Semiahmoo during this consultation Phase include:

- Introductory letter notifying Semiahmoo First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

The Ministry met with Semiahmoo and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

The Consultation Plan was revised, based on input received from Semiahmoo and other Aboriginal Groups, and approved by EAO on April 6, 2016. Semiahmoo submitted a letter to the Ministry on October 28, 2015 indicating that funding was required for the duration of the Plan, expressing concerns with the Project's procurement process and requesting specific provisions within the procurement process in relation to Aboriginal participation. The Ministry met with Semiahmoo to discuss these concerns and will continue to work with Semiahmoo in an effort to address any outstanding Project-related issues.

During the Pre-Application Phase, Semiahmoo met with the Ministry twice. A key topic of interest was procurement and Project related benefits. Semiahmoo participated in the EAO-led Working Group.

During this phase, Semiahmoo was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Semiahmoo First Nation was also provided Draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

The Ministry provided draft Consultation Report #1 to Semiahmoo for review and comment prior to finalization and submission to EAO and indicated that feedback received by May 2, 2016 would be incorporated into the final version as appropriate. Semiahmoo indicated that they would not provide comments on these draft documents due to concerns related to the Ministry's approach to Project procurement.

On May 18 2016, the Ministry received a letter from Semiahmoo, Katzie and Kwantlen First Nations expressing concern with the Project's procurement strategy and requesting further dialogue with respect to business opportunities. The Ministry will continue to work with Semiahmoo, Katzie and Kwantlen First Nation to address this and any other Project-related concerns.

Consultation efforts to date sought to identify, address and resolve concerns and issues raised by Semiahmoo. The concerns, issues and interests raised by Semiahmoo during the Initial Consultation and Pre-Application Phases are summarized in **Appendix 10-B Aboriginal Consultation Report 2**.

Squamish Nation

The Ministry initiated consultation with Squamish First Nation (Squamish) in early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

In support of consultation, the following Ministry-led activities have been undertaken with Squamish Nation:

- Meetings with Squamish Nation staff and consultants;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Squamish Nation report.

The Ministry has worked with Squamish Nation with respect to determining a mutually acceptable consultation approach, including the manner in which Squamish Nation is to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) are to be communicated and addressed by the Ministry.

During discussions with Squamish Nation, and as demonstrated in the Consultation Plan and Squamish Nation/GMT Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Squamish Nation.

Between early 2014 and May 2016, the Ministry and the Squamish Nation discussed and exchanged Project-related information through emails, phone calls, letters and meetings. At meetings with Squamish Nation during this Phase, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Squamish Nation's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Squamish Nation's Aboriginal Interests.

During this period, consultation with Squamish Nation focused on: Archaeology/Heritage Resources, Marine Use, Fish and Fish Habitat, River Hydraulics and Morphology, Green Slough concept, Project Description and Key Areas of Study document and the Draft Application Information Requirements.

During the Initial Consultation Phase, the Ministry sought Squamish Nation's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Squamish Nation during this consultation Phase include:

- Introductory letter notifying Squamish Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

In a December 2015 letter to the Ministry, the Squamish Nation identified the need for capacity funding to support Squamish Nation's involvement in Project consultation activities, review of EA-related documents and participation in the Pre-Application phase of the EA process. The letter also indicated that Squamish Nation is concerned that the Project could potentially impact their fishing rights on the Fraser River.

On February 2, 2016, the Ministry responded to the letter indicating that the Ministry would follow up with Squamish upon issuance, by EAO, of the final section 11 Order. The section 11 Order assigned Squamish to Schedule B. Squamish Nation was invited to two EAO-led Working Group meetings and has had communications directly with EAO with respect to the EA process. Squamish did not attend either of the two Working Group meetings for the Project.

During consultation, Squamish Nation identified the need for funding for a Squamish Nation Study. The Ministry and Squamish Nation worked together to finalize a funding agreement.

During the Pre-Application phase, Squamish was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Squamish was also provided Draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report 2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Squamish Nation reviewed draft Aboriginal Consultation Report #1 and had no comments on the document. Squamish also reviewed and commented on draft Part C content of the Application. The draft content was revised in response to input received.

Consultation efforts to date sought to identify and address concerns and issues raised by Squamish during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Stzùminus First Nation

Stzùminus First Nation engaged directly with the Ministry on the Project and also collectively with Cowichan Tribes, Penelakut Tribe and Stz'uminus First Nation as member nations of the Cowichan Nation Alliance. The Ministry provided information and funding directly to Cowichan Tribe. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribe represented Cowichan Nation Alliance in correspondence, meetings and fieldwork.

Stzùminus First Nation has actively engaged in consultation with the Ministry since early 2014.

During the Initial Consultation Phase, consultation activities included:

- Meetings with Stzùminus First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Cowichan Nation Alliance Study.

During initial discussions with Stzùminus First Nation, and as demonstrated in the Consultation Plan and participation funding agreement with Stzùminus First Nation, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Stzùminus First Nation.

In addition to meetings with Stzùminus First Nation representatives during the Initial Consultation Phase, Stzùminus First Nation participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, proposed plans for Deas Slough and Deas Island, and anticipated works and enhancements opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Stzùminus First Nation's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

During the Initial Consultation Phase, the Ministry sought Stzùminus First Nation's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Heritage Resources Overview Assessment
- Draft Archaeological Heritage Resources Impact Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Stzùminus First Nation during this consultation Phase include:

- Introductory letter notifying Stzùminus First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

The Ministry met with Cowichan Nation Alliance to review all documents except the Aboriginal Consultation Plan. Focused discussions were intended to explain the scope and content, to respond to any initial questions and to elicit input.

From the beginning of consultation, the Ministry worked with Stzùminus First Nation to develop a mutually acceptable consultation approach, including the manner in which Stzùminus First Nation was to be kept informed about the Project, and the means by which comments were to be communicated and addressed by the Ministry. Cowichan Nation Alliance provided comments on the Draft Aboriginal Consultation Plan in a letter dated October 30 2015. These comments were summarized in Aboriginal Consultation Report #2.

Between early 2014 and May 2016, the Ministry and Stzùminus First Nation and Cowichan Nation Alliance discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. The Ministry met with Cowichan Nation Alliance to discuss the scope of the Project, Project-related studies, Valued Components, mitigation, Project updates, EA process, Stzùminus First Nation concerns, issues and Aboriginal Interests, and Project-related documents.

At meetings with Stzùminus First Nation and Cowichan Nation Alliance during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Stzùminus First Nation's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Stzùminus First Nation's Aboriginal Interests. The Ministry also sought to determine Stzùminus First Nation's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this Phase, key topics and/or presentations covered during meetings with Stzùminus First Nation included archaeology/heritage resources, wildlife, marine use, fish and fish habitat, traffic, human health (air and noise), river hydraulics and morphology, utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report, and the draft Application Information Requirements.

Documents and formal comments shared by Stzùminus First Nation during this phase include:

- Ministry of Forests, Lands, and Natural Resource Operations' Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Proposed Studies (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Stzùminus First Nation with funding for the submission of a traditional use study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015
- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015
- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

During the Pre-Application Phase, the Ministry met with Stzùminus First Nation Chief and Council, staff and consultants and Cowichan Nation Alliance representatives; shared Project-related materials and draft documents for review and comment; and invited Stzùminus First Nation to participate in fieldwork.

Stzùminus First Nation shared the following documents with the Ministry:

- Environment Canada's Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Names (Working Group March 10, 2016)

During the Pre-Application Phase, the Ministry met three times with Cowichan Nation Alliance. Stzùminus First Nation attended one of those meetings. The Ministry also conducted a conference call in relation to Stzùminus First Nation's interest in the procurement process and Project-related benefits and to discuss comments on the draft Part C content and Aboriginal Consultation Report 1. Cowichan Nation Alliance represented Stzùminus First Nation on that call.

During this phase, Stzùminus First Nation was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Stz'uminus First Nation was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Cowichan Nation Alliance provided feedback on draft Part C content and Aboriginal Consultation Report 1. Where appropriate, revisions were made to these drafts based on the input received.

Stz'uminus First Nation communicated directly with EAO with respect to the EA process. EAO led two Working Group meetings noted in **Section 10.1.2.10**. Halalt First Nation represented Cowichan Nation Alliance at the first Working Group meeting. Cowichan Tribes and Halalt First Nation represented Cowichan Nation Alliance at the second Working Group meeting.

In addition, the Ministry undertook two meetings with the Cowichan Nation Alliance focused specifically on topics and content covered at each of the Working Group meetings. These were attended by Cowichan Tribe, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation.

Consultation efforts to date sought to identify and address concerns and issues raised by Cowichan Nation Alliance during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-C Aboriginal Consultation Report 2**).

Tsawwassen First Nation

Tsawwassen First Nation (Tsawwassen) has actively engaged in consultation with the Ministry since late 2012. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

Between early 2012 and May 2016, the Ministry and Tsawwassen discussed and exchanged Project-related information through emails, phone calls, letters and meetings.

During the Initial Consultation Phase, the Ministry sought Tsawwassen’s input on the following EA-related documents:

- Meetings with Tsawwassen First Nation Chief and Council, staff and consultants;
- Community meeting
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Tsawwassen Project Impact Study.

During initial discussions with Tsawwassen, and as demonstrated in the Consultation Plan and Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Tsawwassen.

In December 2014, the Ministry conducted a Tsawwassen community meeting. The Ministry presented on various aspects of the Project including the scope and key components, schedule and proposed studies.

During this period, key topics and/or presentations covered during meetings with Tsawwassen include: Project scope and schedule, Tsawwassen’s concerns/interests and Tsawwassen’s past, present and desired future use of the Project area for the exercise of Aboriginal Interests, EA Process, Consultation with Tsawwassen, Archaeology/Heritage Resources, Wildlife, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

In addition to meetings with Tsawwassen representatives during the Initial Consultation Phase, Tsawwassen participated in a site visit which focused on key Project components, mutual sharing of information plans for tunnel decommissioning, Deas Slough and Deas Island, and anticipated works and enhancements opportunities for Green Slough.

During the Initial Consultation Phase, the Ministry sought Tsawwassen’s input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Tsawwassen First Nation during this consultation Phase include:

- Introductory letter notifying Squamish Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

With the exception of the Draft Aboriginal Consultation Plan, the Ministry met with TFN and walked through the above- listed draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input. TFN request one change to the draft Aboriginal Consultation Plan. The Ministry revised the Plan to reflect the requested edit.

During the Pre-Application Phase, the Ministry met three times with Tsawwassen. These meetings included a review of information shared at Working Group #2, a Project update and a discussion regarding GMT procurement and a meeting to discuss draft Aboriginal Consultation Plan 1 and draft Part C content. A meeting was also held with Tsawwassen's Natural Resources Committee with a focus on the fish and fish habitat assessment. During this Phase, Tsawwassen attended one EAO-led Working Group meeting and has met one-on-one with EAO with respect to the EA process.

During this phase, Tsawwassen was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Tsawwassen was also provided with draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report #2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Tsawwassen First Nation reviewed draft Aboriginal Consultation Report 1 and draft Part C content and had no comments or concerns.

Consultation efforts to date sought to identify and address concerns and issues raised by Tsawwassen during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

Tsleil-Waututh Nation

Tsleil-Waututh First Nation (Tsleil-Waututh) has actively engaged in consultation with the Ministry since early 2014. Meetings for all phases of consultation are listed in the Aboriginal Consultation Reports.

The Ministry initiated consultation with Tsleil-Waututh Nation in early 2014. In support of consultation, the following Ministry-led activities have been undertaken with Tsleil-Waututh Nation during these phases:

- Meetings with Tsleil-Waututh Nation staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Tsleil-Waututh Nation Knowledge Study.

From the beginning of consultation, the Ministry worked with Tsleil-Waututh to develop a mutually acceptable consultation approach, including the manner in which Tsleil-Waututh was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry. Tsleil-Waututh provided the Ministry with the Tsleil-Waututh Stewardship Policy (2009) which outlines Tsleil-Waututh's expectations and requirements with respect to consultation.

Comments were received from Tsleil-Waututh on the draft Consultation Plan on November 16, 2015 via letter/email. The Ministry responded to Tsleil-Waututh's comments, explaining how input had been considered and discussed any outstanding concerns or questions. Based on feedback received to date and discussions with Tsleil-Waututh on this matter, the Ministry is of the understanding that Tsleil-Waututh has no outstanding concerns or comments with respect to the Plan.

During initial discussions with Tsleil-Waututh, and as outlined in the Consultation Plan and Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Tsleil-Waututh.

In addition to meetings with Tsleil-Waututh representatives during the Initial Consultation Phase, Tsleil-Waututh participated in a site visit which focused on key Project components, mutual sharing of information, plans for tunnel decommissioning, plans for Deas Slough and Deas Island, and anticipated works and enhancements opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, Tsleil-Waututh's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and identification of potential impacts on Tsleil-Waututh's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

During the Initial Consultation Phase, the Ministry sought Tsleil-Waututh's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Heritage Resources Overview Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

Letters sent to Tseil-Waututh during this consultation Phase include:

- Introductory letter notifying Tseil-Waututh of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment Letter requesting review and comment on the draft Archaeological Overview Assessment (document also provided).

The Ministry met with Tsleil-Waututh and walked through the Project Description and Key Areas of Study and Draft Application Information Requirements documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input Tsleil-Waututh comments on draft EA documents shared during this Phase. Tsleil-Waututh provided comments on the Draft Heritage Resources Overview Assessment (Letter/email October 27, 2014). The Ministry also received feedback from TWN on the draft Application Information Requirements and Project Description and Key Areas of Study documents. Additional information on TWN's comments is provided in Aboriginal Consultation Report 2.

Between early 2014 and May 2016, the Ministry and the Tsleil-Waututh discussed and exchanged Project-related information through emails, phone calls, letters and meetings.

At meetings with Tsleil-Waututh during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Tsleil-Waututh's past, present and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Tsleil-Waututh's Aboriginal Interests. The Ministry also sought to determine Tsleil-Waututh's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

During this period, key topics and/or presentations covered during meetings with TWN include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

During the Initial Consultation Phase, Tsleil-Waututh submitted the following documents to the Ministry:

- Letter/email (October 27, 2014) Comments on the Draft Archaeological Overview Assessment
- Email (December 04, 2014) TWN Stewardship Policy
- Letter/email (2014-12-05) Comments on Draft Project Description and Proposed Studies
- Letter/email (November 16, 2015) comments on draft Aboriginal Consultation Plan

The Ministry provided Tsleil-Waututh with funding for the submission of a Project-related study and received the "Tsleil-Waututh Knowledge Study for the George Massey Tunnel Project" during the Initial Consultation Phase.

During the Pre-Application Phase, the Ministry met twice with Tsleil-Waututh and conducted two conference calls in relation to Tsleil-Waututh's input on the draft Application Information Requirements. Tsleil-Waututh attended two EAO-led Working Group meetings and engaged directly with EAO with respect to the EA process.

During this phase, Tsleil-Waututh Nation was consulted on the following Project-related documents:

- Draft project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Components of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Tsleil-Waututh was also provided draft Consultation Report 2 for review and comment. Where appropriate, comments received on Report 2 have been incorporated into the revised document.

The following correspondence was shared via email and via mail/courier:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Documents/information shared by Tsleil-Waututh during this Phase include:

- Information related to suicide prevention concept (Email January 27, 2016)
- STIC Community Health Indicators (Email January 27, 2016)
- Smart Roadways Feasibility Study outlined (Email February 22, 2016)
- Comments on Draft Part C (Letter/email April 27, 2016)
- Comments on Aboriginal Consultation Plan #1 (Letter/email May 6, 2015)

Tsleil-Waututh provided comments on draft Aboriginal Consultation Report 1 and on draft Part C content. Revisions to these drafts were made based on input received from Tsleil-Waututh. Feedback on draft Consultation Report 1 is reflected in Consultation Report 2.

Consultation efforts to date sought to identify and address concerns and issues raised by Tsleil-Waututh raised by Tsleil-Waututh during the Initial Consultation and Pre-Application Phases (summarized in **Appendix 10-B Aboriginal Consultation Report 2**).

10.1.2.11 Planned Future Consultation

The Ministry will continue to work with Schedule B Aboriginal Groups during the Application Review Phase to further refine community-specific consultation activities and to coordinate the provision of Application Review Stage participation funding. Application Review Consultation activities for Schedule B Aboriginal Groups are described below. These activities are subject to

change and may be modified pending further planning with each Aboriginal Group. Proposed activities include:

- Notifying Aboriginal Groups of the submission of the Application.
- Providing copies of the Application to Aboriginal Groups (in preferred format).
- Conducting meetings with Chief and Council and/or staff to support their review of the Application (with participation of appropriate technical experts), address issues and concerns, refine mitigation measures, discuss Project-related benefits and opportunities (economic and non-economic), identify and plan follow up strategies, and ensure additional consultation and engagement requirements or commitments in relation to the Project's approval and construction are undertaken.
- Providing correspondence/communications related to, among other things, coordination of consultation activities, Project updates, resolution of concerns/issues, and identification of measures to avoid, mitigate or otherwise accommodate potential adverse effects on Aboriginal Interests.
- Delivering presentations to Chief and Council, or in the case of Tsawwassen First Nation, to Advisory Council, Executive Council or the Natural Resources Committee.
- Facilitating open houses or other special meetings (per request of Aboriginal Groups).
- Providing responses to Aboriginal Groups' comments and maintaining an issue/response tracking table that will be provided to EAO.
- Undertaking requirements as specified under the section 11 Order.

If an Environmental Assessment Certificate (EAC) is issued, then following the issuance of the EAC the Ministry will:

- Notify Schedule B Aboriginal Groups of the outcome of the Application Review, including requirements of the EAC and related commitments and assurances.
- Continue to consult with Schedule B Aboriginal Groups to fulfill obligations outlined in the EAC, including, but not limited to, review of construction-related plans and designs, and involvement in Project components of interest such as environmental enhancement and mitigation.
- Continue to ensure the fulfillment of commitments between the Ministry and specific Schedule B Aboriginal Groups.
- Actively explore, with Schedule B Aboriginal Groups, opportunities to provide economic and non-economic benefits to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training and contracting as well as environmental enhancement works and other components of the Project.
- Maintain ongoing communication and engagement with Schedule B Aboriginal Groups, including providing regular updates in relation to construction and Project milestones.

The Ministry will continue to document the following for future consultation phases:

- Consultation activities with Schedule B Aboriginal Groups.
- Opportunities provided to Schedule B Aboriginal Groups to identify Aboriginal Interests and concerns related to the Project.
- Information distributed to Schedule B and C Aboriginal Groups and consultation undertaken with Schedule B Aboriginal Groups.
- Issues and concerns raised during the Application Review and permitting stages, and the construction and operation phases and how these matters are to be addressed.

10.1.2.12 Key Issues and Concerns Raised by Aboriginal Groups

As noted in the individual summaries above, the Ministry received feedback from Schedule B Aboriginal Groups during the Project's Initial and Pre-Application Stage consultations. Consultation efforts to date sought to identify and address concerns and issues raised by Schedule B Aboriginal Groups. The concerns, issues and interests raised by Schedule B Aboriginal Groups during the Initial Consultation and Pre-Application Phases are included in the specific summaries for each Group.

10.1.2.13 Process for Resolving Outstanding Issues Raised by Aboriginal Groups

The Ministry acknowledges that some issues, concerns, or interests raised by Aboriginal Groups during the engagement and consultation process to date were not fully resolved prior to submission of the Application. During the Application Review stage the Ministry will give particular attention to addressing any concerns that remain outstanding through continued consultation with Aboriginal Groups as required (e.g., meetings with Chief and Council, information presentations, Working Group meetings).

After the issuance of the EAC, the Ministry will proceed with implementation of Project commitments and agreements with Aboriginal Groups where such agreements are undertaken. The Ministry will also work with regulatory authorities and Aboriginal Groups to obtain regulatory permits, and will monitor regulatory compliance throughout the Project's construction, operation, and tunnel decommissioning phases.

10.1.3 Aboriginal Interests Assessment

This section presents, for each Schedule B Aboriginal Group identified in **Section 10.1.1 Background Information**, the results of the assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, defined in the section 11 Order for the Project as asserted or determined Aboriginal rights, including title, or treaty rights. The results of the

assessment include the identification of potential Project-related interactions and effects and proposed mitigation measures, as well as whether residual effects are expected to persist following the implementation of mitigation.

10.1.3.1 Context and Boundaries

As indicated in **Section 10.1.1 Background Information**, Aboriginal Interests are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.

Aboriginal rights, including title, may be asserted by an Aboriginal group or determined through court proceedings.

As set out by the Supreme Court of Canada in *R. v. Van der Peet*, [1996] 2 S.C.R. 507, for an activity to be established as an Aboriginal right, it must be an element of a practice, custom, or tradition that is integral to the distinctive culture of the Aboriginal group claiming the right. This practice, custom, or tradition must also have continuity with the practices, customs and traditions that existed prior to European contact, the date of which varies across British Columbia. Examples of activities that have been found by the courts to ground Aboriginal rights in specific contexts include but are not limited to fishing, hunting, trapping, and gathering (e.g., *R. v. Sparrow*, [1990] 1 S.C.R. 1075, which confirmed Musqueam's right to fish for food, social, and ceremonial purposes in Canoe Pass and potentially in other areas, as referenced in **Section 10.1.1.7 Musqueam Indian Band**, and further discussed in **Section 10.1.3.2** below.

As set out by the Supreme Court of Canada in *Delgamuukw v. British Columbia*, [1997] 3 S.C.R. 1010, Aboriginal title is a specific form of Aboriginal right that pertains to the exclusive use and occupation of the land held pursuant to that title for a variety of purposes. These purposes need not be aspects of those Aboriginal practices, customs, or traditions that are integral to distinctive Aboriginal cultures; however, the land itself must have been of central significance to the distinctive culture of the Aboriginal group claiming title. To establish an Aboriginal title claim, the land in question must have been occupied by the Aboriginal group claiming title at the time the Crown asserted sovereignty over that land, which in British Columbia has been set by the courts at 1846. Occupation sufficient to ground Aboriginal title may apply to specific sites of settlement or to tracts of land that were regularly used for fishing, hunting, or otherwise utilizing resources, and over which the Aboriginal group was exercising effective control (i.e., exclusivity) at the time of the assertion of European sovereignty (*Tsilhqot'in Nation v. British Columbia*, 2014 SCC 44). To the Ministry's knowledge, there has been no declaration of Aboriginal title by a court with respect to lands in or near the Project area.

Treaty rights are established through formal agreements that have been negotiated between the Crown and Aboriginal groups. The only Treaty Nation named on Schedule B of the section 11 Order is the Tsawwassen First Nation. The Ministry is aware that the Project lies within and near areas subject to the Tsawwassen First Nation Final Agreement (TFN et al. 2009a,b), as referenced in **Section 10.1.1.10 Tsawwassen First Nation**, and further discussed in **Section 10.1.3.2** below.

The Crown is legally obligated to consult and, if necessary, accommodate adverse impacts to asserted or determined Aboriginal rights, including title, or treaty rights that may occur as a result of government decisions. Pursuant to the Supreme Court of Canada's decision in *Haida Nation v. British Columbia (Minister of Forests)*, 2004 SCC 73 (*Haida*), the extent or level of consultation owed by the Crown is proportionate to preliminary assessments of the following factors:

- Strength of the claim to the asserted Aboriginal right, including title, that may be adversely affected; and
- Seriousness of the potential adverse impact of the contemplated Crown action or activity to the Aboriginal Interest.

The extent or level of the Crown's obligation to consult is described in *Haida*, and in subsequent decisions regarding the duty to consult, as lying on a spectrum from notification to deep consultation. The section 11 Order for the Project identifies where on the spectrum the EAO has placed Aboriginal Groups at the outset of the environmental assessment (EA) process, as reflected in Schedule B and Schedule C of that Order. The Ministry, as the Proponent of the proposed Project, has been directed through the section 11 Order to identify potentially affected Aboriginal Interests, including all those raised by Aboriginal Groups, and to identify measures to avoid or mitigate the potential adverse effects and/or to otherwise address or accommodate the concerns of Aboriginal Groups, as appropriate. In an assessment report following the close of the Application Review period, the EAO will provide conclusions on the adequacy of measures proposed by the Ministry to avoid, reduce, or otherwise manage potential Project-related effects on the exercise of Aboriginal Interests based on the EAO's analysis of the strength of claim or, where applicable, determined rights of each Aboriginal Group and the predicted degree of Project-related effects on each Aboriginal Group's Aboriginal Interests. Where effects on determined rights (proven Aboriginal rights or treaty rights) are predicted, the EAO will undertake a justification analysis regarding potential infringement of the exercise of those determined rights. The EAO will also provide Aboriginal Groups with an opportunity to review the EAO's assessment report prior to finalization, and to make separate submissions to the Minister in addition to that assessment report.

Pursuant to Section 14.1 of the section 11 Order for the Project, the Ministry sought input from each Schedule B Aboriginal Group on the nature and scope of their Aboriginal Interests and how they might be impacted by the Project, including through Ministry-funded traditional use and knowledge studies specific to the Project (see **Section 10.1.2 Consultation Activities**). The analysis of potential Project-related impacts to the exercise of Aboriginal Interests in this section of the Application is grounded in relevant information that was provided by Schedule B Aboriginal Groups, or that was otherwise publicly available, regarding their past, present, and desired future uses of the Project area and surroundings for traditional purposes or pursuant to treaty, as summarized below for each Aboriginal Group in **Section 10.1.3.2**. “Traditional use” is used in this assessment to denote past, present, or future use activities that have been identified by Schedule B Aboriginal Groups as ancestral and passed down from generation to generation since before contact with Europeans, and includes cultural knowledge related to those activities. The information available to the Ministry on traditional use has been organized within **Section 10.1.3.2** according to activities that are either protected by treaty or have been previously found by courts to ground asserted Aboriginal rights and title (i.e., fishing, hunting/trapping, gathering), as well as related interests, such as language and culture (e.g., as represented by named places), cultural sites (e.g., habitation sites, sacred or spiritual areas, transportation routes), and cultural landscapes. For a description of the approach to integrating traditional knowledge into Part B assessments, refer to **Section 3.0 Assessment Methodology**.

The identification and analysis of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation forms the basis of the Aboriginal Interests assessment. In evaluating these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application, including identified mitigation measures, residual effects, cumulative effects and follow up strategies, were considered based on the relevance of these VCs to the exercise of Aboriginal Interests:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in relation to potential effect pathways on the exercise of Aboriginal Interests that may not involve pathways through VCs:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented below in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA will be publicly available on the Project's website at www.masseytunnel.ca and a summary of the key findings is provided in Section 7.2 Health Impact Assessment.

Indicators

The indicator(s) chosen for the assessment of potential Project-related effects on the exercise of Aboriginal Interests and the rationale for their selection are presented in **Table 10.1-4**.

Table 10.1-4 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Assessment Boundaries

Spatial Boundaries

Spatial boundaries for the assessment of potential Project-related effects on the exercise of Aboriginal Interests are defined in **Table 10.1-5**, followed by the rationale for their definition.

Table 10.1-5 Spatial Boundary Definitions for Aboriginal Interests

| Spatial Boundary | Description of Assessment Area |
|---------------------------------------|--|
| Local Assessment Area (LAA) | The LAA corresponds to each Schedule B Aboriginal Group’s traditional territory ⁵ or otherwise defined area(s) of traditional use (as provided by the Aboriginal Group to the Ministry). The assessment for the exercise of Aboriginal Interests that are related to ICs or VCs will focus on the exercise of Aboriginal Interests in areas that overlap the LAAs for those ICs and VCs; however, the territory or otherwise defined area(s) of traditional use remains the buffer for the assessment of potential Project effects on the exercise of Aboriginal Interests. |
| Regional Assessment Area (RAA) | Same as LAA. |

The LAA was established to encompass the area within which the Project may interact directly or indirectly with, and therefore potentially have an effect on, the exercise of Aboriginal Interests. In defining LAA boundaries for the Aboriginal Interests assessment, consideration was given to the specific nature and characteristics of Aboriginal Interests, which are understood to be exercised in relation to specific locations and resources based on traditional patterns of use, recognizing that these patterns have changed over time due to a number and range of factors. See **Figure 10-2** through **Figure 10-10** for boundaries of traditional territories or otherwise defined area(s) of traditional use that each serve as the LAA for the identified Schedule B Aboriginal Group. These figures were provided by the Ministry to Schedule B Aboriginal Groups for review and comment prior to the submission of the Application.

The RAA is the same as the LAA.

Temporal Boundaries

The temporal boundaries established for the assessment of potential Project effects on the exercise of Aboriginal Interests encompass the Project’s construction and operation phases, as described in **Section 1.1 Description of Proposed Project**. The Project construction phase (commencing 2017) includes, in addition to building of the new bridge and improvements at specific points along the Highway 99 corridor, decommissioning of the Tunnel and bridge over Deas Slough (after the commissioning of the new bridge). The Project operation phase (including maintenance) will be ongoing over the service life of the new bridge, which, once

⁵ References to “traditional territory” in this Application are to the asserted traditional territory of the Aboriginal Group, except where defined by treaty.

commissioned (2022), will be a permanent component of the regional and provincial transportation system, with no plans for decommissioning. Potential Project effects on the exercise of Aboriginal Interests during a decommissioning phase are therefore not considered in the assessment.

Temporal characteristics specific to Aboriginal Interests are considered in **Section 10.1.3.2 Existing Conditions** and **Section 10.1.3.3 Potential Effects**.

Administrative Boundaries

The assessment of Aboriginal Interests is constrained by the administrative limitations identified for the IC and VC assessments linked to the Aboriginal Interests assessment (see list of relevant IC and VC chapters above).

Technical Boundaries

The assessment of Aboriginal Interests is constrained by the technical limitations identified for the IC and VC assessments linked to the Aboriginal Interests assessment (see list of relevant IC and VC chapters above), as well as the data collection and reporting methodologies employed in existing information sources and Project-specific studies on traditional use and knowledge used to support the Aboriginal Interests assessment, as identified in the following section (Information Sources).

Information Sources

Information sources used to identify the exercise of Aboriginal Interests in relation to the proposed Project area, and assess potential adverse effects of the proposed Project on identified Aboriginal Interests, include:

- The description of the proposed Project and other Project-related information;
- Project-specific studies on traditional use and knowledge prepared by Schedule B Aboriginal Groups:
 - Cowichan Nation Alliance:
 - Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 2015
 - George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 2015

- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 2010

Hwlitsum, Hwlitsum First Nation Traditional Use and Occupation of the area now known as British Columbia, January 28, 2016

Katzie First Nation, George Massey Tunnel Replacement: Katzie First Nation Traditional Use Study, February 2016

Kwantlen First Nation, Kwantlen Land-Use and Occupation in the Vicinity of Highway 99, November 2015

Lake Cowichan First Nation, Ts'uubassatx Interests, November 2015

Lyackson First Nation, Preliminary Lyackson Use and Occupancy Mapping Study for BC MOTI's George Massey Tunnel Replacement Project, September 2015

Musqueam Indian Band, "Salmon so thick, that you could walk on water": Preliminary Scope of Musqueam Valued Components for the Environmental Impact Assessment of the Proposed George Massey Tunnel Replacement Project, November 2015

Tsawwassen First Nation, George Massey Tunnel Replacement: Project Impact Study, August 2015

Tsleil-Waututh Nation, Knowledge Study: George Massey Tunnel Project. February 2015

- Other traditional use and knowledge information provided by Schedule B Aboriginal Groups to the Ministry in the context of the Project (e.g., [Cowichan Land Use] Richmond, near No. 7 Rd., September 2014, submitted by Penelakut Tribe to the Ministry; A Cultural Impact Assessment of the Gateway Program, April 2007, submitted by Katzie First Nation to the Ministry)
- Publicly available and relevant traditional use and knowledge studies or ethno-historical or anthropological material pertaining to the area;
- Regulatory applications and reports, including submissions made by Schedule B Aboriginal Groups, for other nearby projects (e.g., Vancouver Airport Fuel Delivery Project, South Fraser Perimeter Road Project, and Roberts Bank Terminal 2 Project);
- Tsawwassen First Nation Final Agreement (TFNFA) and related documents;
- Relevant court decisions (e.g., *R. v. Sparrow*);
- Publicly available and relevant resource agreements between Schedule B Aboriginal Groups and government;
- Aboriginal communal licence information for Fisheries and Oceans (DFO) Pacific Fisheries Management Areas (PFMAs) overlapping the Project area;
- Schedule B Aboriginal Group websites;

- Records of consultation between the Ministry and Schedule B Aboriginal Groups in relation to the proposed Project; and
- Findings of relevant IC and VC chapters in Part B of the Application (as identified in the list above).

10.1.3.2 Existing Conditions

This section summarizes, for each Schedule B Aboriginal Group and based on the sources identified above in **Section 10.1.3.1** (Information Sources), relevant information on past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Aboriginal Interests.⁶

As indicated in **Section 10.1.3.1**, the information on traditional use within each Aboriginal Group's subsection has been organized according to activities that are either protected by treaty or have been previously found by courts to ground asserted Aboriginal rights and title (i.e., fishing, hunting/trapping, gathering), followed by a discussion of related interests, such as language and culture (e.g., as represented by named places), cultural sites (e.g., habitation sites, sacred and spiritual areas, transportation routes), and cultural landscapes. Traditional use is understood to be by definition ancestral, given that it is passed down from generation to generation since before contact with Europeans. Because of this characteristic, the precise time horizon of use (e.g., historical, within living memory, recent past, or still occurring) described in the following summaries of "existing" conditions may be difficult to discern. Further, some Aboriginal Groups have advised that where traditional use currently occurs (or is absent), such use may not be reflective of desired future use or where Aboriginal Interests exist or may be exercised in the future (including treaty rights). Aboriginal Groups have also indicated that an absence of use of certain locations or resources in the following descriptions of existing conditions does not necessarily reflect the absence of actual use by individual community members, which is often not known in any detail by Aboriginal Group representatives. For a detailed review of concerns raised by Aboriginal Groups in consultation with the Ministry regarding the proposed Project, see **Section 10.1.2 Consultation Activities**.

⁶ Any statements in this Application regarding traditional use are based on information provided by Aboriginal groups in the context of consultation on the Project, or as available in publicly available sources, and do not constitute admissions, acknowledgments or endorsements of the claims, positions, or accuracy of the information by the Province of British Columbia.

Cowichan Tribes

Key sources relied upon for this summary are the George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands (BKRC 2015); Historical Geography of Cowichan Land Use and Occupancy, Lower Fraser River: Map Series and Report (Brealey 2010); Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area (CT 2015); a map showing “Cowichan Land Use” in the Project area, provided by Penelakut Tribe (PT 2014); regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Cowichan Tribes. As part of that ongoing consultation, the Cowichan Tribes was provided with a draft of this summary and the information that appears in **Section 10.1.1.1** for review and comment. Comments were received from the Cowichan Nation Alliance, on behalf of the four member First Nations, and have been incorporated. In this summary, specific information on Cowichan Tribe’s traditional use has been supplemented with general information on traditional use by Cowichan Nation Alliance and Hul’qumi’num Treaty Group Nation Alliance member First Nations.

The Project area intersects with the claimed core territory or “title lands” of the member First Nations of the Hul’qumi’num Treaty Group, including *Tl’uq̓tinus* (**Appendix 10-A, Figure 10-2**), which lies along the Fraser River less than 4 km upstream from the north end of the George Massey Tunnel (BKRC 2015). *Tl’uq̓tinus* has been described as a “great summer village of the Cowichan-speaking people of Vancouver Island” (Suttles 2004), with “winter-village style houses” (Rozen 1985) surrounded by cultivated grounds (see **Plate 1** below). More recently, *Tl’uq̓tinus* has been described as a permanently occupied, multi-seasonal Cowichan Nation settlement (Brealey 2010), with a significant winter population and a summer population in the thousands (BKRC 2015). The lands over which *Tl’uq̓tinus* is said to have extended along the south shore of Lulu Island have been reported as “conservatively located on portions of Sections 21, 22, 23, 24, 26, 27, 28, 33, and 34 of Block 4 North, Range 5 West, as well as a waterfront portion of Block 4 North, Range 4 West” (Woodward and Company 2011).

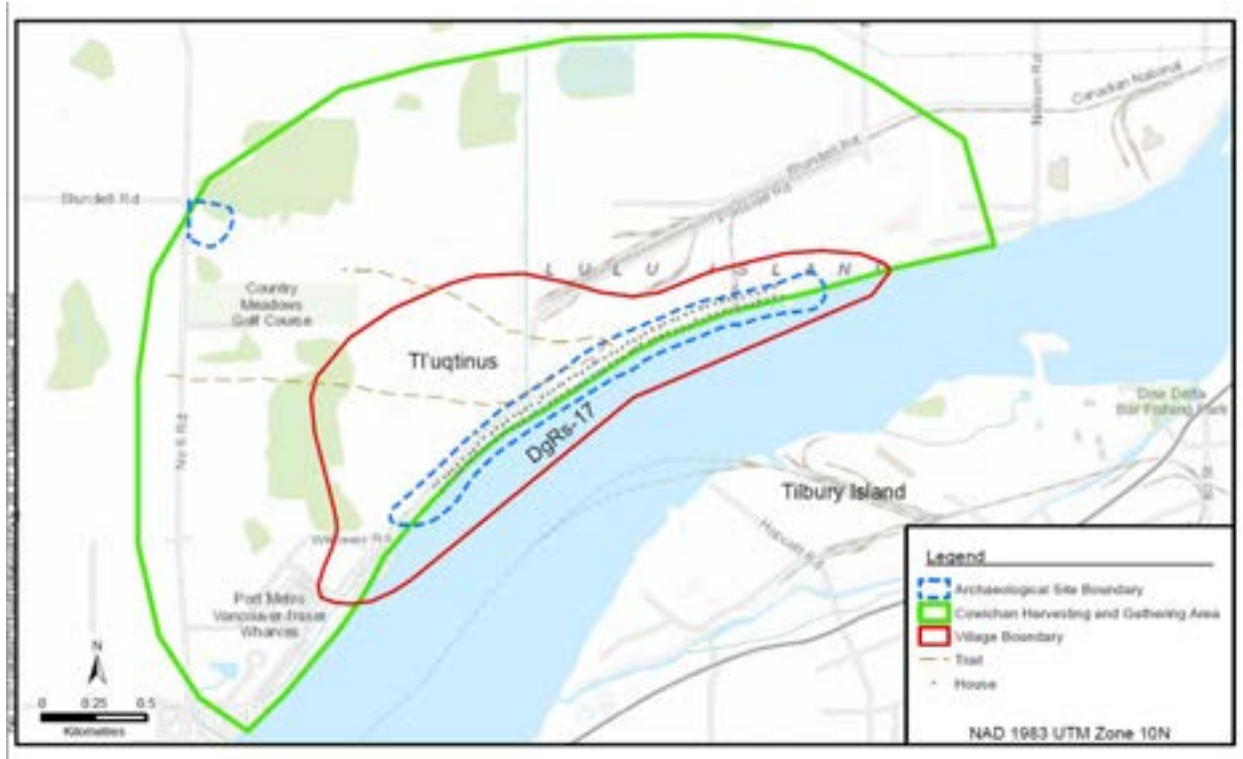


Plate 1. Lands of *Tl'uq̓tinus* Claim Area (CNA 2016a).⁷

The Cowichan Nation Alliance has stated that *Tl'uq̓tinus* was a home base occupied and used exclusively by the Cowichan Nation, the descendants of which are members of the First Nations represented by the Cowichan Nation Alliance (CT 2015), as well as other member bands affiliated with the Hul'qumi'num Treaty Group (BC and PMV 2012, CT 2015, Woodward and Company 2011). This shared or joint occupation and use reportedly extended from well before 1792 until after 1859 (Woodward and Company 2011), and constituted a base of operations for a shared land use regime that reached up the Fraser River at least as far as the fisheries at the Fraser Canyon (Brealey 2010). As indicated in **Section 10.1.1.1**, the Cowichan Nation Alliance is working to reestablish a permanent land base and river access at *Tl'uq̓tinus* for residential and/or commercial purposes (CNA 2016a,b).

⁷ This figure is a representation of information provided by the Cowichan Nation Alliance regarding *Tl'uq̓tinus* (2016a) in the context of consultation on the Project and does not constitute an admission, acknowledgment, or endorsement of that claim, position, or the accuracy of the information by the Ministry.

Fishing

Cowichan Tribes followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round (BC and PMV 2012, CT 2015, HTG 2005, Rozen 1985). Seasonal movements reportedly involved the relocation of entire households, including house planks and supplies, from location to location within the collective traditional territory, between three and five times annually. Within this round, the Fraser River estuary has been described as the “most important economically” (HTG 2005). Species harvested historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals; dried clams and other foodstuffs (e.g., camas) were also traded to other First Nations while *Hul’q’umi’num’*-speaking groups were resident in and around the area (BC and PMV 2012, BKRC 2015). The Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while resident on the Fraser River (CNA 2011). Cowichan Tribes used *Tl’uq’tinus* seasonally for the foregoing purposes (TMPL 2014). (BC and PMV 2012, TMPL 2014).

Areas within the wider Fraser River estuary were also utilized by *Hul’q’umi’num’*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay) (HTG 2005). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations within their trans-Georgia Strait settlement round. Sockeye salmon and eulachon in particular could not be found in any river within Cowichan Nation’s territory on Vancouver Island (CT 2015).

The *Hul’q’umi’num* Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul’q’umi’num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area (HTG 2005). The *Hul’q’umi’num* Treaty Group have also reported that government regulations introduced in the same era also had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul’q’umi’num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century (CT 2015, HTG 2005, TMPL 2014).

Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO) (Cohen Commission 2011). Access to sockeye for member First Nations (including other members of the Hul'qumi'num Treaty Group) is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River” (Cohen Commission 2011). In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008 (DFO 2016). In those years, the specific locations in the South Arm in which member First Nations of the Hul'qumi'num Treaty Group (i.e., Cowichan Tribes) fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area) (DFO 2016). DFO records for communal FSC licences in the Fraser River downstream of the Port Mann Bridge do not suggest that any of these groups, individually or collectively, has had access to fisheries in this area in the last eight years (DFO 2016). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River (CNA 2016a).

Hunting / Trapping

Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species (CNA 2011). Along the Fraser River, including Canoe Pass, as well as elsewhere in their collective territory, brant goose, canvasback duck, common merganser, and mallard have been specifically identified as harvested species by Cowichan Tribes, and that this harvesting would have taken place in the fall (BKRC 2015, TMPL 2014). Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round (BKRC 2015).

The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm (BKRC 2015, CT 2015). Cowichan Tribes may also have hunted for mountain goat in the mountains of the lower Fraser River (BKRC 2015). The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area (CNA 2011, CT 2015).

The Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted (CNA 2011).

Gathering

Member bands of the Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested (PMV 2015, PT 2014). Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed (BC and PMV 2012, BKRC 2015, CT 2015, HTG 2005, PT 2014, TMPL 2014, Woodward and Company 2011). With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees” (North et al. 1979; Woodward and Company 2011).

The Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl'uqtinus*, which is currently surrounded by blueberry farms, the Cowichan Nation Alliance have raised the potential for their former berry grounds to be re-established (Woodward and Company 2011).

Tree species available in the vicinity of the Fraser River and traditionally used by the Cowichan Tribes for manufacturing include crabapple, willow, alder, cottonwood, cedar, spruce, aspen, yew, hemlock, and vine maple (BKRC 2015).

Related Interests

The Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl'uqtinus*, and given where *Tl'uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. The Cowichan Nation Alliance has advised that it is also working to reestablish culturally integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl'uqtinus* (CNA 2016a).

The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members (PMV 2015).

Halalt First Nation

Key sources relied upon for this summary are the George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands (BKRC 2015); Historical Geography of Cowichan Land Use and Occupancy, Lower Fraser River: Map Series and Report (Brealey 2010); Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area (CT 2015); a map showing “Cowichan Land Use” in the Project area, provided by Penelakut Tribe (PT 2014); regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Halalt First Nation. As part of that ongoing consultation, Halalt First Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.1** for review and comment. Comments were received from the Cowichan Nation Alliance, on behalf of the four member First Nations, and have been incorporated. In this summary, specific information on Halalt’s traditional use has been supplemented with general information on traditional use by Cowichan Nation Alliance and Hul’qumi’num Treaty Group Nation Alliance member First Nations.

The Project area intersects with the claimed core territory or “title lands” of the member First Nations of the Hul’qumi’num Treaty Group, including *Tl’uqtinus* (**Appendix 10-A, Figure 10-2**), which lies along the Fraser River less than 4 km upstream from the north end of the George Massey Tunnel (BKRC 2015). *Tl’uqtinus* has been described as a “great summer village of the Cowichan-speaking people of Vancouver Island” (Suttles 2004), with “winter-village style houses” (Rozen 1985) surrounded by cultivated grounds (see **Plate 1** below). More recently, *Tl’uqtinus* has been described as a permanently occupied, multi-seasonal Cowichan Nation settlement (Brealey 2010), with a significant winter population and a summer population in the thousands (BKRC 2015). The lands over which *Tl’uqtinus* is said to have extended along the south shore of Lulu Island have been reported as “conservatively located on portions of Sections 21, 22, 23, 24, 26, 27, 28, 33, and 34 of Block 4 North, Range 5 West, as well as a waterfront portion of Block 4 North, Range 4 West” (Woodward and Company 2011).

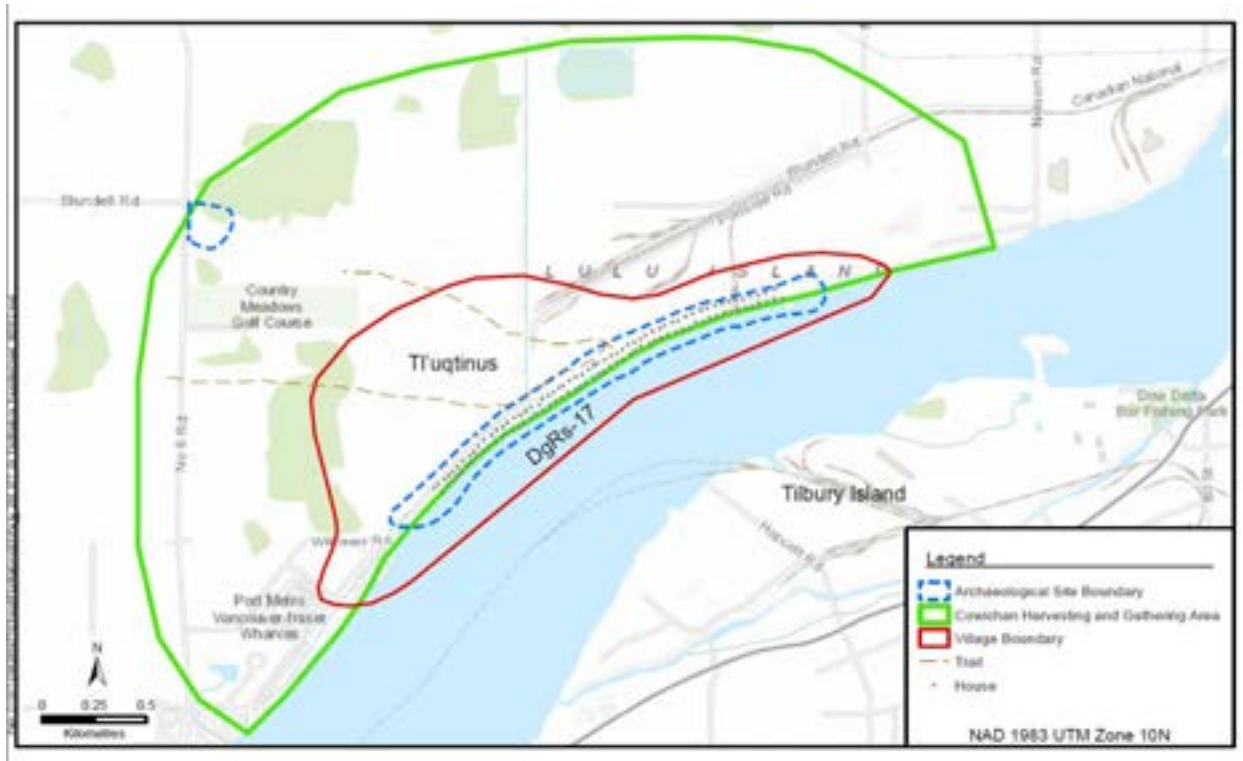


Plate 1. Lands of *Tl'uq̓tinus* Claim Area (CNA 2016a).⁸

The Cowichan Nation Alliance has stated that *Tl'uq̓tinus* was a home base occupied and used exclusively by the Cowichan Nation, the descendants of which are members of the First Nations represented by the Cowichan Nation Alliance (CT 2015), as well as other member bands affiliated with the Hul'qumi'num Treaty Group (BC and PMV 2012, CT 2015, Woodward and Company 2011). This shared or joint occupation and use reportedly extended from well before 1792 until after 1859 (Woodward and Company 2011), and constituted a base of operations for a shared land use regime that reached up the Fraser River at least as far as the fisheries at the Fraser Canyon (Brealey 2010). As indicated in **Section 10.1.1.1**, the Cowichan Nation Alliance is working to reestablish a permanent land base and river access at *Tl'uq̓tinus* for residential and/or commercial purposes (CNA 2016a,b).

⁸ This figure is a representation of information provided by the Cowichan Nation Alliance regarding *Tl'uq̓tinus* (2016a) in the context of consultation on the Project and does not constitute an admission, acknowledgment, or endorsement of that claim, position, or the accuracy of the information by the Ministry.

Fishing

Halalt followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round (BC and PMV 2012, CT 2015, HTG 2005, Rozen 1985). Seasonal movements reportedly involved the relocation of entire households, including house planks and supplies, from location to location within the collective traditional territory, between three and five times annually. Within this round, the Fraser River estuary has been described as the “most important economically” (HTG 2005). Species harvested historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals; dried clams and other foodstuffs (e.g., camas) were also traded to other First Nations while *Hul’q’umi’num*-speaking groups were resident in and around the area (BC and PMV 2012, BKRC 2015). The Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while resident on the Fraser River (CNA 2011). Halalt used *Tl’uq̓tinus* seasonally for the foregoing purposes; Halalt have reported that they used the area specifically in July to fish for sockeye and pink salmon, from Canoe Pass to as far up as Hope, with other member nations of the Cowichan Nation Alliance (TMPL 2014).

Areas within the wider Fraser River estuary were also utilized by *Hul’q’umi’num*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay) (HTG 2005). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations within their trans-Georgia Strait settlement round. Sockeye salmon and eulachon in particular could not be found in any river within Cowichan Nation’s territory on Vancouver Island (CT 2015).

The *Hul’q’umi’num* Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul’q’umi’num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area (HTG 2005). The *Hul’q’umi’num* Treaty Group have also reported that government regulations introduced in the same era also had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul’q’umi’num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century (CT 2015, HTG 2005, TMPL 2014).

Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO) (Cohen Commission 2011). Access to sockeye for member First Nations (including other members of the Hul'qumi'num Treaty Group) is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River” (Cohen Commission 2011). In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008 (DFO 2016). In those years, the specific locations in the South Arm in which member First Nations of the Hul'qumi'num Treaty Group fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area) (DFO 2016). DFO records for communal FSC licences in the Fraser River downstream of the Port Mann Bridge do not suggest that any of these groups, individually or collectively, has had access to fisheries in this area in the last eight years (DFO 2016). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River (CNA 2016a).

Halalt participates in the Hul'qumi'num Fisheries Limited Partnership (HFLP), a commercial fishing business, with Penelakut Tribe and Stz'uminus First Nation. Species harvested through this enterprise are crab (one Area H licence), prawn (two local / coast wide licences), halibut (one licence and annual TAC quota), herring (13 gillnet and 1 seine), rockfish (two Area Inside licences, targeting yelloweye, quillback, copper, china, and tiger), sablefish (annual TAC quota), and salmon (five Area E gillnet licences) (HFLP 2014). Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island (PMV 2015, LFN 2016).

Hunting / Trapping

Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species (CNA 2011). Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round (BKRC 2015).

The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm (BKRC 2015, CT 2015). The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area (CNA 2011, CT 2015).

The Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted (CNA 2011).

Gathering

Member bands of the Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested (PMV 2015, PT 2014). Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed (BC and PMV 2012, BKRC 2015, CT 2015, HTG 2005, PT 2014, TMPL 2014, Woodward and Company 2011). With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees” (North et al. 1979; Woodward and Company 2011).

The Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl'uqtinus*, which is currently surrounded by blueberry farms, the Cowichan Nation Alliance have raised the potential for their former berry grounds to be re-established (Woodward and Company 2011).

Related Interests

The Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl'uqtinus*, and given where *Tl'uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. The Cowichan Nation Alliance has advised that it is also working to reestablish culturally integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl'uqtinus* (CNA 2016a).

The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members (PMV 2015).

Katzie First Nation

Key sources relied upon for this summary include George Massey Tunnel Replacement: Katzie First Nation Traditional Use Study (Katzie First Nation 2016a), A Cultural Impact Assessment of the Gateway Program (Katzie First Nation 2007), regulatory documents for other projects in close proximity to the Project area (e.g., MOT 2006), and ongoing consultation between the Ministry and Katzie First Nation. As part of that ongoing consultation, Katzie First Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.3** for review and comment. Katzie First Nation advised the Ministry that they required no changes.

Katzie First Nation has reported that their territory (**Appendix 10-A, Figure 10-4**) historically provided them ready access to freshwater and saltwater resources (i.e., five species of Pacific salmon, sturgeon, steelhead, trout, and eulachon), a wide variety of mammals and birds (e.g., elk, deer, mountain goat), and a plentiful supply of plant species, including but not limited to wapato (Katzie First Nation 2016a).

The ancestors of the Katzie First Nation are said to have once lived in at least ten villages throughout Katzie First Nation territory, eventually congregating at the village of *q'ə 'ye 'əy* (from which the anglicized “Katzie” derives), about 2 km downstream of Port Hammond (Katzie First Nation 2016a). This village, located 40 km from the mouth of the Fraser River, reportedly features heavily in Katzie oral history (Katzie First Nation 2016a). In addition to this village site (now Katzie 1), the only other Katzie village sites still permanently occupied are those at Barnston Island 3 and Katzie 2 (at the mouth of Yorkson Creek) in Langley (Katzie First Nation 2002, 2016a). The tributaries of Yorkson Creek are described as “within portage distance of the larger Nicomekl River,” which along with the Serpentine River, was a travel and trade corridor, connecting Katzie to Boundary Bay and the “salt-water people” who resided there (i.e., Semiahmoo), as well as downstream of Katzie on the Fraser River (i.e., Musqueam, Tsawwassen) (Katzie First Nation 2016a).

Katzie have stated that the Fraser River and other waterways within the Fraser River estuary, including the Nicomekl and Serpentine rivers, served as the focal point for harvesting fish, wildlife, and plant resources (Katzie First Nation 2007, 2016a, PMV 2012). They also served to strengthen important socio-economic (i.e., kinship and resource) ties between Katzie and

neighbouring groups on the outer coast, and Katzie have said that these ties remain a vital component of Katzie identity (Katzie First Nation 2016a). Katzie have also said, however, that twentieth-century dyking and dredging programs and agricultural development, widening some parts of the Fraser River and draining wetlands, have changed the waterways that facilitated these ties (Katzie First Nation 2016a).

Fishing

Katzie are said to have had access to freshwater clams from Pitt Lake, and marine invertebrate species have been found in archaeological deposits at Port Hammond (e.g., clams, mussels, cockles, whelks). Some reports suggest that marine resources would have been brought to Katzie by their relatives living on the outer coast, and that Katzie themselves did not harvest them directly; however, other reports suggest that Katzie may have obtained these resources while visiting their relatives, trading wapato and other goods in exchange for shellfish, or to trade for opportunities to harvest at certain shellfish beaches, such as Mud Bay, in the northeastern portion of Boundary Bay, at mouths of the Nicomekl and Serpentine rivers (Katzie First Nation 2016a).

The area between Barnston Island and the south bank of the Fraser River has been identified as an important fishing site for Katzie. Beginning in late April through to end of May, Katzie would gather at the village on the north bank of the Fraser River to harvest eulachon in Bishop's Reach, approximately 1 km downstream of the Golden Ears Bridge (BC and PMV 2012, Katzie First Nation 2016a). As the Fraser River began to flood during the spring rise, Katzie would then travel to their various sturgeon-fishing grounds on the Alouette River, Sturgeon Slough, Pitt Polder, Pitt River, and Pitt Lake. In August Katzie would return to the Fraser River for sockeye, leaving again in September in smaller groups to multiple locations to fish for dog salmon. Over the fall, fishing would continue, particularly for sturgeon, and picked up again in March, when families departed winter residences. At this time of year, sturgeon were reportedly abundant in the shallower sloughs of the territory, such as Sturgeon Slough, which Katzie say "was renowned as a famous sturgeon spawning ground" (Katzie First Nation 2016a).

Katzie First Nation has previously reported that, from the 1940s through the 1980s, many Katzie were involved in the commercial fishery, with some running their own boats (Katzie First Nation 2007). As recently as 2014, Katzie and other Lower Fraser First Nations, participated in an economic opportunity fishery for sockeye, of which Katzie are said to have had a share of 10,000 sockeye that could be sold (Melnychuk 2014). Sockeye, described as the Katzie's most valued resource, is referred to as an "elder brother," believed to take human form during the oceanic portion of their lifecycle, but returning as fish to swim upriver (Suttles 1955, Osborne 2010).

Currently, Katzie are among the numerous First Nations involved in the Lower Fraser River salmon fishery under food, social and ceremonial (FSC) licences issued by Fisheries and Oceans Canada (DFO). Of the 570 registered members of Katzie First Nation, roughly one third of those members is reportedly licenced to fish during openings on the Fraser River, and an estimated 120 Katzie vessels use the Fraser River to harvest fish annually, with 50 to 70 Katzie vessels on the water at once during the largest openings (Melnychuk 2014, MOT 2006).

Katzie are typically licenced to fish for FSC purposes in the stretch of Fraser River between the Port Mann Bridge to the Mission portion of the Lower Fraser, using both drift and set nets; however, DFO records from 2004 onward indicate that Katzie are also often licenced to fish within a smaller subsection of this area – that is, Port Mann Bridge to Kanaka Creek/Derby Reach. Katzie have previously reported that their fishing area, which is in the vicinity of their communities, is renowned as one of the best, most productive areas to fish in the lower Fraser River between Hope and the estuary (MOT 2016). Since 2004, Katzie appear to have been licenced to fish in this area for Chinook, sockeye, and chum salmon, steelhead, and eulachon, as well as for chum salmon specifically in the Pitt River, although the targeted species, timing, and frequency have varied year over year. Katzie has also accessed Fraser River FSC fisheries as part of the Lower Fraser River First Nations (DFO 2016).

In 2015, Katzie had opportunities to harvest salmon from the Fraser River under communal license, accessing Chinook on three 12-hour occasions (September 5, 6, and 7), between Port Mann Bridge and Mission. Katzie also had three limited participation (i.e., ceremonial) licences in 2015, accessing Chinook on September 3 (for 12 hours) and chum on November 8 and 15 (for eight hours each day), between Port Mann Bridge and Kanaka Creek/Derby Reach. Also harvested in 2015 under limited participation licences was eulachon on two occasions, April 4 and 8 (for 6 hours each day), also between Port Mann Bridge and Kanaka Creek/Derby Reach. In 2015, other fishing opportunities for Katzie would have been provided through licences to the Lower Fraser River First Nations (DFO 2016).

Hunting /Trapping

Deer, elk, mountain goat, and black bear, some smaller fur-bearing animals (e.g., beaver, marten, mink, raccoon), seals have been identified by Katzie as hunted in the past, with game targeted in the early to mid-summer months, then again in October through winter (Katzie First Nation 2016a). Katzie also harvested waterfowl, which they say was plentiful on the shores of Pitt River and Pitt Lake, particularly on the marshy flats east of Pitt River and around Silver (Widgeon) Creek (Katzie First Nation 2016a, Suttles 1955).

Katzie have identified hunting as second only to fishing in importance to their subsistence and ceremonial lives (Katzie First Nation 2007); however, Katzie have also said that they now have limited areas over which they can still hunt and discharge firearms given land development in their territory. For example, Katzie have said that while they still harvest waterfowl on Barnston Island, they currently hunt only on the north and east aspects of the island, having voluntarily stopped the practice on the south side to limit public concerns (MOT 2006).

Gathering

Summer harvest of roots and berries were important for the provision of nutritional and cultural sustenance for Katzie (Usborne 2010), though harvesting of plants was not restricted to the summer months, often also occurring in fall (Katzie First Nation 2016a). Seasonally flooded lands in Katzie territory provided them with an abundance of bogs and marsh plants; two of the most important were the cranberry, which became ripe in September, and wapato, an aquatic, potato-like root plant that grows in shallow sloughs and ponds (Katzie First Nation 2007). Cranberry harvesting areas included the mouth of the Alouette River, around Sturgeon Slough, and at Widgeon Creek; some cranberry bogs were said to be shared by all Katzie while others belonged exclusively to particular families (Katzie First Nation 2016a, Suttles 1955). Wapato was reportedly harvested in October and November on the flats north of Sturgeon Slough and around Siwash Island on the west bank of Pitt River (Suttles 1955). The wapato patches in Katzie territory have been described as “famous among First Nations,” where once a number of other groups would have visited Katzie in the fall to gather them (Katzie First Nation 2016a). Other plants identified as traditionally harvested by Katzie include, but are not limited to, bog blueberries, strawberries, salmonberries, blackberries, blackcaps, thimbleberries, red and blue huckleberries, Saskatoons, salal-berries, the fruit of the crab-apple, oso plum, and black haw (Suttles 1955). Katzie have reported that they also gathered cedar bark for use in manufacturing clothes and other household items (Katzie First Nation 2016a).

Related Interests

Katzie have said that their identity and territory are inseparable, and have described that relationship in the following way (Katzie First Nation 2016a):

To travel through the territory that Katzie call home is to encounter a landscape imbued with meaning. It is this landscape that anchors and informs a distinct Katzie identity, but also ties Katzie to a wider community of kin who share common ancestry and similar relationships to cultural landscapes informed by their own distinctive sense of place.

Katzie have also described this landscape to which they are attached as sacred, and the role of harvesting resources within this territory as an important means of strengthening family relations and transmitting knowledge and values to new generations. Katzie have remarked that, as access to their territory declines, each opportunity to continue practicing traditional activities becomes even more significant (Katzie First Nation 2007). Katzie have previously said that this practice of traditional use, including use and activity areas, spiritual and ceremonial sites, named locations, and cultural landmarks, are all considered to be, in addition to archaeological sites, part of Katzie cultural heritage (MOT 2006).

Kwantlen First Nation

Key sources relied upon for this summary include, but are not limited to, *Kwantlen Land-Use and Occupation in the Vicinity of Highway 99* (Kwantlen First Nation 2015), regulatory documents for other projects in close proximity to the Project area (i.e., MOT 2007), and ongoing consultation between the Ministry and Kwantlen First Nation. As part of that ongoing consultation, the Kwantlen First Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.4** for review and comment. Comments were received from the Kwantlen First Nation and have been incorporated.

As indicated in **Section 10.1.1.4**, Kwantlen First Nation has recently provided a map of their territory that indicates that its southwestern extent takes in Deas Island and all of Lulu Island, as well as portions of the Project area south of the Fraser River (Kwantlen First Nation 2015). Kwantlen reports that the westward reach of their territory extends, on the North Arm of the Fraser River, to a small creek above Marpole (*kəxənmit* and other variations), and on the South Arm of the Fraser River, “to a small slough (Deas Slough) a few hundred yards above Ladner.” Kwantlen also reports that these descriptions of Kwantlen territory are reflected in ethnographic sources. They further say that documents pertaining to the arrival of Simon Fraser in Kwantlen territory in 1808 demonstrate Kwantlen control of these areas, as well as further upstream, where they were occupying, at that time, a village in present day New Westminster and a summer camp and fishing station at *q’əq’yət*, across the Fraser River from New Westminster, at Brownsville (Surrey) (Kwantlen First Nation 2015). Later in the nineteenth century, Kwantlen had a reserve set aside for them at *q’əq’yət*, adjacent to a now former Musqueam reserve (Crockford 2010), but Kwantlen have said that, by then, they had moved from their primary village at New Westminster to Fort Langley, where they still reside (Kwantlen First Nation 2015).

Fishing

Kwantlen First Nation consider the vitality of the Fraser River and its resources to be an important element of Kwantlen culture (Kwantlen First Nation 2015). Kwantlen Elders have explained how X_á:ls (their Creator) located the Kwantlen people at the shores of the Fraser River so they could have access to the region's rich resources. Salmon was and remains a primary resource to them and the basis of their economy (MOT 2007), and are held sacred as a bequest from X_á:ls. Kwantlen's traditional seasonal rounds were determined by salmon runs, when they joined other First Nations on tributaries and lakes to fish and preserve it for winter (Kwantlen First Nation n.d.).

Currently, Kwantlen are among the numerous First Nations involved in the Lower Fraser River salmon fishery under food, social and ceremonial (FSC) licences issued by Fisheries and Oceans Canada (DFO). Kwantlen are typically licenced to fish for FSC purposes in the stretch of the Fraser River between the Port Mann Bridge and Mission, using both drift and set nets (DFO 2016); however, DFO records from 2004 onward indicate that Kwantlen are also often licenced to fish within smaller subsections of this area – that is, Port Mann Bridge to Kanaka Creek/Derby Reach or Kanaka Creek/Derby Reach to Mission. Since 2004, Kwantlen appear to have been licenced to fish in this area for Chinook, sockeye, and chum salmon and eulachon, although the timing and frequency have varied year over year. Kwantlen has also accessed Fraser River FSC fisheries in this area as part of the Lower Fraser River First Nations (DFO 2016).

In 2015, Kwantlen had opportunities to harvest salmon from the Fraser River under FSC communal licences, limited participation (i.e., ceremonial) licences, and economic opportunity licences. Communal licences appear to have been issued only for Chinook salmon, over three days in September, while limited participation licences were issued for Chinook and chum salmon for a portion of one day each, in April and November, respectively, and eulachon on four occasions in April. While Kwantlen would have also accessed Fraser River fisheries as part of the Lower Fraser River First Nations in 2015 (e.g., for chum under economic opportunity licences), for comparison, in 2004, Kwantlen fished under communal licence for Chinook from March until July, sockeye in July and August, and chum over October and November (DFO 2016). Kwantlen have previously noted and expressed concern about diminishing fish stocks (Murray 2014).

Kwantlen has reported that they used the upper intertidal area of Mud Bay, at the northeastern aspect of Boundary Bay, for shellfish harvesting (Kwantlen First Nation 2015). This area was reportedly accessed by transportation routes from the Fraser River, as discussed further below (see “Related Interests”).

Hunting / Trapping

Kwantlen reportedly hunted deer, elk, mountain goats and other small game (e.g., ducks, geese, and grouse), and trapped beaver and martin. Stave River, a tributary of the Fraser River, is said to have been important to Kwantlen for hunting and trapping and as a training area for youth (Kwantlen First Nation n.d.).

Gathering

Kwantlen have identified a former berry/plant gathering area at a bog located in the eastern and northern portion of Lulu Island, along the south bank of the North Arm of the Fraser River. Cranberries are specifically identified (Kwantlen First Nation 2015).

Related Interests

Kwantlen have reported that they understand their cultural heritage sites to include “any geographically-defined site (on land or water) used for the purposes of settlement, occupation, cultural use, resource gathering, transportation, or similar activity,” and note that while these sites “may lack the physical evidence of human-made artifacts or structures,” they are still of cultural significance. Kwantlen say that some of the “most highly significant” cultural heritage sites are associated with fishing on the Fraser River (Kwantlen First Nation 2015).

In addition to locations identified above primarily in relation to fishing and other resource harvesting, Kwantlen have identified several traditional transportation routes to the east of the project corridor, including, but not limited to: a trail from the head of Mud Bay to the South Arm of the Fraser and to *Kikait* (*q’əq’yət*), across from New Westminster; a trail/canoe route leading from the Fraser River at the west end of Barnston Island to the Serpentine River, leading to Mud Bay; a trail/canoe route from the Fraser River along the Salmon River then overland to the Serpentine River, leading to Mud Bay; the Nicomekl River itself (*neq’əmeqəl* and other variations); a trail/canoe/portage route from the mouth of the Salmon River at the Fraser River to its source, then by portage to the upper forks of the Nicomekl River, and downriver to the mouth of the Nicomekl River (i.e., Black Spit or *stətaq*); and a trail leading from the headwaters of the Nicomekl River southward across Langley Prairie to Campbell River, then following this river to its mouth at Semiahmoo Bay (Kwantlen First Nation 2015).

Lake Cowichan First Nation

Key sources relied upon for this summary are *Ts'uubaasatx Interests: George Massey Tunnel* (Chuuchkamalthnii 2015), regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Lake Cowichan First Nation. As part of that ongoing consultation, Lake Cowichan First Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.5** for review and comment. Comments had not been received by the time of Application submission.

The Project area intersects with the claimed core territory or “title lands” of the member bands of the Hul'qumi'num Treaty Group (**Appendix 10-A, Figure 10-2**), with which the Lake Cowichan has been affiliated. This area includes *Tl'uqtinus*, in the vicinity of the north end of the George Massey Tunnel. It has been previously reported that each of the six Hul'qumi'num Treaty Group member nations had “a share of the title interest” at *Tl'uqtinus*, meaning that each group owned permanent houses and the land their respective houses were situated on. These houses and “house lands” were not shared between *Hul'qumi'num'*-speaking groups. All other nations would have been considered “guests,” and would have to have sought the express permission of the heads of the *Hul'qumi'num' Mustimuhw* households to stay at the village. Harvesting areas or stations were also recognized as property of households, or specific families or individuals within those households (BC and PMV 2012, VAFFC 2011).

A Lake Cowichan First Nation community member recently stated that they have not used any resources from the George Massey Tunnel area since 1960, but that they do occasionally access the area (Chuuchkamalthnii 2015).

Fishing

Hul'qumi'num Mustimuhw, which includes the Lake Cowichan, followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round (BC and PMV 2012, HTG 2005, Rozen 1985). Seasonal movements reportedly involved the relocation of entire households, including house planks and supplies, from location to location within the collective traditional territory, between three and five times annually. Within this round, the Fraser River estuary has been described as the “most important economically” (HTG 2005).

Species harvested historically on the South Arm of the Fraser River included salmon, sturgeon, eulachon, shellfish, and marine mammals (particularly seals); dried clams and other foodstuffs (e.g., camas) were also traded to other First Nations while *Hul'q'umi'num'*-speaking groups were resident in and around the area (BC and PMV 2012). According to an 1827 Hudson's Bay Company journal, the "Saumni" (i.e., Somenos, ancestors of the Lake Cowichan) were among those residing on the South Arm of the Fraser River "around the present site of the George Massey Tunnel," and specifically at its north end, at *Tl'uq'tinus* (Rozen 1985).

Areas within the wider Fraser River estuary were also utilized by *Hul'q'umi'num'*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Roberts Bank, Tsawwassen, Point Roberts, Boundary Bay) (Chuuchkamalthnii 2015, HTG 2005). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations within their trans-Georgia Strait settlement round.

As a collective, the *Hul'q'umi'num* Treaty Group has reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul'q'umi'num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area. The *Hul'q'umi'num* Treaty Group has also reported that government regulations introduced in the same era also had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul'q'umi'num Mustimuhw* continued to use the Fraser River for fishing into the early twentieth century (HTG 2005).

Access to sockeye for *Hul'q'umi'num* Treaty Group member nations for food, social, and ceremonial (FSC) purposes is said to be provided annually by Fisheries and Oceans Canada (DFO) in Johnstone Strait and "off the mouth of the Fraser River" (Cohen Commission 2011). In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008 (DFO 2016). In those years, the specific locations in the South Arm in which member nations of the *Hul'q'umi'num* Treaty Group (i.e., Cowichan Tribes, Penelakut Tribe) fished for FSC purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area) (DFO 2016). DFO management areas to which Lake Cowichan FSC licences apply are not specified in their latest available fisheries agreement with DFO; however, Lake Cowichan's agreement mentions sockeye, which does not occur in the Cowichan River system (LCFN and DFO 2013). DFO records for communal FSC licences in the Fraser River downstream of the Port Mann Bridge do not suggest that Lake Cowichan has had recent access to fisheries in this area (DFO 2016). Lake Cowichan have reported, however, that one of their

FSC fishers has obtained fish at the mouth of the Fraser River and Roberts Bank area in two of the last three years. Two species of salmon have been targeted at Roberts Bank – sockeye and spring (Chinook) -- with approximately 20 to 50 of each species harvested annually (spring through fall) (PMV 2015).

Lake Cowichan First Nation currently participates in the Hul'qumi'num Fisheries Limited Partnership (HFLP), a commercial fishing business, along with Cowichan Nation Alliance member groups and Lyackson First Nation. Species harvested under commercial licences through this enterprise are crab (one Area H licence), prawn (two local / coast wide licences), halibut (one licence and annual TAC quota), herring (13 gillnet and 1 seine), rockfish (two Area Inside licences, targeting yelloweye, quillback, copper, china, and tiger), sablefish (annual TAC quota), and salmon (five Area E gillnet licences) (HFLP 2014). Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island (PMV 2015, LFN 2016).

Hunting / Trapping

Descriptions of past, present, and desired future hunting and trapping activities in the Project area specifically by the Lake Cowichan First Nation were not identified in information reviewed to date; however, it is assumed that these activities would have resembled what has been reported for other *Hul'qumi'num' Mustimuhw* while resident on the Fraser River. Large game likely included deer and black bear; small game, fur-bearing mammals, and waterfowl from aquatic settings along sloughs and wetlands, such as beaver, muskrat, otters, mink, ducks, geese, and swans, would also have been targeted (VAFFC 2011).

Lake Cowichan have reported they are harvesting seals (Chuuchkamalthnii 2015) and ducks, specifically mallards and coots (mud hens), at Roberts Bank. They have previously expressed concern regarding the diminishing numbers of marine birds in the area (PMV 2015).

Gathering

Lake Cowichan First Nation has reported gathering eelgrass at Roberts Bank in the intertidal zone (PMV 2015). Other gathering activities of the Lake Cowichan First Nation specifically in the vicinity of the Project area were not available in sources reviewed, but have been inferred from descriptions pertaining to the Hul'qumi'num Treaty Group as a whole. Other member bands of the Hul'qumi'num Treaty Group have reported that berries and other plants were gathered and cultivated by *Hul'qumi'num' Mustimuhw* ancestors at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included cranberries, blueberries, blackberries, wapato, and bulrushes/reeds (*stth'equn*) (HTG 2005, Woodward and Company 2011). With

respect to berry plants at *Tl'uq̓tinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees” (North et al. 1979, Woodward and Company 2011).

Related Interests

Members of the Lake Cowichan First Nation community are actively working to find members that have dispersed from the community, and they have expressed their desire to, at some time in the future, visit the Project area with these new members in order to renew their relationship with and learn about their “traditional rights” in the area (Chuuchkamalthnii 2015).

Lyackson First Nation

Key sources relied upon for this summary are *Preliminary Lyackson Use and Occupancy Mapping Study (LUOMS) for BC MoTI's George Massey Tunnel Replacement Project* (LFN 2015), regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Lyackson First Nation. As part of that ongoing consultation, the Lyackson First Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.6** for review and comment. Comments were received from the Lyackson First Nation and have been incorporated, where possible. Lyackson First Nation requested that additional sources be reviewed by the Ministry and cited in the following summary regarding their past, present, and desired future use (LFN 2016); however, the specific information from those sources that Lyackson First Nation wished to have included in the summary had not been identified by Lyackson First Nation to the Ministry by the time of Application submission.

Lyackson First Nation has described *Le'eyqsun* (Valdes Island) as their homeland and ancestral territory (LFN 2015, PMV 2015). *Le'eyqsun* lies approximately 45 km to the west of the Project area; however, the Project area intersects with the claimed core territory or “title lands” of the member bands of the Hul'qumi'num Treaty Group (**Appendix 10-A, Figure 10-2**), with which Lyackson First Nation has been affiliated. This area includes *Tl'uq̓tinus*, in the vicinity of the north end of the George Massey Tunnel, opposite Tilbury Island. The Lyackson First Nation reportedly had a house at *Tl'uq̓tinus* along with each of the other Hul'qumi'num Treaty Group member bands (BC and PMV 2012, LFN 2015, PMV 2015). Lyackson Elders and knowledge holders have described *Tl'uq̓tinus* as having been like a “little New York,” and a powerful and permanent *Hul'qumi'num Mustimuhw* trading centre for a number of commodities (BC and PMV 2012).

Fishing

Hul'qumi'num Mustimuhw, which includes the Lyackson First Nation (LFN 2014), followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round (BC and PMV 2012, HTG 2005, Rozen 1985). Seasonal movements reportedly involved the relocation of entire households, including house planks and supplies, from location to location within the collective traditional territory, between three and five times annually.. Lyackson members have reported that having a base at the mouth and South Arm of the Fraser River, where they could prepare and preserve food before crossing the Strait of Georgia, was an important part of their subsistence system (LFN 2015).

The Fraser River, from its mouth up to Seabird Island (east of Chilliwack), has been described as a key fish and shellfish harvesting area for Lyackson, with Canoe Passage (*Hwlhitsu'm*) identified as particularly important for salmon fishing. Lyackson Elders recall crossing the Strait of Georgia to the mouth of the Fraser River to participate in commercial fishing, primarily for sockeye. Salmon and other fish were said to be abundant and easily fished in large numbers from small vessels. Dried clams and other foodstuffs (e.g., camas) were also traded to other First Nations while *Hul'qumi'num*-speaking groups were resident in and around the area (BC and PMV 2012, LFN 2015).

Areas within the wider Fraser River estuary were also utilized by *Hul'qumi'num*-speaking peoples for fishing salmon, sturgeon, groundfish, halibut, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay) (HTG 2005, LFN 2015). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations within their trans-Georgia Strait settlement round. The same has also been reported by Lyackson in regard to marine mammals (i.e., seals, porpoise, sea otters, sea lions, and whales) (LFN 2015, PMV 2015).

As a collective, the *Hul'qumi'num* Treaty Group has reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul'qumi'num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area. The *Hul'qumi'num* Treaty Group has also reported that government regulations introduced in the same era also had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul'qumi'num Mustimuhw* continued to use the Fraser River for fishing into the early twentieth century (HTG 2005).

Access to sockeye for Hul'qumi'num Treaty Group member bands for food, social, and ceremonial (FSC) purposes is said to be provided annually by Fisheries and Oceans Canada (DFO) in Johnstone Strait and "off the mouth of the Fraser River" (Cohen Commission 2011). In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008 (DFO 2016). In those years, the specific locations in the South Arm in which member nations of the Hul'qumi'num Treaty Group (i.e., Cowichan Tribes, Penelakut Tribe) fished for FSC purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area) (DFO 2016). DFO management areas to which Lyackson FSC licences apply are not specified in their latest available fisheries agreement with DFO; however, Lyackson's agreement suggests that their current fishing focus is on traditional areas in and around *Le'eyqsun*, surrounding Gulf Islands, and locations on Vancouver Island (e.g., Chemainus River, Bonsall Creek) (LFN and DFO 2013). DFO records for communal FSC licences in the Fraser River downstream of the Port Mann Bridge do not suggest that Lyackson has had recent access to fisheries in this area (DFO 2016). Lyackson Elders confirm that, at one time, family ties and arrangements between communities provided consistent access to salmon at the mouth of the Fraser River, but that, today, other First Nations attempt to require Lyackson to seek permission prior to harvesting in the area (PMV 2015).

Lyackson First Nation has said that the mouth and South Arm of the Fraser River is currently the source of over 50% of their current subsistence salmon catch (LFN 2015); however, they have also said that low present-day fish populations require larger boats and more expensive technology to obtain fish in sufficient numbers to meet their subsistence and commercial needs. For these and other reasons, they say fishing in the Fraser River area has become largely unavailable to them (PMV 2015). Specifically, Lyackson have reported that it costs \$10,000 for them to make each trip, and that they would fish in the Fraser River if that is where the fish were, but they can no longer afford to make that trip and they do not catch fish there when they drop their nets (LFN 2016).

The Hul'qumi'num Fisheries Limited Partnership (HFLP) is a commercial fishing business in which the Lyackson First Nation currently participates. Species harvested through this enterprise are crab (one Area H licence), prawn (two local / coast wide licences), halibut (one licence and annual TAC quota), herring (13 gillnet and 1 seine), rockfish (two Area Inside licences, targeting yelloweye, quillback, copper, china, and tiger), sablefish (annual TAC quota), and salmon (five Area E gillnet licences) (HFLP 2014). Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island. Lyackson First Nation also hold, independently of the HFLP, a commercial licence for red sea urchin (PMV 2015) and a 1/16th block of geoduck, purchased in the last quarter of 2015 (LFN 2016).

Hunting / Trapping

Lyackson report that, in the past, they hunted for ducks and geese in the Project area, while deer were hunted farther up the Fraser River (LFN 2015). Lyackson report currently harvesting ducks, deer, and grouse at Porlier Pass, which they say remains a particularly important marine and terrestrial resource harvesting area for Lyackson given the range of resources that occur there (PMV 2015).

Gathering

Lyackson First Nation has said that members recall harvesting berries (including salmonberries and huckleberries), cattails, and fiddleheads in the Project area (LFN 2015). With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees” (North et al. 1979, Woodward and Company 2011). Berry-picking sites are said to be currently available to Lyackson at Porlier Pass (PMV 2015).

Related Interests

Lyackson First Nation has identified a number of culturally important places, including *S'utl'qulus* (or *s7etl'keles*), meaning “facing outside,” for the east side of *Le'eyqsun*, and *Kw'ukw'iyukwun*, a fishing area off the southeastern end of *Le'eyqsun*, in the Strait of Georgia. A newly constructed youth camp, where the canoes of their ancestors once lined up in preparation for trips to Fraser River, is also located on the eastern side of *Le'eyqsun* (PMV 2015).

Musqueam Indian Band

Among sources relied upon for this summary are *Salmon so thick, that you could walk on water: Preliminary Scope of Musqueam (xʷməθkʷəyəm) Valued Components for the Environmental Impact Assessment of the Proposed George Massey Tunnel Replacement Project* (MIB 2015) and *Musqueam Comprehensive Land Claim: Preliminary Report on Musqueam Land Use and Occupancy* (MBC 1984), regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Musqueam Indian Band. Musqueam Indian Band was provided with a draft of this summary and the information that appears in **Section 10.1.1.7** for review and comment. Comments received from Musqueam have been incorporated, where possible. The Ministry is committed to working with Musqueam with respect to concerns raised regarding this summary.

The Musqueam Indian Band has described areas within its traditional territory (**Appendix 10-A, Figure 10-6**) over which extended families exercised exclusive use and occupation (MBC 1984):

Certain resource sites of a restricted or concentrated nature, such as waterfowl and deer netting stations, fish trap locations, certain berry patches, or fields of edible roots were ‘corporately’ owned by extended families. These were used to the exclusion of other families, although their use might be shared with permission. Unlike things considered private property [e.g., moveable goods, such as tools, fishing equipment, canoes, house-boards, matting, utensils, and foods], these places and resource sites could not be alienated from the extended family group. ... [These areas] were recognized as ‘property’ over which Musqueam exercised exclusive rights.

It is not known whether the Musqueam Indian Band asserts that any of these areas are specifically within or near the Project footprint; however, it is known that the Musqueam Indian Band asserts title to its traditional territory generally (MIB 1976), and has recently asserted title to *Zuq̓tinus* or *λ’əqətines* (BC and PMV 2012, MIB 2011, VAFFC 2011). Rozen (1985) reports that this location was likely a summer camp of the Musqueam originally, used later by other groups with the permission of the Musqueam and “other Mainland Halkomelem.”

Fishing

The Musqueam Indian Band have an established right to fish for food, social, and ceremonial (FSC) purposes in the area of Canoe Pass on the South Arm of the Fraser River (SCC 1990; also described in the SCC’s decision as “the waters of Ladner Reach and Canoe Passage”). The Musqueam also assert an Aboriginal right to fish for FSC purposes in a broader area that includes but is not limited to all waters of the Fraser River – including its North Arm, Middle Arm, and South Arm – downstream of the Port Mann Bridge to the Strait of Georgia (BC and PMV 2012, PMV 2015). The Project area lies immediately upstream of the area in which the Musqueam’s right to fish for FSC purposes has been established, and within the area where this right is considered by the Ministry to be asserted.

All five species of Pacific salmon, steelhead, rockfish (rock cod, red snapper), herring and herring spawn, smelt, halibut, eulachon, trout, and sturgeon were fished historically by the Musqueam in their traditional territory (see previous section), and all were important economically. The most commonly harvested marine mammals included harbour seal, sea lion, and porpoise; harvesting areas included the Fraser River estuary. At productive beaches within Musqueam traditional territory, abalone, barnacles, clams, chitons, cockles, mussels, crabs, crayfish, octopus, oysters, prawn, scallops, sea urchins, sea cucumber, shrimp, and seaweed were harvested and set aside for winter supplies; however, clams were the most abundant and heavily harvested, including at Boundary Bay (MBC 1984; MIB 2015; PMV 2015).

Fishing remains central to the Musqueam, and they have specified that the waters outside Steveston, Canoe Passage, and the lower of the Fraser River, and Roberts Bank are their most intensive salmon harvesting areas (PMV 2015). Salmon is a key species to the Musqueam, important for FSC and economic purposes, forming a basis for trade with other First Nations (PMV 2015).

In the mid-1980s, species harvested included all five species of Pacific salmon, all varieties of cod fish, steelhead, sturgeon, flounder, halibut, crayfish, herring, octopus, seals, prawn, shrimp, mussels, sea urchins, abalone, scallops, cockles, barnacles, chiton, sea cucumbers, and seaweed. Other species harvested within Musqueam traditional territory or obtained beyond that territory through self-harvesting, trade, or barter included clams, oysters, herring roe, smelts, and eulachon (MBC 1984; MIB 2015). Lingcod, midshipmen, sculpin (specifically buffalo, red Irish lord, and staghorn), rock sole, limpets, and dog whelks have also been identified as species traditionally used by Musqueam (MIB 2015).

In 2013 salmon allocations for FSC purposes, pursuant to agreement between DFO and Musqueam (DFO and MIB 2013), were 1,200 pieces of Chinook, 75,000 pieces of sockeye, 17,325 pieces of pink, 16,500 pieces of chum, and incidental harvest of hatchery-marked coho. Conservation concerns, also shared by Musqueam, have resulted in restrictions on the targeted fishing of coho, access to Chinook, and retention of steelhead (PMV 2015).

While Musqueam once harvested salmon daily and throughout the year, Fisheries and Oceans Canada (DFO) records for the last few years indicate that fishing opportunities no longer occur with such frequency (DFO 2016).

In 2013 Musqueam had opportunities to harvest salmon under communal licence, as follows:

- Chinook salmon on 14 occasions, between 8 and 18 hours each, May 18 through September 1;
- Sockeye salmon during 2 openings, one each in July and August, for 24 and 36 hours, respectively;
- Pink salmon over 4 openings in September, between 19 and 24 hours; and,
- Chum salmon on 3 occasions in October, lasting between 36 and 48 hours each.

There were 15 additional, limited participation fisheries (i.e., ceremonial purposes) in 2013:

- Chinook salmon on 8 occasions over May, July, August and September (6 to 12 hours each);
- Sockeye salmon on 2 occasions, one each in July and August (24 and 32 hours, respectively);
- Pink salmon on 2 occasions, in September (12 hours each); and,
- Chum salmon on 3 occasions, in October (between 6 and 12 hours).

In late September and late October 2013, Musqueam also participated in economic opportunity fisheries, which draw from the annual FSC allocation, and allow for the sale of pink and chum salmon harvested during specific opening times.

In 2014, Musqueam were issued communal licences to harvest salmon as follows:

- Chinook salmon on 11 occasions, between 5 and 36 hours each, May 18 through July 20;
- Sockeye salmon on 6 occasions, between 4 and 36 hours each, July 26 through August 23; and
- Chum salmon on 3 occasions, between 24 and 48 hours each, October 5 through October 19.

There were no communal licences issued for pink salmon in 2014. There were an additional eight limited participation fisheries in 2014:

- Chinook salmon on 2 occasions, in June and July (12 and 15 hours respectively); and
- Sockeye salmon on 6 occasions, in late July and August (4 to 56 hours each).

Musqueam also participated in economic opportunity fisheries in 2014:

- Sockeye salmon on 18 occasions, in August and September (4 to 16 hours each); and
- Chum salmon on 2 occasions, in October (10 hours each).

In 2015, Musqueam were issued communal licences to harvest salmon as follows:

- Chinook salmon on 21 occasions, May 2 through September 6 (between 12 and 24 hours each);
- Sockeye salmon on 3 occasions August 1 through August 9 (between 12 and 16 hours each);
- Chum salmon on 1 occasion, October 10 through October 12 (48 hours); and
- Pink salmon on 6 occasions September 12 through September 30 (6 to 12 hours each).

There were an additional five limited participation fisheries in 2015:

- Chinook salmon on 3 occasions, in July and August (7 to 8 hours each); and
- Sockeye salmon on 2 occasions, in August (12 hours each).

Musqueam also participated in economic participation fisheries in 2015, with two opportunities to harvest pink salmon on September 14 and 15 (6 and 4 hours respectively), and two opportunities to harvest chum salmon on October 22 and 25 (5 and 12 hours respectively) (DFO 2016).

Retained catch for the period 2009 to 2015, including limited participation and economic fisheries, is presented in **Table 10.1-6**. Musqueam report that they are not able to catch enough salmon to meet their communal needs (PMV 2015).

Table 10.1-6 Musqueam Salmon Catch (Kept), 2009 to 2015

| Species | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---------|--------|---------|---------|--------|--------|---------|--------|
| Chinook | 5,889 | 2,988 | 3,643 | 2,546 | 1,500 | 2,169 | 2,834 |
| Sockeye | 3,673 | 231,847 | 84,097 | 41,403 | 20,528 | 193,199 | 16,115 |
| Pink | 39,102 | 0 | 105,012 | 0 | 65,278 | 0 | 843 |
| Coho | 198 | 87 | 690 | 261 | 713 | 242 | 147 |
| Chum | 13,082 | 8,158 | 15,315 | 14,849 | 24,145 | 20,249 | 25,158 |

Source: (DFO 2016)

Areas in which Musqueam fishing for salmon for FSC purposes is permitted include all or portions of Fisheries and Oceans Canada (DFO) management subareas 29-3, 29-4, 29-6, 29-7, 29-9, 29-10, 29-11, 29-12, 29-13, 29-14, and 29-17 (DFO and MIB 2013). Musqueam fishing for other species for FSC purposes is also largely limited to these areas, described collectively as follows:

Those waters of the Fraser River westerly of the power lines immediately downstream of the Port Mann Bridge and the waters of the Strait of Georgia bounded by a line commencing at Point Grey thence northerly to the light on Point Atkinson, thence westerly to the light on Point Cowan on Bowen Island, thence following the southerly shoreline of Bowen Island to the light on Cape Roger Curtis, thence in a direct line southeasterly to the Roberts Bank LL# 309 (known as the Hooter Buoy) thence due west to the 40 metre contour line as shown on C.II.S. 3463, thence follow the 40 metre contour line to the International border.

Subareas 29-13 and 29-14 overlap the Project area; however, there are areas outside of Area 29, most notably in Area 28, over which Musqueam traditional territory also extends (e.g., Indian Arm, Burrard Inlet, and waters off Point Grey), but within which Musqueam fishing for FSC purposes is not permitted.

Starry flounder are harvested in the South Arm of the Fraser River, outside Canoe Passage, and from Steveston through Roberts Bank. Currently, Musqueam are not licenced to retain flounder as a by-catch, but have requested a licence through DFO. Musqueam report that halibut, once fished within their traditional territory, in both shallow and deep waters, can no longer be easily found (PMV 2015).

Certain species, such as sturgeon and steelhead, are not harvested in Musqueam traditional territory because of conservation concerns. Musqueam maintain they would not have survived without sturgeon, which range throughout the South Arm of the Fraser River, concentrating around Canoe Passage and adjacent areas when eulachon enter the channel. The sloughs in which Musqueam once caught sturgeon have been largely filled in. However, Musqueam have observed an increasing number of sturgeon as by-catch, potentially indicating a recovery of the species and the potential for Musqueam to resume sturgeon harvesting for FSC purposes, within conservation limits (PMV 2015).

Musqueam report that historically they travelled up the Fraser River as far as New Westminster and Mission to harvest eulachon. A decade ago, harvesting eulachon was pursued under open licences. Currently in the lower Fraser River, eulachon can be fished by drift net in limited amounts for ceremonial purposes, but only on a case-by-case basis. There were three, 5 to 6 hour openings for Musqueam in 2013 (April 13, 16, 17); seven, 6 hour openings in 2014 (April 11, 12, 13, 15, 16, 18, 19); and six, 6 hour openings in 2015 (April 10, 11, 13, 14, 15, 16) (DFO 2016). Eulachon harvesting occurs in Canoe Passage, Ladner Reach, and waters around Duck, Rose, Kirkland, Gunn, and Barber Islands (PMV 2015).

Herring, once a staple fishery, was harvested throughout the Fraser estuary, as well as Howe Sound, Burrard Inlet, and False Creek. Herring are still harvested in Canoe Passage and on the north shore of the South Arm of the Fraser River. Herring roe, once gathered within Musqueam asserted territory, is now traded for because of conservation and contamination concerns. Once contamination and conservation concerns are addressed, Musqueam desire to return to harvesting roe. They continue to target rockfish (there are no DFO restrictions in place). Musqueam have also expressed a desire to resume harvesting ratfish (used medicinally) and dogfish (PMV 2015).

In 2013, 2014, and 2015, Musqueam were licenced to harvest crab (targeting Dungeness, graceful and red rock) within the Musqueam Crab Area and prawn in PFMA sub-areas 29-2, 29-3, and 29-4 throughout the year (DFO 2016). Musqueam have expressed a desire to obtain DFO licences, allowing them to use FSC allocations of crab, as well as other species, for economic or commercial purposes, as they would have undertaken traditionally (PMV 2015).

Musqueam report concerns regarding the decreasing areas in which crab can be harvested within Musqueam asserted territory as well as the compromised quality of crab in areas that remain accessible. For example, they state crab in Burrard Inlet (within their asserted territory) should no longer be consumed and identify the lack of tidal flows and increasing sedimentation, created by the terminals and causeways at Roberts Bank as contributing factors to less productive crab habitat conditions (PMV 2015).

Octopus, a traditional food source, is caught a by-catch to Musqueam fishers but cannot be retained without a licence. Musqueam are seeking to obtain a licence to address the ongoing community need and demand for the resource (PMV 2015).

Sea urchin and sea cucumber once harvested for food and medicine, are no longer harvested due to contamination concerns. Musqueam explain clams and cockles once gathered around Tsawwassen are no longer believed to be safe for consume. They must now trade for these resources with their relatives from other Aboriginal groups, or buy the seafood for from stores for their Elders. They express a desire to harvest these resources again and express concern that forced changes in diet, for example as a result of food avoidance, may be a contributing factor to the overall health of community members (PMV 2015). PFMA 28 and 29 are subject to a permanent biotoxin (as well as more localized sanitary) closures, prohibiting the harvest of all bivalve shellfish for consumption.

The most commonly harvested marine mammals were the harbor seal, sea lion, and porpoise. Seal harvesting occurred throughout the Fraser River Estuary, including all areas of the South Arm of the Fraser River and offshore of Steveston, Westham Island, and Brunswick Point. Musqueam report also harvesting seal outside of Steveston (PMV 2015).

The meat of seal and sea lion meat is valued as a food source, and the whiskers have important ceremonial functions. Seal skins have been used in drum-making and seal fat was once rendered for oil. Although seals and sea lions may be harvested by Aboriginal peoples under a special DFO licence, Musqueam report that the meat of the animal is high in pollutants, and although resumption of harvesting is desired, it is dependent on contamination and conservation concerns being lessened (PMV 2015).

The Musqueam Indian Band is involved in commercial fisheries through Salish Seas Limited Partnership, a business owned jointly with the Tsleil-Waututh Nation and Sliammon First Nation. Species harvested commercially through this enterprise include crab, prawn, halibut, and herring. Individual Musqueam members also hold commercial licences (PMV 2015).

Hunting / Trapping

Deer, wapiti (elk), bear, and mountain goat were once harvested in several areas of Musqueam traditional territory (MBC 1984). Musqueam report that deer and bear have been taken at Burns Bog within living memory; deer have also been harvested at areas along the South Arm of the Fraser River (i.e., the south shore between Tilbury and Annacis Islands). Harvesting of game (e.g., deer, mountain goat) continues to take place in the more northerly parts of Musqueam asserted territory (PMV 2015).

Small land mammals were abundant throughout Musqueam asserted territory and trapping of these animals was once common. Mink, muskrat, and otter were used mainly for furs; beaver and rabbit were harvested for both food and furs (MBC 1984).

Grouse were hunted in the open fields of Lulu Island, and pheasant were taken in meadows throughout the Fraser River delta (MBC 1984). In the area of the Project, waterfowl was harvested at the western extent of Lulu Island, Westham Island, Canoe Passage, and Musqueam IR 4 (about 0.5 km south of the middle reach of Canoe Passage and 2 km east of Brunswick Point). The most common species taken included, but were not limited to, mallard, widgeon, pintail, teal, murrelets, grebes, loons, scoters, scaups, and harlequins. Food sources also included migratory species of Canada goose, snow goose, and swans, and the eggs of ducks and gulls (MBC 1984).

More recently, hunting within Musqueam traditional territory has been focused primarily on wildfowl, including mallard, teal, widgeon, pintail, black duck (scoters, including white-wing, surf, and American varieties, preferred for their size and fat content), geese (including brant), grouse, and pheasant, and has taken place on the river banks, marshes, and meadows throughout the Fraser delta, including but not limited to the foreshore areas adjacent to the Musqueam Indian Band reserve on Canoe Pass and those adjacent to Tsawwassen Lands (MBC 1984). Musqueam identify mergansers as having specific cultural importance, while brant geese are reportedly not as abundant as they once were (PMV 2015).

Musqueam report that swans, herons, cranes, and raptors (e.g., eagles, osprey) were formerly harvested for food and ceremonial use, but are not currently due to conservation concerns. These birds and their parts, which are derived from birds collected by conservation officers, remain vital to the Musqueam and continue to be used for ceremonial purposes (PMV 2015).

Additional species identified as having been traditionally harvested by Musqueam include wolves, martens, skunks, raccoons, wood and goldeneye ducks, oldsquaws, buffleheads, cormorants, and seagulls (MIB 2015).

Gathering

Common plant foods consumed domestically were wapato, camas lily, huckleberry, blueberry, salmonberry, elderberry, bog cranberry, *slehal* (salal) berries, and Pacific crabapple. Of these, berries were particularly central; important berry grounds were owned by certain families, and, dried berries served with fish or seal oil formed a fundamental part of the winter diet. Bog cranberries were also a commodity, exchanged with other nations; these were harvested, for example, on Lulu Island, on the islands in the South Arm of the Fraser River, and at Burns Bog (MBC 1984).

Berry gathering and exchange remains important for food and ceremonial purposes. Ladner and Richmond have been identified as areas within which harvesting (i.e., of thimbleberry, salmonberry, salal berry, soapberry and huckleberry) still occurs; however, the most heavily harvested areas are around the main reserve community, as well as at Musqueam Park and within the University Endowment Lands at Point Grey. This also applies to floral resources used for medicinal and curative purposes. Harvested species include cascara bark, Labrador tea, alder, elderberry root, Oregon grape, cherry bark, devil's club, juniper, balsam, foxglove, nettle, ferns (a variety of roots), burdock, hemlock, rosehip, chokecherry, horsetail, skunk cabbage, vine maple, regular maple, wild crabapple, clover, dandelion, silverweed, mountain ash, chamomile, blackberry leaves, and strawberry, blueberry, and cranberry plants (MBC 1984). Additional species traditionally used by Musqueam include pacific cinquefoil, pink spirea (hardhack), canary grass, Indian consumption plant (bare-stem desert parsley), red ochre, feathers, fowl eggs, sedge, wild rye, bunchgrass, ocean spray, thimbleberries, black hawthorn berries, and blackcaps (black raspberries). Additional tree species include Douglas fir, Sitka spruce, white birch, cottonwood, willows, grand fir, shore pine, yew, dogwood, broadleaf maple, and wax/snowberry (MIB 2015).

Musqueam identify Brunswick Point as an important area for harvesting aquatic and terrestrial plants for food, medicinal, ceremonial, and manufacturing purposes. Intertidal species harvested include cattail, tule (hard-stemmed bulrush), and grasses (conceivably canary grass, used for weavings, basketry, and tumplines). Other key harvesting areas for these plants include Westham Island, Canoe Passage, Musqueam IR 4, and Ladner. Musqueam report that although they continue to harvest many of these resources, some are no longer accessible in former locations due in part to changing intertidal landscapes and barriers associated with commercial and industrial development (PMV 2015).

Cattail and tule are used ceremonially, for weavings and mats; the bulbs and roots of cattail are edible. Musqueam report cattails are also indicators of environmental health; if the plant is aromatic when first cut the environment is healthy and foul-smelling when the environment is compromised. These plants are also used as wind indicators when hunting. The practice of cutting cattails to let salmon through is the basis for the place-name *šx^whíc'əm*, on the south shore of Canoe Passage, near Brunswick Point (PMV 2015).

Horsetail, wild rose, and thistle were harvested at Brunswick Point, as well as Musqueam IR 4 for medicinal, curative, or ceremonial purposes. Musqueam also harvest broad-leaf plantain (medicinal plant) and stinging nettle (multi-purpose plant, including net-making). The latter is reportedly scarce as is Indian consumption plant, which Musqueam obtain through trade or harvest around Tsawwassen First Nation Lands (PMV 2015).

Musqueam report that kelp, once harvested throughout Roberts Band and Sturgeon Bank, remains an important food and medicinal plant. Now it is traded either because it cannot be found or is avoided due to contamination concerns. The same issues are noted for seaweeds generally. Musqueam attribute the loss of healthy kelp and eelgrass, which serve as an important habitat for crab and other marine life, to the effects of industrial activity in the region and habitat alteration (PMV 2015).

Plants were and remain used as ingredients and materials for dyes, basketry, cordage, and manufacturing. To the Musqueam, the single most important plant species was cedar. Cedar remains important for cultural purposes, as do other woods, tree products, feathers, shells, bulrushes, and other non-food resources (e.g., mountain goat wool), which are still gathered, both within and, where necessary, beyond Musqueam traditional territory (MBC 1984).

Related Interests

Musqueam report that, historically, they could navigate from the North Arm of the Fraser River through what is currently known as Richmond (Lulu Island) and Delta, using slough channels as an alternate to ocean travel. These sloughs, which once supported fishing locations, no longer survive. They maintain that the remaining waterways have become reportedly congested with log booms and increasing vessel traffic, resulting in more vessel interactions, loss of fishing gear, and safety concerns (PMV 2015).

Musqueam identify several trails within the Fraser River estuary, including trails associated with the following place names: *λ'eqtines* (Lulu Island, across from Deas Island; *sc'əl'əx^wqən'* (Ladner); and, *spəlxən* (two trails on the eastern margins of Crescent Slough, at the western aspect of Burns Bog). They also reference a trail running north-south along the western shore of Lulu Island, to and from the Steveston area (*q^weya?x^w*, *q^wleyəm*) (PMV 2015).

Penelakut Tribe

Key sources relied upon for this summary are the George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands (BKRC 2015); Historical Geography of Cowichan Land Use and Occupancy, Lower Fraser River: Map Series and Report (Brealey 2010); Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area (CT 2015); a map showing “Cowichan Land Use” in the Project area, provided by Penelakut Tribe (PT 2014); regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Penelakut Tribe. As part of that ongoing consultation, Penelakut Tribe was provided with a draft of this summary and the information that appears in **Section 10.1.1.1** for review and comment. Comments were received from the Cowichan Nation Alliance, on behalf of the four member First Nations, and have been incorporated. In this summary, specific information on Penelakut’s traditional use has been supplemented with general information on traditional use by Cowichan Nation Alliance and Hul’qumi’num Treaty Group Nation Alliance member First Nations.

The Project area intersects with the claimed core territory or “title lands” of the member First Nations of the Hul’qumi’num Treaty Group, including *Tl’uq̓tinus* (**Appendix 10-A, Figure 10-2**), which lies along the Fraser River less than 4 km upstream from the north end of the George Massey Tunnel (BKRC 2015). *Tl’uq̓tinus* has been described as a “great summer village of the Cowichan-speaking people of Vancouver Island” (Suttles 2004), with “winter-village style houses” (Rozen 1985) surrounded by cultivated grounds (see **Plate 1** below). More recently, *Tl’uq̓tinus* has been described as a permanently occupied, multi-seasonal Cowichan Nation settlement (Brealey 2010), with a significant winter population and a summer population in the thousands (BKRC 2015). The lands over which *Tl’uq̓tinus* is said to have extended along the south shore of Lulu Island have been reported as “conservatively located on portions of Sections 21, 22, 23, 24, 26, 27, 28, 33, and 34 of Block 4 North, Range 5 West, as well as a waterfront portion of Block 4 North, Range 4 West” (Woodward and Company 2011).

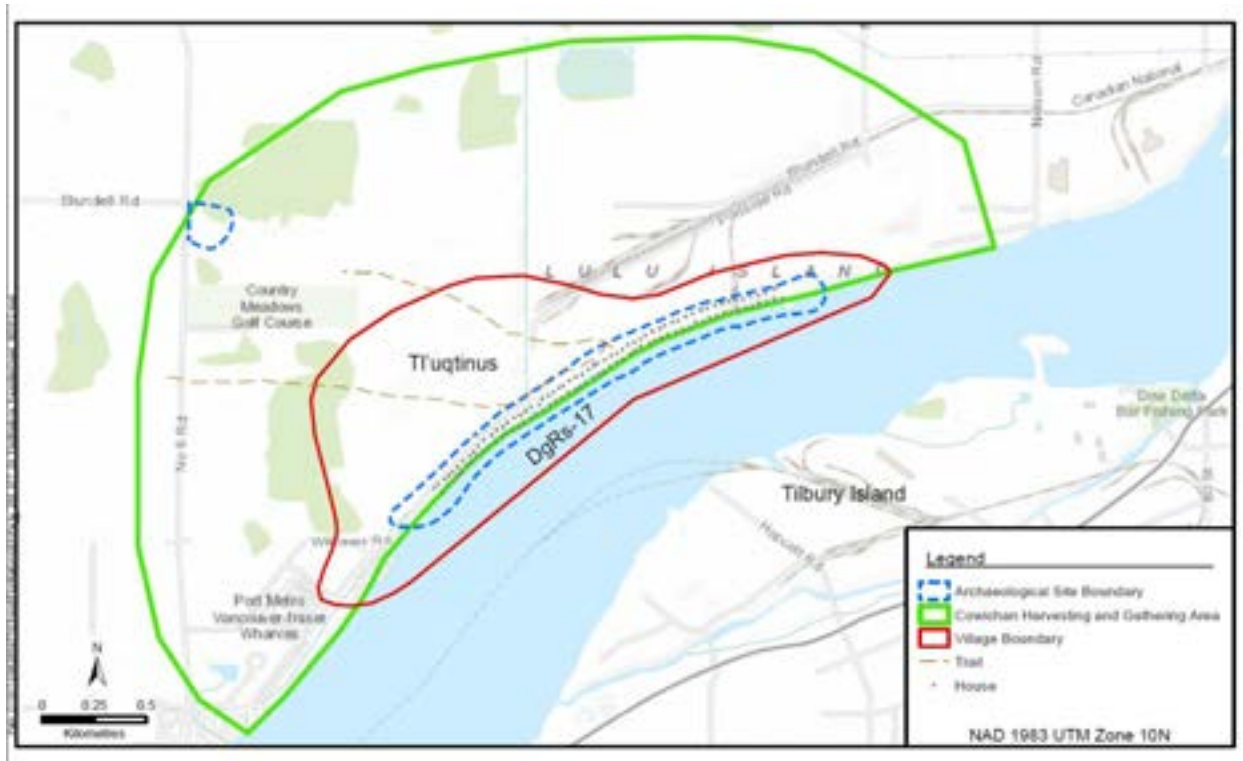


Plate 1. Lands of *Tl'uq̓tinus* Claim Area (CNA 2016a).⁹

The Cowichan Nation Alliance has stated that *Tl'uq̓tinus* was a home base occupied and used exclusively by the Cowichan Nation, the descendants of which are members of the First Nations represented by the Cowichan Nation Alliance (CT 2015), as well as other member bands affiliated with the Hul'qumi'num Treaty Group (BC and PMV 2012, CT 2015, Woodward and Company 2011). This shared or joint occupation and use reportedly extended from well before 1792 until after 1859 (Woodward and Company 2011), and constituted a base of operations for a shared land use regime that reached up the Fraser River at least as far as the fisheries at the Fraser Canyon (Brealey 2010). As indicated in **Section 10.1.1.1**, the Cowichan Nation Alliance is working to reestablish a permanent land base and river access at *Tl'uq̓tinus* for residential and/or commercial purposes (CNA 2016a,b).

⁹ This figure is a representation of information provided by the Cowichan Nation Alliance regarding *Tl'uq̓tinus* (2016a) in the context of consultation on the Project and does not constitute an admission, acknowledgment, or endorsement of that claim, position, or the accuracy of the information by the Ministry.

Fishing

Penelakut followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round (BC and PMV 2012, CT 2015, HTG 2005, Rozen 1985). Seasonal movements reportedly involved the relocation of entire households, including house planks and supplies, from location to location within the collective traditional territory, between three and five times annually. Within this round, the Fraser River estuary has been described as the “most important economically” (HTG 2005). Species harvested historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals; dried clams and other foodstuffs (e.g., camas) were also traded to other First Nations while *Hul’q’umi’num*-speaking groups were resident in and around the area (BC and PMV 2012, BKRC 2015). The Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while resident on the Fraser River (CNA 2011). Penelakut used *Tl’uq̓tinus* seasonally for the foregoing purposes (TMPL 2014). Penelakut also used other habitation sites in the area, including ones along a slough at the southern extent of No. 4 Road, and on a little bay just below Brunswick Point, on the south side of the western entrance to Canoe Pass (BC and PMV 2012, TMPL 2014).

Areas within the wider Fraser River estuary were also utilized by *Hul’q’umi’num*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay) (HTG 2005). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations within their trans-Georgia Strait settlement round. Sockeye salmon and eulachon in particular could not be found in any river within Cowichan Nation’s territory on Vancouver Island (CT 2015).

The *Hul’q’umi’num* Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul’q’umi’num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area (HTG 2005). The *Hul’q’umi’num* Treaty Group have also reported that government regulations introduced in the same era also had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul’q’umi’num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century (CT 2015, HTG 2005, TMPL 2014).

Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO) (Cohen Commission 2011). Access to sockeye for member First Nations (including other members of the Hul'qumi'num Treaty Group) is said to be provided by DFO annually in Johnstone Strait and "off the mouth of the Fraser River" (Cohen Commission 2011). In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008 (DFO 2016). In those years, the specific locations in the South Arm in which member First Nations of the Hul'qumi'num Treaty Group (i.e., Cowichan Tribes, Penelakut Tribe) fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area) (DFO 2016). DFO records for communal FSC licences in the Fraser River downstream of the Port Mann Bridge do not suggest that any of these groups, individually or collectively, has had access to fisheries in this area in the last eight years (DFO 2016). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River (CNA 2016a).

Penelakut participates in the Hul'qumi'num Fisheries Limited Partnership (HFLP), a commercial fishing business, with Halalt First Nation and Stz'uminus First Nation. Species harvested through this enterprise are crab (one Area H licence), prawn (two local / coast wide licences), halibut (one licence and annual TAC quota), herring (13 gillnet and 1 seine), rockfish (two Area Inside licences, targeting yelloweye, quillback, copper, china, and tiger), sablefish (annual TAC quota), and salmon (five Area E gillnet licences) (HFLP 2014). Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island (PMV 2015, LFN 2016).

Hunting / Trapping

Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species (CNA 2011). Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round (BKRC 2015).

The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm (BKRC 2015, CT 2015). The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area (CNA 2011, CT 2015).

The Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted (CNA 2011).

Gathering

Member bands of the Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested (PMV 2015, PT 2014). Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed (BC and PMV 2012, BKRC 2015, CT 2015, HTG 2005, PT 2014, TMPL 2014, Woodward and Company 2011). With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees” (North et al. 1979; Woodward and Company 2011).

The Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl'uqtinus*, which is currently surrounded by blueberry farms, the Cowichan Nation Alliance have raised the potential for their former berry grounds to be re-established (Woodward and Company 2011).

Related Interests

The Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl'uqtinus*, and given where *Tl'uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. The Cowichan Nation Alliance has advised that it is also working to reestablish culturally integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl'uqtinus* (CNA 2016a).

The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members (PMV 2015).

Semiahmoo First Nation

Key sources relied upon for this summary are regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015) and ongoing consultation between the Ministry and Semiahmoo First Nation. As part of that ongoing consultation, Semiahmoo First Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.8** for review and comment. Comments had not been received by the time of Application submission. The Ministry also notes that a Project-specific traditional use study was expected from the Semiahmoo First Nation, but that the study had not been received by the time of Application submission.

Semiahmoo First Nation has explained that their “traditional economy was based on animals or fish that move around, and that there is a circulatory effect from the Fraser River into Boundary and Semiahmoo Bays,” which form the centre of their asserted territory (**Appendix 10-A, Figure 10-7**) (BC and PMV 2012). They also report having “regularly traveled through and gathered a number of foodstuffs from their traditional territory, including the Fraser estuary, Boundary Bay and areas now in Washington State,” and that their “members continue to use their traditional territory for their traditional economy on both sides of the border” (SFN 2011a). This use includes fishing in the lower Fraser River, which the Semiahmoo have characterized as enabled by relationships with other First Nations (SA 2006).

The Semiahmoo understand their Aboriginal rights to include, “amongst other things, the right to practice their culture in its entirety and the right to food security as per the traditional economy”; however, they have reported that their ability to pursue a traditional economy has been “severely limited” by urbanization and contamination of their food supply within their traditional territory (SFN 2011a). They are therefore seeking to restore or maintain, within that territory, the conditions necessary to promote the exercise of ancestral uses in the future (SFN 2011b).

Fishing

Within their traditional territory, Semiahmoo First Nation has reported that they once fished for salmon, sturgeon, halibut, eulachon, herring, smelts, sea mammals (including hair seals, sea lions, and porpoises), and a range of beach foods (BC and PMV 2012). Important salmon

fishing areas have been previously identified as including but not limited to Cannery Point on the southeast tip of the Point Roberts Peninsula and the Nicomekl and Little Campbell rivers that feed into Boundary Bay, where sturgeon was also taken (BC 2006).

Semiahmoo First Nation has said that they practiced their fishing rights in the Fraser River in the summer season at *Ti'ektines*, in the vicinity of the north end of the George Massey Tunnel. They have previously “acknowledged that Cowichan Tribes fished in the South Arm of the Fraser River and that access to this area was gained by the Semiahmoo First Nation via a series of marriage ties between Semiahmoo First Nation and Cowichan Tribes” (BC and PMV 2012). Semiahmoo First Nation has also said that they have access rights to the Salmon River and Kanaka Creek, which both join the Fraser River in the vicinity of MacMillan Island, near Fort Langley (PMV 2015).

Salmon has been described as central to the Semiahmoo, and reef-netting, an off-shore salmon fishing technique employed by the Semiahmoo and other Northern Straits Salish-speaking peoples, was a key harvesting mechanism; however, the technique could only be effectively applied in specific areas within Georgia Strait (SA 2006). These areas included the waters surrounding the Point Roberts Peninsula (i.e., Roberts Bank and Boundary Bay). While the Semiahmoo are closely associated with Boundary Bay, they reportedly maintained residences at Roberts Bank for the purposes of managing the three to four reef-net locations they owned in that vicinity (BC 2006, SA 2006). Reef-net sites were owned by family groups and inherited by the first-born son (PMV 2015).

Coho and chum, which in their preserved form have been described as being vital winter food, were harvested by other techniques within Semiahmoo territory, including Nicomekl and Little Campbell rivers, which drain into eastern Boundary Bay on the Canadian side of the international border. Salmon was also harvested on the American side of Boundary Bay, in Dakota and California Creeks and around Tongue Spit in Drayton Harbor (PMV 2015).

Shellfish were also important to the Semiahmoo, and Boundary Bay has been characterized as formerly one of the most productive shellfish harvesting locations on the Pacific coast (Norman, n.d.). This feature is said to have made it a key shellfish harvesting location for the Semiahmoo and other First Nations, who reportedly shared the area for this purpose (BC and PMV 2012).

Semiahmoo report that the focus of their sea mammal harvesting was on seals. They have said that seals travelled as far up the Fraser River as Harrison Lake in pursuit of salmon (PMV 2015).

In 2006, the Senco'ten Alliance, a now defunct organization with which the Semiahmoo were once affiliated, advised that it had been “approximately two decades or so since Sencot'en members...owned boats and fished directly (commercially or otherwise) in the Roberts Bank

vicinity.” The organization also advised that “there are very close ties between Semiahmoo, Katzie and Tsawout and [that], within those communities, some Sencot’ en fishing is undertaken every year in the lower Fraser, as has been the tradition since before contact” (SA 2006).

Fisheries and Oceans Canada (DFO) records over the last six years indicate that Semiahmoo First Nation has held communal licences to fish for food, social and ceremonial (FSC) purposes in the Fraser River upstream of between Port Mann Bridge to Kanaka Creek-Derby Reach (DFO 2016a). In 2015, Chinook were targeted during two 12 hour openings, on August 10 and 11. In 2014, sockeye was targeted during two 12 hour openings, on August 5 and 6. There was no Semiahmoo access in 2013, and access in 2012 was limited to between Kanaka Creek-Derby Reach and Mission, again in August, with only sockeye targeted. There were four sockeye openings for Semiahmoo in August 2011, of between 9 and 12 hours each, and only two openings in August and September 2010. Semiahmoo licences in 2010 and 2011 applied to the Port Mann Bridge to Kanaka Creek-Derby Reach section of the river. No access was indicated for 2009. Communal licence records dating back to 2004 indicate that all Semiahmoo access, when permitted, has occurred upstream of the Port Mann Bridge. Semiahmoo report that they are not currently engaged in commercial salmon fisheries (PMV 2015).

Concerning other fish species harvested for traditional purposes, sturgeon once served as an important substitute for other fisheries; however, current conservation measures prohibit sturgeon retention. Semiahmoo report that they also consumed eulachon, which is also under conservation measures, but whether it was, in the past, directly harvested or obtained through trade was not identified (PMV 2015).

Current Semiahmoo crab harvesting for FSC purposes, targeting Dungeness, graceful, and red rock varieties, has typically ranged from June through December, although there have been years where no openings have been reported (2009, 2012 to present), and other years where the harvest has been open year-round (2010). In 2011, the harvest was licenced for June through December in Pacific Fishery Management Area 29-8 (Boundary Bay), which corresponds to commercial crab Area J. Semiahmoo report that currently they are not participating in the commercial crab fishery, which in their opinion is inadequately regulated and results in overharvesting, resulting in fewer crab for the FSC harvest, fewer Semiahmoo participating in the harvest, and fewer opportunities for transference of knowledge about crab harvesting to youth (PMV 2015).

The once productive shellfish grounds of Boundary Bay, as identified above and where Semiahmoo once harvested steamer, manila, and butter clams, was closed to bivalve harvesting in 1962 for sanitary reasons (Norman n.d.; PMV 2015). The American side of the bay was recently opened to restricted use (Norman n.d., SFN 2011a); however, a sanitary and

biotoxin closure remains in place in British Columbia (DFO 2016b). This key resource area around which Semiahmoo territory is centred has therefore been unavailable to them for several decades for the purposes of harvesting bivalve species. Semiahmoo have conveyed an interest in becoming involved in commercial shellfish harvesting, particularly of geoduck, and in developing aquaculture and commercial harvesting of sea cucumber (PMV 2015).

Hunting/Trapping

Semiahmoo hunting has been previously reported as concentrated in and around lands to the east of Boundary Bay, on both the Canadian and American sides of the border. Lake Terrell, approximately 6 km (as the crow flies) southeast of Birch Bay in Washington State, was an area in which Semiahmoo hunted for elk, deer, and beaver. Beaver is also said to have been taken at the heads of the Serpentine and Nicomekl rivers (present-day Surrey and Langley), as well as bear (BC and PMV 2012). Mountain goat was reportedly accessed outside of Semiahmoo territory, and specifically on the north side of the Fraser River, via a trail along Kanaka Creek (PMV 2015).

Cranes, ducks, geese, swans, and other migratory birds were reportedly harvested for food, while ducks and duck down were also utilized for ceremonial and textile purposes. It has been previously reported that Semiahmoo hunted ducks at Tongue Spit on Drayton Harbor north of Birch Bay, and at the mouths of Dakota and California creeks, which both drain into Drayton Harbor (BC and PMV 2012). Semiahmoo have said that duck hunting sites at Tongue Spit were family owned (PMV 2015).

Gathering

Camas has been described as harvested in the past by the Semiahmoo on Waldron Island in Washington State, across Boundary Pass from South Pender and Saturna islands. The Semiahmoo also reportedly had prairies behind their villages where they could harvest camas and other bulbs. Gathered plants were exchanged with other nations for other foodstuffs; for example, the Semiahmoo reportedly received potatoes from the Snokomish at Blackie Spit, at the mouth of the Nicomekl River, after the founding of Fort Langley in 1827 (BC and PMV 2012).

Aquatic plants were also harvested, including bulrushes, tule rushes, and grasses. These were reportedly used extensively in the manufacture of mats, which were in turn used for a variety of purposes, including housing materials, beds, and food preparation. Mats have also been described as an important trade item; for example, they were once traded with the Nuuchahnulth nations for halibut. Tule rushes were harvested in May, and bulrushes in July. Gathering

locations for tule rushes and bulrushes are said to have included Burns Bog and the San Juan Islands, while grasses, used to bind the edges of mats, were found in parts of the Fraser River Valley (PMV 2015).

Semiahmoo reportedly practiced selective burning to boost berry plant growth, which also had the effect of increasing the availability of deer. Blackberries, blueberries, dew berries, huckleberries, salmon berries, Saskatoon berries, and thimbleberries were important summer harvests for Semiahmoo; gooseberries, raspberries, and strawberries were also consumed, but were not as common. Semiahmoo First Nation has said cranberry harvesting provided seasonal employment for their members following non-Aboriginal settlement (VAFFC 2011, PMV 2015).

Among other plants used traditionally by Semiahmoo have been identified as devil's club, rose hip, stinging nettle, and the wood, bark, or roots of various tree species (e.g., cedar, cherry, fir, spruce, willow, and yew), for a variety of purposes (VAFFC 2011, PMV 2015). The lower Fraser River, in the vicinity of Deas and Tilbury Islands, has previously been identified as an area where current plant harvesting by Semiahmoo may still occur (VAFFC 2011).

Related Interests

Semiahmoo First Nation has said that the use of lands and resources, access to which they report as now limited, has a spiritual and sacred element not readily separated from practical considerations. Legendary stories are also integrated into this world view, which relay that people related to the first ancestors, who descended from the sky, were transformed by Khaals (i.e., a mythical leader) into physical and biological elements of the landscape, and who remain relatives of the Semiahmoo. The Semiahmoo therefore consider themselves part of the landscape, of their territory, and this landscape serves as their sacred place, their history book, their storehouse of raw materials, as well as their training ground (PMV 2015).

Named places in the vicinity of the Project area previously reported by Semiahmoo include *SĆUOƧEN*, or Tsawwassen, as well as three sites on the the eastern aspect of the Point Roberts Peninsula, fronting Boundary Bay, as follows from north to south: *ŒESEWEL*, *ŚAWOM*, and *ĆEL,ŁTENEM* (also rendered *Chelhtenem* or *Tsel-lhtenem*, at Cannery or Lily Point). *ĆEL,ŁTENEM* has been previously identified as a summer residence of the Semiahmoo, as well as an important reef-net location for sockeye, while another summer residence of the Semiahmoo, where clams were harvested, has been previously identified in the vicinity of *ŒESEWEL* and *ŚAWOM*. One named place has also been previously identified along the main stem of the Fraser River upstream of the Port Mann Bridge, at *KITEY*, or Katzie (PMV 2015).

Squamish Nation

Key sources relied upon for this summary are publicly available information, as cited, and ongoing consultation between the Ministry and the Squamish Nation. As part of that ongoing consultation, Squamish was provided with a draft of this summary and the information that appears in **Section 10.1.1.9** for review and comment. Comments had not been received by the time of Application submission; however, Squamish Nation provided a shapefile of the territorial boundary that appears in **Appendix 10-A, Figure 10-8**).

Fishing

While Squamish Nation territory (**Appendix 10-A, Figure 10-8**) reportedly extends south as far the South Arm of the Fraser River, Squamish Nation do not currently fish directly in the Fraser River for food, social or ceremonial (FSC) purposes based on information previously reported by Squamish Nation (SN 2014) and a review of Fisheries and Oceans Canada (DFO) records regarding “Lower Fraser River Fisheries” from the last few years (DFO 2016). According to those DFO records, Howe Sound and the Squamish River have been the key areas for Squamish Nation salmon harvesting, and specifically within Pacific Fishery Management Area (PFMA) 28, subareas 28-2 to 28-4. Over the period 2013 to 2015, FSC salmon fishing in these areas was identified as taking place over several openings between July and December (DFO 2016).

As with salmon, Squamish Nation has also been licenced to harvest crab, prawn, and shrimp for FSC purposes in PFMA 28-2 to 28-4, and therefore well north of the Fraser River. From 2013 to 2015, the Squamish Nation were licenced to harvest crab (targeting Dungeness, graceful, and red rock) and shrimp within Howe Sound (PFMA 28-2 to 28-4), from mid-June through December. In 2015, the shrimp species targeted were coonstripe, humpback, pink (including flexed and smooth), and sidestripe. Squamish Nation was also licenced to harvest prawn in the same locations and during the same time frame (i.e., mid-June through December), but with four additional openings in January and February of 2013 (DFO 2016).

Squamish Nation report that, historically, they harvested Fraser River sockeye, based on family ties with other First Nations (i.e., Musqueam), and that Squamish presence on the Fraser River is well documented in historic accounts, including one from 1827. They have said that there is no other source for sockeye in Squamish Nation territory, and that fishing sockeye on the Fraser is integral to Squamish Nation culture. Accordingly, for many years, including initiating a formal request to DFO in 2011, Squamish Nation say they have sought an increase to their Fraser River sockeye allocation for FSC purposes (20,000 pieces) and an extension of their FSC fishing area to include the Lower Fraser River. Squamish Nation report that their current allocation per member is about 5 sockeye, which they say is the lowest per capita of any First

Nation that accesses Fraser River sockeye, and falls far short of their food needs. They have requested that their current allocation, set in 1992, be increased to 70,000 pieces, or 17 pieces per member. The current FSC allocation of Fraser River sockeye is reportedly obtained by a contracted seine boat that harvests in the Johnstone Strait area, outside Squamish Nation territory and traditional fishing areas. Squamish Nation has said that by expanding their FSC fishing area to include the Lower Fraser River, they would be able to fish Fraser River sockeye the way their ancestors did (i.e., directly) and re-establish their historical connections to the area (SN 2014).

Hunting/Trapping

Past, present, or desired future hunting or trapping of resources by the Squamish Nation in the vicinity of the Project area was not identified in sources reviewed.

Gathering

Past, present, or desired future gathering of terrestrial resources by the Squamish Nation in the vicinity of the Project area was not identified in sources reviewed.

Related Interests

Further information relating to Squamish Nation interests in the vicinity of the Project area beyond that provided above was not identified in sources reviewed.

Stz'uminus First Nation

Key sources relied upon for this summary are the George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands (BKRC 2015); Historical Geography of Cowichan Land Use and Occupancy, Lower Fraser River: Map Series and Report (Brealey 2010); Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area (CT 2015); a map showing "Cowichan Land Use" in the Project area, provided by Penelakut Tribe (PT 2014); regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Stz'uminus First Nation. As part of that ongoing consultation, Stz'uminus was provided with a draft of this summary and the information that appears in **Section 10.1.1.1** for review and comment. Comments were received from the Cowichan Nation Alliance, on behalf of the four member First Nations, and have been incorporated. In this summary, specific information on Stz'uminus First Nation's traditional use has been supplemented with general information on traditional use by Cowichan Nation Alliance and Hul'qumi'num Treaty Group Nation Alliance member First Nations.

The Project area intersects with the claimed core territory or “title lands” of the member First Nations of the Hul’qumi’num Treaty Group, including *Tl’uq̓tinus* (**Appendix 10-A, Figure 10-2**), which lies along the Fraser River less than 4 km upstream from the north end of the George Massey Tunnel (BKRC 2015). *Tl’uq̓tinus* has been described as a “great summer village of the Cowichan-speaking people of Vancouver Island” (Suttles 2004), with “winter-village style houses” (Rozen 1985) surrounded by cultivated grounds (see **Plate 1** below). More recently, *Tl’uq̓tinus* has been described as a permanently occupied, multi-seasonal Cowichan Nation settlement (Brealey 2010), with a significant winter population and a summer population in the thousands (BKRC 2015). The lands over which *Tl’uq̓tinus* is said to have extended along the south shore of Lulu Island have been reported as “conservatively located on portions of Sections 21, 22, 23, 24, 26, 27, 28, 33, and 34 of Block 4 North, Range 5 West, as well as a waterfront portion of Block 4 North, Range 4 West” (Woodward and Company 2011).

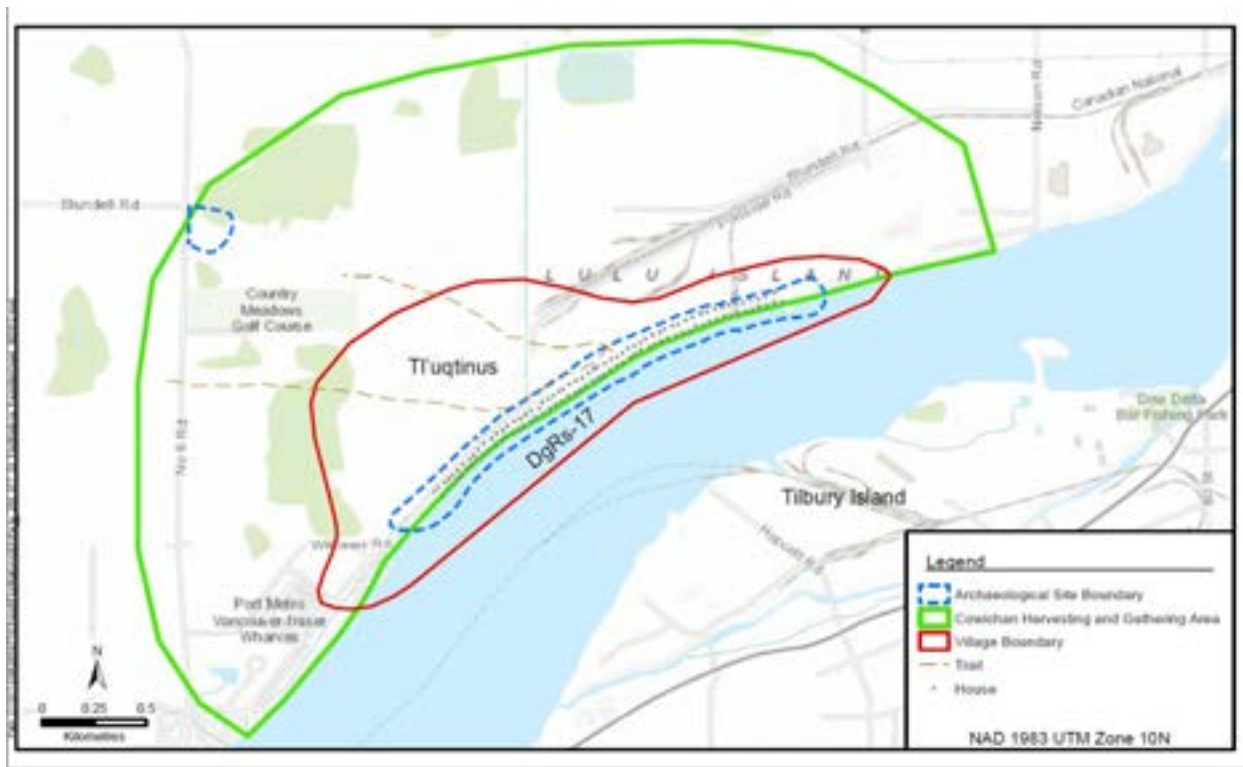


Plate 1. Lands of *Tl’uq̓tinus* Claim Area (CNA 2016a).¹⁰

¹⁰ This figure is a representation of information provided by the Cowichan Nation Alliance regarding *Tl’uq̓tinus* (2016a) in the context of consultation on the Project and does not constitute an admission, acknowledgment, or endorsement of that claim, position, or the accuracy of the information by the Ministry.

The Cowichan Nation Alliance has stated that *Tl'uqtinus* was a home base occupied and used exclusively by the Cowichan Nation, the descendants of which are members of the First Nations represented by the Cowichan Nation Alliance (CT 2015), as well as other member bands affiliated with the Hul'qumi'num Treaty Group (BC and PMV 2012, CT 2015, Woodward and Company 2011). This shared or joint occupation and use reportedly extended from well before 1792 until after 1859 (Woodward and Company 2011), and constituted a base of operations for a shared land use regime that reached up the Fraser River at least as far as the fisheries at the Fraser Canyon (Brealey 2010). As indicated in **Section 10.1.1.1**, the Cowichan Nation Alliance is working to reestablish a permanent land base and river access at *Tl'uqtinus* for residential and/or commercial purposes (CNA 2016a,b).

Fishing

Stz'uminus followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round (BC and PMV 2012, CT 2015, HTG 2005, Rozen 1985). Seasonal movements reportedly involved the relocation of entire households, including house planks and supplies, from location to location within the collective traditional territory, between three and five times annually. Within this round, the Fraser River estuary has been described as the “most important economically” (HTG 2005). Species harvested historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals; dried clams and other foodstuffs (e.g., camas) were also traded to other First Nations while *Hul'q'umi'num'*-speaking groups were resident in and around the area (BC and PMV 2012, BKRC 2015). The Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while resident on the Fraser River (CNA 2011). Stz'uminus used *Tl'uqtinus* seasonally for the foregoing purposes (TMPL 2014). Stz'uminus also used other habitation sites in the area, including one at Steveston (BC and PMV 2012, TMPL 2014).

Areas within the wider Fraser River estuary were also utilized by *Hul'q'umi'num'*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay) (HTG 2005). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations within their trans-Georgia Strait settlement round. Sockeye salmon and eulachon in particular could not be found in any river within Cowichan Nation's territory on Vancouver Island (CT 2015).

The Hul'qumi'num Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul'qumi'num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area (HTG 2005). The Hul'qumi'num Treaty Group have also reported that government regulations introduced in the same era also had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul'qumi'num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century (CT 2015, HTG 2005, TMPL 2014).

Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO) (Cohen Commission 2011). Access to sockeye for member First Nations (including other members of the Hul'qumi'num Treaty Group) is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River” (Cohen Commission 2011). In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008 (DFO 2016). In those years, the specific locations in the South Arm in which member First Nations of the Hul'qumi'num Treaty Group fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area) (DFO 2016). DFO records for communal FSC licences in the Fraser River downstream of the Port Mann Bridge do not suggest that any of these groups, individually or collectively, has had access to fisheries in this area in the last eight years (DFO 2016). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River (CNA 2016a).

Stz'uminus participates in the Hul'qumi'num Fisheries Limited Partnership (HFLP), a commercial fishing business, with Halalt First Nation and Penelakut Tribe. Species harvested through this enterprise are crab (one Area H licence), prawn (two local / coast wide licences), halibut (one licence and annual TAC quota), herring (13 gillnet and 1 seine), rockfish (two Area Inside licences, targeting yelloweye, quillback, copper, china, and tiger), sablefish (annual TAC quota), and salmon (five Area E gillnet licences) (HFLP 2014). Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island (PMV 2015, LFN 2016).

Hunting / Trapping

Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species (CNA 2011). Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round (BKRC 2015).

The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm (BKRC 2015, CT 2015). The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area (CNA 2011, CT 2015).

The Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted (CNA 2011).

Gathering

Member bands of the Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested (PMV 2015, PT 2014). Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed (BC and PMV 2012, BKRC 2015, CT 2015, HTG 2005, PT 2014, TMPL 2014, Woodward and Company 2011). With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees” (North et al. 1979; Woodward and Company 2011).

The Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl'uqtinus*, which is currently surrounded by blueberry farms, the Cowichan Nation Alliance have raised the potential for their former berry grounds to be re-established (Woodward and Company 2011).

Related Interests

The Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl'uqtinus*, and given where *Tl'uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. The Cowichan Nation Alliance has advised that it is also working to reestablish culturally integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl'uqtinus* (CNA 2016a).

The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members (PMV 2015).

Tsawwassen First Nation

Key sources relied upon for this summary are the Tsawwassen First Nation *George Massey Tunnel Replacement: Project Impact Study* (GMT 2015), Tsawwassen First Nation Final Agreement (TFNFA, TFN et al. 2009a,b), regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015a,b), and ongoing consultation between the Ministry and Tsawwassen First Nation regarding the Project. As part of that ongoing consultation, Tsawwassen First Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.10** for review and comment. The Ministry is aware that Tsawwassen First Nation expressed general satisfaction with the information provided for review but had received no specific comments by the time of Application submission.

The rights specified under the TFNFA, which are limited by measures necessary for conservation, public health, and public safety, include (TFN et al. 2009a):

- Tsawwassen First Nation Fishing Right, including harvesting aquatic plants;
- Tsawwassen First Nation Right to Harvest Migratory Birds;
- Tsawwassen First Nation Right to Harvest Wildlife;
- Tsawwassen First Nation Right to Gather Plants;
- Tsawwassen First Nation Right to Harvest Renewable Resources; and
- Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture.

The nature and extent of these treaty rights, and areas to which these treaty rights apply, are described in the relevant sections that follow below and shown in **Appendix 10-A, Figure 10-9**.

Fishing

Marine resources are largely discussed in Chapter 9 of the TFNFA (TFN et al. 2009a). Under the TFNFA, “fish” are defined as fish, intertidal bivalves and other shellfish, crustaceans, and marine animals (excluding cetaceans), the parts of these fish, as well as their the eggs, sperm, spawn, larvae, spat, juvenile stages and adult stages. “Intertidal bivalves” are further defined as manila clams, littleneck clams, butter clams, horse clams, soft-shell clams, varnish clams, blue mussels, cockles, and oysters. The Tsawwassen Fishing Area, which applies to fish and aquatic plants but excludes intertidal bivalves, takes in all or portions of PFMA 29 subareas 29-3, 29-4, 29-6 through 29-14 and 29-17. These subareas cover the waters of the Main Arm of the Fraser River westerly of the power lines downstream of the Port Mann Bridge, the waters of the North Arm of the Fraser River from the junction of the Main Arm downstream to the Arthur Laing Bridge, the Middle Arm of the Fraser River, the South Arm of the Fraser River, and parts of the waters of the Strait of Georgia and Boundary Bay (TFN et al. 2009b, Appendix J-1). Tsawwassen report that they actively fish in the South Arm of the Fraser River and within the Project area, and that portions of the Project occur within the two subareas 29-13 (Canoe Pass to Deas Island) and 29-14 (Steveston to Pattullo Bridge) (TFN 2015). Canoe Pass and the waters in and around Rose-Kirkland Island (i.e., Ladner Reach, Woodward Reach), which lie about 1 km downstream of the Project area, have been previously described as particularly important fishing areas (VAFFC 2011, BC and PMV 2012).

The right to harvest fish allows designated members of the Tsawwassen First Nation to exercise the right for domestic purposes and to trade or barter those fish among themselves or with other Aboriginal people resident in BC (TFN et al. 2009a, Chapter 9). Domestic allocations for sockeye, chum, pink, chinook, and coho salmon, which are centrally important to the

Tsawwassen First Nation, are calculated using formulas described in the TFNFA; generally, set at 625 Chinook, 15,226 sockeye, 2,500 pink (odd years only), 500 coho, and 2,576 chum (TFN et al. 2009b, Appendix J-2). Retained catch for the period 2009 through 2015 is presented in **Table 10.1-7**.

Table 10.1-7 Tsawwassen Domestic Salmon Catch (Kept), 2002 to 2015

| Species | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---------|-------|--------|-------|-------|--------|--------|--------|
| Chinook | 995 | 338 | 583 | 440 | 726 | 1,060 | 598 |
| Sockeye | 1,132 | 15,226 | 9,995 | 6,649 | 5,118 | 94,452 | 2,851 |
| Pink | 72 | 2 | 84 | 2 | 16,156 | 7 | 20 |
| Coho | 57 | 3 | 43 | 22 | 220 | 159 | 11 |
| Chum | 1,320 | 2,019 | 214 | 2,577 | 8,508 | 8,462 | 10,446 |

Source: (DFO 2016)

In 2009, Tsawwassen harvested salmon for domestic purposes during 27 openings (April 15 to November 15); in 2010 during 14 openings (June 20 to October 31); and in 2012, during 18 openings (June 17 to October 14) (PMV 2015a).

In 2013, Tsawwassen First Nation fished under communal licence for chinook salmon (8 to 18 hour openings, May 18, June 1, 8, 15, 22, 29, July 7, 13, 20, August 10, 11, 30, 31, September 1); sockeye salmon (24 to 36 hour openings, July 27 to 28, August 3 to 4); and chum salmon (36 to 48 hour openings, October 5 to 6, 12 to 14). There were no coho openings (although catch statistics report retained coho), and pink salmon were not harvested for domestic purposes in 2013 (see below); however, there were two additional “limited participation” fisheries (i.e., for ceremonial purposes) for chinook salmon in late August (PMV 2015a).

In 2014, Tsawwassen First Nation fished under communal licence for chinook salmon (8 to 48 hour openings, May 18, 24, 31, June 7, 14, 21 to 22, 27 to 29, July 4 to 6, 11 to 13, 18 to 20, August 31); sockeye salmon (12 to 24 hour openings, July 26 to 27, August 2 to 3, 10); and chum salmon (24 to 48 hour openings, October 4 to 5, 10 to 12, 18 to 19). There were no coho or pink salmon openings (although catch statistics report retained coho). There were two “limited participation” fisheries for sockeye salmon (4 hour openings, August 23 and September 12) in 2014 (DFO 2016).

In 2015, Tsawwassen First Nation fished under communal licence for chinook salmon (12 to 36 hour openings, May 2 to 3, 9 to 10, 23 to 24, June 6 to 7, 13 to 14, 20 to 21, 27 to 28, July 27, 28, 31, August 2 to 3, 10 to 11, 22, 23, 29, 30, September 5, 6); sockeye salmon (12 hour opening, August 1); and chum salmon (8-36 hour openings, October 10 to 11, 17, 18). There were no coho or pink salmon openings (although catch statistics report retained coho). There was one “limited participation” fishery for chinook salmon in 2015 (6 hour opening, July 25) (DFO 2016).

In addition to domestic fishing, the Tsawwassen First Nation Harvest Agreement, which is a contractual arrangement between the parties to the TFNFA that is separate from the TFNFA and does not “create, recognize or affirm aboriginal or treaty rights”, is intended to increase commercial fishing capacity for the Tsawwassen First Nation (TFN 2015). The Tsawwassen First Nation Harvest Agreement provides for an annual commercial allocation of Fraser River sockeye, chum, and pink salmon (odd years only). These commercial allocations vary with the size of the Canadian Commercial Total Allowable Catch (TAC) for sockeye and pink salmon and the Terminal Commercial Catch for chum salmon (TFN 2015). In 2013, there were seven openings for these purposes for pink salmon in September, and two openings for chum salmon in late October. In 2014, there were nine commercial openings for sockeye salmon in August and September, and two openings for chum salmon in late October. There were also two commercial openings for chum salmon in late October 2015 (DFO 2016).

The Tsawwassen First Nation Harvest Agreement is supported by the Tsawwassen Commercial Fish Fund and Tsawwassen Commercial Crab Fund, the monies from which are used to secure general commercial licences for salmon or crab for conversion to Tsawwassen First Nation Harvest Agreement licences (PMV 2015a). While commercial fishing by Tsawwassen members, either under a general commercial fishery licence or a Tsawwassen First Nation Harvest Agreement licence, is not treaty protected, the TFNFA does provide that Tsawwassen will be advised appropriately of any proposal to establish new emerging commercial fisheries in PFMA 14 through 20, 28, and 29 (the last of which includes the Project area), and will be consulted on the process for entry into and determining allocations for those fisheries (Chapter 9, paragraphs 106-107, cited in PMV 2015a). The TFNFA also requires that Canada compensate Tsawwassen if it reduces the number of licences or terminates the Tsawwassen First Nation Harvest Agreement (TFN 2015).

Fraser River eulachon, a traditional species, are fished in Canoe Passage in limited quantities (up to 50 lbs (23 kg) on average) for specific domestic purposes, typically in April and May, and only after conservation goals have been met. Three to six licences for eulachon were issued between 2009 and 2011 (TFN 2010, 2011, 2012); no licences were issued in 2012, and

only two were issued in 2013. Four licences were issued in 2014, and fisheries were limited to 6-hour periods on April 25 and 26, and on May 1 and 2. Another four licences were issued in 2015, with openings limited to 6-hour periods on April 11, 18, and 26, and on May 1 (DFO 2016). Tsawwassen report that eulachon, once very abundant, in particular in Canoe Passage, is now only available for distribution to Elders. They have expressed concern that any impact to eulachon may lead to a complete collapse of the species. Herring, another traditional species of continuing importance (MOT 2006), is not currently harvested, nor is herring spawn, which has been observed locally on crab traps (PMV 2015a).

Canoe Passage was once a key sturgeon harvesting area. Neither sturgeon nor steelhead can be kept due to conservation concerns. Sturgeon is among released salmon by-catch, largely in the stretch between Canoe Passage to Deas Island (PFMA subarea 29-14); however steelhead is rarely caught as by-catch (PMV 2015a). Trout and char are not identified in the annual post-season fisheries reports that have been generated since the TFNFA came into effect.

Groundfish (i.e., rockfish, lingcod, halibut, dogfish, and sole) may be harvested year-round for domestic purposes in the Tsawwassen Fishing Area. This harvest has not occurred since the TFNFA came into effect (TFN 2010, 2011, 2012). Tsawwassen report the return of halibut to the Roberts Bank area, and the harvesting of dogfish has occurred in the shallows near the Roberts Bank terminal. Rockfish, dogfish, and halibut are used for food as well as crab bait, with rockfish being the preferred species for bait as it discourages seals from interfering with the traps. Sole, and flounder, present in Canoe Passage, are reported to be small, and some flounder appear to be diseased (i.e., with growths or black spots). They are among released crab and salmon by-catch (PMV 2015a).

Since the TFNFA came into effect, four to five licences have been issued for the domestic crab harvest, targeting Dungeness, graceful, and red rock species; domestic harvests of crab are currently not subject to allocation limits and are permitted throughout the year. In 2009, 2011, and 2012, only Dungeness crab were kept (24,712, 20327, and 24,441, respectively); while in 2010 two red rock crab were kept along with 21,588 Dungeness crab. Tsawwassen report that since 2010 they have been operating a live holding tank to aid in the distribution of crab to their members throughout the year, and to prepare events such as Elder gatherings (PMV 2015a).

Tsawwassen report commercial crab harvesting currently occurs in Crab Management Area I, from June through November (PMV 2015a; see above for details about the relevance of the Tsawwassen First Nation Harvest Agreement to commercial crab fishing).

Shrimp and prawn may be harvested for domestic purposes at any time of year under the TFNFA; however, although a harvest document was issued in 2010, no recorded harvests have been made since the TFNFA came into effect (TFN et al. 2009a, PMV 2015a). Tsawwassen members report an interest in harvesting prawn on the eastern side of the Strait of Georgia. In areas where crabbing currently occurs (i.e., Roberts Bank and Boundary Bay), shrimp (copepods) have been caught as by-catch, along with other marine invertebrates such as sea pens, octopus, and amphipods (PMV 2015a).

Intertidal bivalves may be harvested in the Tsawwassen Intertidal Bivalve Fishing Area, which lies in PFMA 18 and includes the shorelines around Galiano Island, Mayne Island, Samuel Island, Saturna Island, and Tumbo Island (TFN et al. 2009b, Appendix J-1). Tsawwassen First Nation is in consultation with Hul'qumi'num nations to discuss intertidal bivalve fishing in areas of overlap with the traditional territories of those nations (TFN 2010, 2011, 2012). There has been no harvest of intertidal bivalves in the designated areas since the TFNFA came into effect (TFN 2010, 2011, 2012). Tsawwassen has expressed interest in developing shellfish aquaculture (PMV 2015a).

Tsawwassen report that from Sturgeon Bank south to Point Roberts, clams, cockles, mussels, oysters and abalone were once harvested by their members for food and other purposes such as trade and ceremonial regalia. Boundary Bay was considered an important harvesting area for bivalves, especially clams, cockles, and oysters, while scallops, sea cucumbers were taken from Boundary Bay through to Canoe Passage. Tsawwassen Elders report barnacles, which were harvested by being scraped from rocks, have reduced in size over the years. They also note that abalone, along with a large oyster bed (lying just south of the B.C. Ferries Terminal), began to disappear after development in the Roberts Bank area (i.e. Roberts Bank terminals and B.C. Ferry Terminal). The Elders have also reported that they stopped harvesting shellfish from the area before DFO put in place the existing biotoxin and sanitary closures (prohibiting harvesting of edible bivalves in several areas, including PFMA 29, restricting them from harvesting what was formerly a mainstay of their diet along the eastern side of the Strait of Georgia (PMV 2015a).

Aquatic plants (including attached and detached kelp and seaweeds) may be harvested for domestic purposes in the Tsawwassen Fishing Area at any time of day or year. These plants are specifically defined in the TFNFA as all benthic and detached algae, brown algae, red algae, green algae, golden algae and phytoplankton, and all marine and freshwater flowering plants, ferns and mosses, growing in water or soils that are saturated during most of the growing season (see "Gathering" section, below). Harvesting of these plants has not occurred since the TFNFA came into effect (2010, 2011, 2012).

Tsawwassen have previously reported that bulrushes have been harvested for basketry, and also for their medicinal properties. Tsawwassen members have also previously reported that at one time, seaweed grew “all over” and would be, along with sea asparagus, harvested “all along the shoreline” of Tsawwassen’s main community, although there is currently little to none reportedly left in these areas (PMV 2015a).

Marine mammals, including porpoise, seals, and sea lions, were once harvested by the Tsawwassen within the mouth and estuary of the Fraser River (VAFFC 2011). These marine animals (with the exception of porpoise, a cetacean) fall within the meaning of fish under the TFNFA (TFN et al. 2009a, Chapter 9). Tsawwassen have indicated that the community does not currently harvest marine mammals and that there is no desire to harvest marine mammals; however, they remain culturally important to the community (PMV 2015b).

Tsawwassen report seals are interfering with crab and fish harvesting, opening traps and damaging nets in search of food. They attribute this behaviour to an over-population of seals in this area, and a lack of Chinook (spring) salmon, a species declining in numbers. Seals have also been observed travelling further up the Fraser River than previously, including beyond the Alex Fraser Bridge. Tsawwassen explain they are increasingly fishing closer to New Westminster to avoid conflicts with the seals (PMV 2015a).

Hunting / Trapping

“Wildlife” is defined under the TFNFA as all vertebrate and invertebrate animals, including mammals, birds, reptiles, and amphibians, and the eggs, juvenile stages, and adult stages of these animals. The definition excludes fish (see previous section) and migratory birds.

“Migratory birds” means birds, as defined under federal law enacted further to international conventions, and includes their eggs.

The Tsawwassen Wildlife Harvest Area and Tsawwassen Migratory Bird Harvest Area are coextensive with Tsawwassen Territory (TFN et al. 2009b, Appendix K-1 and Appendix L-1); these areas therefore overlap the Project area. Specific species and harvesting sites (except Burns Bog for wildlife) are not identified in the TFNFA; however, locations near the Project area have been previously identified as preferred wildlife and migratory bird harvesting areas, particularly for deer, beaver, ducks, and geese. These locations include the south side of Lulu Island, the small islands, sloughs, marshes, and tidal flats of the Lower Fraser River, as well as the tidal flats at Boundary Bay (BC and Canada 2006, BCTC 2006, MOT 2006, BC and Canada 2008).

The Tsawwassen First Nation's right to harvest wildlife and migratory birds allows designated members to harvest wildlife and migratory bird resources for domestic purposes and to trade or barter wildlife, wildlife parts, and migratory birds among themselves or with other Aboriginal people resident in BC (TFN et al. 2009a, Chapter 10 and Chapter 11). Harvested wildlife, wildlife parts (including meat and furs), migratory birds, and inedible migratory bird by-products (including down) may also be sold if the sale is permitted by federal, provincial, and Tsawwassen law (VAFFC 2011). Wildlife and migratory bird harvesting rights may be exercised on private land (with the owner's permission) and, in the case of migratory birds, within National Wildlife Areas (with Canada's permission). With respect to wildlife harvesting specifically, the TFNFA acknowledges the "limited existing opportunity to harvest Wildlife and the likely future diminution or loss of any meaningful opportunity to harvest Wildlife in the Tsawwassen Wildlife Harvest Area" (TFN et al. 2009a, Chapter 10, paragraph 9).

At present, the Tsawwassen First Nation is not harvesting any wildlife or migratory bird species for which a conservation risk has been identified. Harvesting of migratory birds is permitted throughout the year (TFN et al. 2009a, Chapter 11).

Tsawwassen First Nation hunters have previously described locations throughout their traditional territory as preferred harvesting areas for wildfowl, including all of what are now Tsawwassen First Nation Lands and nearby fields, the shoreline from west of the Roberts Bank causeway up to and including Brunswick Point, and areas in and around Westham Island. Species harvested in the past include mallards, snow geese, and brant along the foreshore, and pintails, teals and wigeons in the back fields. Pheasants were previously taken "all over", and quail was also eaten (PMV 2015a). Other species identified as valuable are gadwall, goldeneye, bufflehead, and canvasback ducks; as well as Canada geese, gulls, and songbirds (TFN 2015).

Tsawwassen explain that birds are no longer as abundant as they once were, with some species, such as the pheasant, now scarcely found and others, such as geese, preferring Boundary Bay over Roberts Bank to nest (PMV 2015). They identify the following factors as impeding access to preferred areas, including development, privatization of lands, dangers related to discharging firearms in public areas, and the George C. Reifel Migratory Bird Sanctuary, on Westham Island's northwestern tip (PMV 2015).

Ducks and geese remain an important winter food and source of feathers, used for ceremonial purposes. Tsawwassen report the number of hunters has diminished and along with it the opportunities for transference of knowledge to youth (PMV 2015).

Tsawwassen explain deer and bear were once hunted from Point Roberts through Tsawwassen to Burns Bog, as well as on the Gulf Islands. Members had traplines for muskrat, otters, beaver, raccoon and rabbits from present-day Tsawwassen First Nation Lands to Westham Island. Currently, they pursue large game (e.g., deer and elk), in areas far removed from their Lands. Although they did not report current hunting or trapping of small animals, they did note there are fewer reporting requirements for small game harvesting than for other species, and thus some degree of harvesting is probable (PMV 2015).

Gathering

The TFNFA defines “plants” as all flora and fungi but does not include aquatic plants (see “Fishing” section, above) or trees except for their bark, branches and roots. Like other rights under the TFNFA, the First Nation’s right to harvest plants for domestic purposes includes the right to trade or barter plants among themselves or with other Aboriginal people resident in BC, as well as to exchange regalia or traditional or artistic objects made of plants among themselves or with other Coast Salish people for ceremonial purposes (TFN et al. 2009a, Chapter 13).

There are four Tsawwassen Plant Gathering Areas designated under the TFNFA (TFN et al. 2009b, Appendix M-1 and Appendix M-2). Two of these areas are located considerably north of the Project area, in Golden Ears Provincial Park and Pinecone Burke Provincial Park, at the northern extent of Tsawwassen Territory. The other two areas are located near the Project:

- the South Arm Marshes Wildlife Management Area, immediately downstream of the Highway 99 Fraser River crossing; and
- Provincial Crown Land within the Burns Bog Ecological Conservancy Area, north of the easternmost extent of the Project footprint.

Specific species harvested in these areas are not identified in the TFNFA; however, plant species and timber resources in the Project area include *quxmin*, salal, bog blueberries, Indian hemp, cattails and rushes, St. John’s wort, western red cedar, Douglas fir, western hemlock, western yew, black cottonwood, red-osier dogwood, and red alder (TFN 2015). Other plant species identified as important by Tsawwassen Elders or resource users include wild berries (e.g. blackberries, huckleberries, salmonberries, strawberries, snowberries, boysenberries, loganberries, raspberries, black caps, red caps), cherries, crabapples, wild onion, wild mint, rhubarb, Labrador tea, wild rose, thistle, Indian Consumption Plant, yellow or curly dock, devil’s club, ferns, cascara bark, barberry bark, and stinging nettle (PMV 2015a). Traditional timber resources also include cherry, hazelnut, and willow trees; driftwood was also collected from the beach to smoke fish, but no community smokehouses remain (PMV 2015a). Tsawwassen have reported that plants are mainly gathered in and around Tsawwassen First Nation Lands (where still available), and plans are currently underway to resume harvesting in designated areas and to support the transfer of traditional plant use knowledge to Tsawwassen youth (PMV 2015a).

Related Interests

The right to practice the culture of the Tsawwassen First Nation, as well as use of the *Hə́ŋqəmiŋə́m* language, is identified in Chapter 14 of the TFNFA. Several *Hə́ŋqəmiŋə́m* place names for important heritage sites in the vicinity of the Project area are also identified (TFN et al. 2009b, Appendix O-4). These include but are not limited to *ł'eqtinəs* (or *Tl'ektines*), identified in the TFNFA as DgRs-17, which places it slightly upstream of the Project area on the north shore of the South Arm of the Fraser River; and *čičiləx^wqəŋ* (Ladner Landing, DgRs-41) and *X^wlic'əm* (Brunswick Point on Canoe Pass, DgRs-35), both downstream of the Project area.

Tsawwassen emphasize the importance of the Fraser River to their members. In addition to reporting that it is used for transportation, recreation, and cultural purposes (TFN 2015), Tsawwassen have stated: “We are not involved in forestry and mining. If you cut us we bleed fish so any change in any aspect of the Fraser River will be a great concern to us” (MOT 2015). Tsawwassen stress the importance of their continued ability to fish, along with and the significance of fishing and associated activities to their community’s culture and economy (TFN 2015). Some traditional activities, such as spending time with Elders in the smokehouse, no longer occur, as the last smokehouse was demolished when Highway 17 was expanded (PMV 2015a).

Tsawwassen report that disturbance of fish and fish habitat (e.g., sturgeon) as well as water quality are their biggest concerns (MOT 2015). Tsawwassen Elders report changes to the foreshore north and south of their Lands (i.e., “our little beach”), to which they attribute access difficulties, decreases in species abundance, and compromised quality of resources, especially shellfish and crab. Accordingly, they say they have also experienced the loss of important and organic means for community gathering and socializing at this important location (i.e., *sčəwa'əən* and *ča yəm*), both internally and with other nations with whom they have traditionally traded. This has also meant the loss of opportunities to pass down traditions related to the use of the beachfront to their youth (PMV 2015).

Tsawwassen explain that participation in fishing, an integral element of Tsawwassen culture, is decreasing, due to diminishing stocks, increasing harvesting restrictions, and higher costs related to having to travel farther to harvest traditional resources. They identify the lack of a local dock as contributing to higher costs. Currently, Tsawwassen crabbers access preferred harvesting areas around Roberts Bank from Steveston, or from marinas in Ladner and Deas Slough. While public docks are available at the southeastern end of B.C. Ferries Terminal and at Brunswick Point in Canoe Passage, these docks are reportedly very busy, particularly in the summer months (PMV 2015a).

Further, Tsawwassen report that physical access to Fraser River fisheries has changed. Chilukthan Slough, which at one time ran between Roberts Bank and the Fraser River, from north of Tsawwassen First Nation Lands to the Ladner area, was considered Tsawwassen’s “short cut” to the Fraser River; the slough was filled along ago as a result of farm development, and was described as a “huge” loss by Tsawwassen Elders (PMV 2015a). Access to the Fraser River by water now involves a longer route around the existing Roberts Bank terminals and B.C. Ferries Terminal. For canoe journeys, Tsawwassen members must navigate as close as possible to the terminals to and from the river to avoid shipping lanes, large vessel traffic, and shallow waters (PMV 2015a).

Tsawwassen members report that the changes to current flows and sediment build up between the Roberts Bank terminals and causeway to Westham Island are the reason that Canoe Passage, an important fishing area and travel corridor to and from the South Arm of the Fraser River, has become difficult to transit other than at high tide. They report Canoe Passage has become narrower, which means that fewer fishing vessels are able to harvest in the area at any one time (PMV 2015a).

Tsleil-Waututh Nation

Key sources relied upon for this summary are Tsleil-Waututh Nation’s *Knowledge Study*, prepared for the Project (TWN 2015), regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Tsleil-Waututh Nation. As part of that ongoing consultation, the Tsleil-Waututh Nation was provided with a draft of this summary and the information that appears in **Section 10.1.1.11** for review and comment. Comments were received from the Tsleil-Waututh Nation and have been incorporated.

The spatial setting in the Tsleil-Waututh’s *Knowledge Study* was defined to include a Study Area that focuses attention on areas that Tsleil-Waututh say may be the most impacted by the Project (TWN 2015), which lies within their Consultaton Area (**Appendix 10-A, Figure 10-10**). The Study Area takes in the North Arm of the Fraser River, extends to the United States border in the south, to Annacis Island in the east, and to the Strait of Georgia, approximately 20 km offshore of Westham Island, in the west. Tsleil-Waututh report that these boundaries were selected to take into consideration the connectivity of adjacent lands, waters, and resources, and to encompass ecosystem characteristics and holistic stewardship values (TWN 2015). Within the Tsleil-Waututh Study Area, use is depicted in terms of buffered points indicating areas of moderate to high use and occupancy, most of which are associated with fishing activities (TWN 2015).

Tsleil-Waututh have previously stated that all the lands and waters draining into Burrard Inlet and Indian Arm constitute their core territory (a subset of their Consultation Area), and that their use of the South Arm of the Fraser River was dependent on kinship ties with other *Hə́ŋqəmiŋəm*-speakers (i.e., Tsawwassen, Musqueam) (PMV 2015). A high degree of use and occupancy has been identified for western and eastern aspects of Deas Slough and Deas Island, and *ł'əqtinəs*, on the north shore of the Fraser River opposite Deas Island. Tsleil-Waututh have identified this location as a Tsleil-Waututh summer fishing village visited by Tsleil-Waututh (TWN 2015). Tsleil-Waututh also reported other high frequency use areas of the Fraser River, including three areas between Westham Island and Lulu Island, an area immediately offshore of Steveston, and the entire stretch of Canoe Passage (TWN 2015). While Tsleil-Waututh continue to access the Fraser River for sockeye, it is not believed the Tsleil-Waututh assert title in or near the Project area.

Fishing

Marine resources were and remain central to Tsleil-Waututh for subsistence and cultural life. Salmon was a food staple, supported by the harvest of the full range of shellfish, including bivalves and crustaceans, sturgeon, a variety of groundfish (e.g., halibut, cod, sole, flounder, lingcod, rockfish, among others), eulachon, herring, and smelt, as well as aquatic plants, such as seaweeds. Seals, porpoises, and sea lions were also harvested. Resources were used immediately, or processed and stored for use in the winter while resident in large villages in and around Burrard Inlet (TWN 2013a), where the present-day community still lives. Tsleil-Waututh have said that access to different species of salmon was important because of their different qualities and requirements for preservation (TWN 2015).

Tsleil-Waututh report they hold a close cultural and spiritual connection to salmon (TWN 2015); however, sockeye salmon do not run in the tributaries of Burrard Inlet. The Tsleil-Waututh Nation has previously reported that their ancestors historically accessed sockeye on the South Arm of the Fraser River through kinship ties, moving to the area in July and August, where they would reside at Tsleil-Waututh seasonal villages with other *Hə́ŋqəmiŋəm*-speaking groups (i.e., Tsawwassen, Musqueam). Historically, they would paddle back to Burrard Inlet village sites with thousands of preserved sockeye from the Fraser River to last throughout the year. Fraser River sockeye remain a primary traditional food source for Tsleil-Waututh families, and salmon, herring, and crab are among the species that still contribute to the contemporary economy of Coast Salish peoples (TWN 2015).

Sturgeon and eulachon were also harvested while resident on the river, which the Tsleil-Waututh also used as a travel corridor (PMV 2015). Tsleil-Waututh report that, historically, billions of eulachon returned to the Fraser River to spawn, providing them with an important

early season fishery. Typically they dried eulachon. Currently, they occasionally receive Fraser River eulachon through relatives and cultural protocols. Sturgeon, due to its decline, is no longer a component of Tseil-Waututh diet. It is their goal to participate in the recovery of these species and their habitats for future generations (TWN 2015).

Tseil-Waututh may fish for FSC purposes under communal licences issued by DFO. PFMA subareas to which these licences apply include 28-11, 28-12, 28-13, 28-14, 29-3, 29-4, 29-6, 29-7, 29-9, 29-10, 29-11, 29-12, 29-13, 29-14, and 29-17 (DFO and TWN 2013). Subareas within PFMA 28 apply to eastern Burrard Inlet and Indian Arm; the other subareas within PFMA 29 cover the Fraser River downstream of the Port Mann Bridge and into the Strait of Georgia (DFO 2016). Subareas 29-13 and 29-14 overlap the Project corridor.

Tseil-Waututh's access to Fraser River salmon extend beyond sockeye and include pink, chum, chinook, and coho (incidental). In addition to communal FSC access, Tseil-Waututh holds 10 to 15 Allocation Transfer Program (ATP) communal commercial fishing licenses. This includes two crab, four to nine herring gill net licenses, one prawn, and three salmon gill net licenses.

In addition to communal licences issued by DFO, Tseil-Waututh report that they may access food fish through other means, such as through cultural protocols and kinship ties with neighbouring communities, when DFO communal licences are unavailable to Tseil-Waututh. Tseil-Waututh advise that they seek to access, protect, and restore traditional foods for future generations, and current and future desired use. For example, Tseil-Waututh report that they have submitted multiple requests to DFO to access Fraser River eulachon – a species traditionally accessed by Tseil-Waututh in the Fraser River – but has been denied an allocation. Tseil-Waututh cautions that DFO communal licence records are therefore not necessarily a comprehensive portrayal of Tseil-Waututh fisheries efforts (TWN 2016).

Tseil-Waututh reports that they have an extensive Fraser River sockeye fishery each year. For the most part, when there are no conservation concerns, Tseil-Waututh says they fulfill their communal allocation. The largest fishing effort occurs in August. Tseil-Waututh has also participated in, and continues to “reserve the right,” to a limited participation fishery for ceremonial purposes outside of the regular Tseil-Waututh sockeye fishing season (TWN 2016).

Tseil-Waututh have advised that, in every year since 2008, they have requested a communal licence for Chinook. With the exception of limited participation access in 2009, 2010, and 2014, Tseil-Waututh Nation has not been granted a DFO communal licence for Chinook. Tseil-Waututh says that they are striving to include Chinook in their Comprehensive Fisheries Agreement (CFA) with DFO, but that DFO continues to manage the Tseil-Waututh allocation of Chinook as a by-catch during other directed fisheries (TWN 2016).

In 2014, Tsleil-Waututh requested communal licences for Fraser River chum. As of 2016, Fraser River chum and pink salmon allocations have been added to Tsleil-Waututh Nation’s CFA (TWN 2016).

Statistics retained by DFO for salmon harvested below the Port Mann Bridge between 2009 and 2015, by First Nation groups other than Musqueam and Tsawwassen, including Tsleil-Waututh, are presented in **Table 10.1-8**.

Table 10.1-8 Below Port Mann Bridge Salmon Catch (kept) for Aboriginal Groups Other Than Tsawwassen and Musqueam, 2009 to 2015

| Species | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 |
|---------|------|--------|-------|-------|-------|--------|-------|
| Chinook | 430 | 91 | 126 | 165 | 30 | 141 | 44 |
| Sockeye | 86 | 12,247 | 9,390 | 6,010 | 3,817 | 10,379 | 1,548 |
| Pink | 2 | 0 | 730 | 0 | 0 | 0 | 53 |
| Coho | 0 | 4 | 5 | 2 | 7 | 3 | 4 |
| Chum | 110 | 60 | 89 | 63 | 62 | 30 | 93 |

Source: (DFO 2016)

Tsleil-Waututh also report having access to PFMA 29 for communal crab licences, and have been working with DFO through an access request process to recognize PFMA 29 for prawn and crab communal fisheries in the Tsleil-Waututh Nation’s CFA (TWN 2016)

Fishing is conducted under communal licences on behalf of the community; distributions of fresh fish are made within the community in season and by preserved methods during the winter months. A key objective of the Tsleil-Waututh’s FSC program is to increase access to all seafood species traditionally harvested in Tsleil-Waututh territory (TWN 2013b), an aspiration pursued in parallel with what the Tsleil-Waututh understand as an obligation to restore the lands and waters of the nation’s territory to its “former state,” for the benefit of future Tsleil-Waututh generations (TWN 2013c).

In addition to communal FSC access, Tsleil-Waututh Nation’s 2013 CFA with DFO also provides the nation with communal commercial fisheries access through an allocation transfer program (DFO and TWN 2013). For 2013, eligible allocations were limited to crab taken in Commercial Crab Management Area I (i.e., PFMA 28 and 29, excluding subareas 29-5 and 29-8), prawns caught “coastwide,” herring by gillnet (area not specified, but assumed to be in the “Gulf,” covering Area 14 to 18), and salmon gill net licences for Area D (Area 11 to 15 and 23 to 27) and Area E (Area 16 to 22, 28, 29, and 121).

Tsleil-Waututh participates in commercial fisheries through Salish Seas Limited Partnership, a business owned jointly with the Musqueam Indian Band and Sliammon First Nation. Species harvested commercially through this enterprise include crab (in Crab Management Area I), prawn, halibut, sablefish and herring (PMV 2015).

Hunting / Trapping

Species hunted historically and continuously by Tsleil-Waututh include ungulates, such as deer and elk, bear, ducks, and other waterfowl. The Tsleil-Waututh Nation has previously reported that waterfowl were hunted while resident on the South Arm of the Fraser River in July and August (PMV 2015). Current waterfowl harvesting by Tsleil-Waututh members in or near the Project area was not identified in sources reviewed.

Gathering

On southern Lulu Island, around No. 5 Road, Tsleil-Waututh Nation has stated that it harvested berries, and specifically cranberries, while resident on the Fraser River (TWN 2015). Tsleil-Waututh has also advised that, in 1870, “Sleholdoo, chief of Slilooet (i.e., Sla-holt, chief of Tsleil-Waututh) was a signatory on a petition to colonial authorities opposing the sale of cranberry patches on the Lower Fraser River.” In addition to demonstrating that Tsleil-Waututh utilized these areas for harvesting cranberries, Tsleil-Waututh consider this to be recognition by other signatory First Nations of Tsleil-Waututh’s “rights of utilization” at this location (TWN 2016). Current gathering activities by Tsleil-Waututh members in or near the Project area were not identified in sources reviewed.

Related Interests

Tsleil-Waututh have reported that all areas used for traditional purposes, such as fishing, hunting, and gathering, are regarded as sacred (TWN 2015). They have explained that the landscape utilized for these purposes was shaped, in the very distant past, by the Transformers—or *Xáls*, *Xexá:ls*, or *Khaals*—who began their journey at the Fraser River delta travelling upstream and creating the world (PMV 2015).

Tsleil-Waututh have also explained that waterways within their asserted territory were the principal means of accessing places such as *λ’əqtinəs* (on the north shore of the Fraser River opposite Deas Island); *kwy-yowka* (on the south shore of Lulu Island), and *ʔələqsən* (on the northern end of Westham Island) within the seasonal round of land and resource use. Tsleil-Waututh report two historic canoe routes connecting Roberts Bank to Boundary Bay, Canoe Passage, the South Arm of the Fraser River, and Sturgeon Bank, and two fishing villages, one opposite Deas Island in the Fraser River (associated with *λ’əqtinəs*) and the other at Cannery Point, on the southeastern corner of Point Roberts peninsula (PMV 2015).

Tsleil-Waututh has advised that, in 1867, “Slehortle of Slewet Burrard Inlet Villages” (i.e., Slaholt, chief of Tsleil-Wauuth)...was a signatory of a petition opposing restriction on First Nations travel on the Fraser River.” In addition to demonstrating that Tsleil-Waututh travelled the Fraser River, Tsleil-Waututh consider this to be recognition by other signatory First Nations of Tsleil-Waututh’s “right of unrestricted travel” within this waterway (TWN 2016).

Hwlitsum

Key sources relied upon for this summary are *The Hwlitsum First Nation’s Traditional Use and Occupation of the area now known as British Columbia* (HFN 2016), regulatory documents for other projects in close proximity to the Project area (e.g., PMV 2015), and ongoing consultation between the Ministry and Hwlitsum. As part of that ongoing consultation, Hwlitsum was provided with a draft of this summary and the information that appears in **Section 10.1.1.2** for review and comment. Comments were received from Hwlitsum and have been incorporated, where appropriate.

The Project is located within Hwlitsum territory (**Appendix 10-A, Figure 10-3**), upstream of Hwlitsum’s current and traditional year-round residence at Canoe Pass and downstream of *Tl’uqtinus*, along the Fraser River in the vicinity of the north end of the George Massey Tunnel. Hwlitsum report that *Tl’uqtinus* was a home base occupied and used exclusively by the Cowichan Nation, of which the Hwlitsum consider themselves to be descendants (HFN 2016a). Hwlitsum have stressed, however, that they are independent of the Cowichan Nation community and consult on their own behalf as a First Nation, and that they have been recognized as such by various levels of government and government entities, including the BC Treaty Commission (HFN 2016b).

Fishing

Like other members of the Cowichan Nation, Hwlitsum followed a seasonal round of resource use and regional settlement that involved spending winter on the Gulf Islands and southern part of Vancouver Island (December to February) and summer on the Lower Mainland (March to November) (HFN 2016a).

Hwlitsum began living year-round at Canoe Pass, reported as the centre of Hwlitsum fishing, after 1863, when the Lamalchi winter settlement on Kuper Island was bombed and burned by the Royal Navy (BC and PMV 2012; PMV 2015). While part of their salmon fishing season was also spent at *Tl’uqtinus* (BC and PMV 2012), all species of salmon, cutthroat, Dolly Varden, dogfish, flounder, steelhead, smelt oysters, crab, sturgeon, eulachon, and trout are or have been obtained by Hwlitsum at Canoe Pass or at nearby locations, such as Kirkland Island (salmon), Cohilakthan Slough (steelhead and salmon), Steveston (eulachon, up to the Highway

99 crossing), Ladner Reach (crab), and Roberts Bank (crab and sockeye) (HFN 2016a; PMV 2015). Salmon, steelhead, trout, and sturgeon were also taken further up the Fraser River and its tributaries. Areas within the wider Fraser River estuary were also reportedly utilized by Hwlitsum for fishing salmon, sturgeon, groundfish, and other marine resources (e.g., Tsawwassen, Point Roberts, Boundary Bay) (HFN 2016a).

Hwlitsum have said that access to and use of Fraser River resources has and remains aided by physical presence, including “a set of houses, two wharves and two net sheds” on or near Canoe Pass, as well as through kinship ties with other First Nations (HFN 2016a); however, other sources suggest that Hwlitsum do not currently have a communal licence to fish in the Fraser River for food, social and ceremonial (FSC) purposes, and that their access to their FSC allocation must be gained through negotiations with First Nations with a communal licence (Cohen Commission 2011).

Hwlitsum harvest crab and bivalve species such as clams (i.e., butter, manila, and littleneck), cockles, mussels, oysters, and abalone in the Gulf Islands. Shrimp are generally harvested throughout the Strait of Georgia (between the Gulf Islands and the Lower Mainland), as well as immediately west of the existing Roberts Bank terminals, with targeted shrimp harvesting at Sturgeon Bank. Other marine invertebrates taken include red and green sea urchin, octopus, squid and sea cucumber, all harvested on the western side of the Strait of Georgia (PMV 2015).

Hunting / Trapping

Hwlitsum have hunted at “Canoe Pass and all along the Fraser River as far up as Hope and Yale” (HFN 2016a). Species harvested by Hwlitsum in the vicinity of the South Arm of the Fraser River have included seal, otter, muskrat (Westham Island), black duck, mallard, widgeon, geese (snow, Canada), brant, pintail, pigeon, pheasant (Ladner Reach), and red fox; at Burns Bog, deer, and black bear have been taken. Many of these species continue to be harvested by Hwlitsum members in these areas and others on the Lower Mainland (e.g., waterfowl at Steveston and Boundary Bay, sandpiper at Roberts Bank), as well as on southeast Vancouver Island and the Gulf Islands (e.g., Valdes, Gabriola, Galiano) (BC and PMV 2012, HFN 2016).

Gathering

Hwlitsum have said they gathered up to 20 plant species from areas throughout their traditional round for food, medicinal, and other purposes. While some plants are no longer harvested, plants said to be currently utilized in the area of Canoe Pass include cattails, rhubarb, crab apple, and plums. Ferns and alder (for firewood and smoking salmon) have been reported as collected at Burns Bog (HFN 2016a), with cottonwood having been gathered in the area of

Tl'uqtinus (TMPL 2014). Hwlitsum have identified a preference for alder over cottonwood for smoking salmon, but have switched to the latter due to a reported unavailability of alder in the last few years. Hwlitsum also report harvesting marine plants, such as kelp, seaweed, and rockweed, from the Gulf Islands (PMV 2015).

Related Interests

Hwlitsum have explained that accessibility and availability of healthy local species for harvest within their traditional territory is important for food security as well as ritual and spiritual practices that are the foundation of their people. These local species are regarded as their ancestors, and the resources found within their asserted territory are what bind them to that landscape. Hwlitsum have said that fish habitat has shrunk or disappeared. Hwlitsum have also said that urbanization and cumulative effects of marine development in the area has contributed to diminished use of terrestrial resources (HFN 2016b, PMV 2015).

Hwlitsum report that these changes in resources and their use have disrupted community life and gatherings. For example, because they are no longer able to access eulachon, families no longer gather annually in the old houses and wharf at Canoe Pass to harvest, process, and distribute eulachon. This is said to be the case for other resources as well, particularly at preferred locations that have spiritual, economic, and ritual importance, and to which their oral traditions are tied. Hwlitsum have explained that changes in resources diminish their community's capacity to act collectively (HFN 2016a, PMV 2015), and that without fishing, hunting, and gathering – practices that Hwlitsum have exercised since time immemorial and that are central and integral to Hwlitsum identify – they will be unable to continue to pass on the teachings of generations of their ancestors (HFN 2016b).

10.1.3.3 Potential Effects

This section describes the potential adverse effects of the proposed Project on the exercise of Aboriginal Interests during Project construction and operation, as identified by Schedule B Aboriginal Groups to the Ministry during consultation on the Project or as derived from public sources. Aboriginal Interests identified in relation to all or portions of the Project area are listed in **Table 10.1-9**.

Table 10.1-9 Aboriginal Interests Identified by Schedule B Aboriginal Groups or in Other Sources as Potentially Affected by the Project

| Aboriginal Group | Aboriginal Interests Identified as Potentially Affected by the Project |
|----------------------------|---|
| Cowichan Tribes | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title (including specifically to <i>Tl'uq̓tinus</i>) |
| Halalt First Nation | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title (including specifically to <i>Tl'uq̓tinus</i>) |
| Hwlitsum | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title |
| Katzie First Nation | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title |
| Kwantlen First Nation | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title |
| Lake Cowichan First Nation | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title |
| Lyackson First Nation | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title (including specifically to <i>Tl'uq̓tinus</i>) |
| Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) |
| | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title (including specifically to <i>λ'eq̓tines</i>) |
| Penelakut Tribe | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title (including specifically to <i>Tl'uq̓tinus</i>) |
| Semiahmoo First Nation | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title |
| Squamish Nation | Asserted Aboriginal Rights |
| Stz'uminus First Nation | Asserted Aboriginal Rights |
| | Asserted Aboriginal Title (including specifically to <i>Tl'uq̓tinus</i>) |
| Tsawwassen First Nation | Tsawwassen First Nation Fishing Right |
| | Tsawwassen First Nation Right to Harvest Migratory Birds |
| | Tsawwassen First Nation Right to Harvest Wildlife |
| | Tsawwassen First Nation Right to Gather Plants |
| | Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture |
| Tseil-Waututh Nation | Asserted Aboriginal Rights |

The assessment of potential Project-related effects on the exercise of Aboriginal Interests identified above is informed by the information provided in **Section 10.1.3.2** regarding past, present, and desired future use of the Project area by each Schedule B Aboriginal Group, and the findings of the assessments for ICs or VCs linked or interrelated with the exercise of Aboriginal Interests (as listed in **Section 10.1.3.1**), including consideration of any cumulative effects and follow-up measures identified in those Part B assessments, as per the methodology outlined in **Section 3.10 Cumulative Effects Assessment** and **Section 3.11 Follow Up Strategy**.

Based on the information provided in **Section 10.1.3.2** regarding past, present, and desired future use and ongoing consultation between the Ministry and Aboriginal Groups, potential incremental Project-related interactions and effects may be experienced by those Aboriginal Groups across the four indicators identified in **Section 10.1.3.1**, namely:

- Access to preferred locations for the exercise of Aboriginal Interests;
- Availability of preferred resources for the exercise of Aboriginal Interests;
- Quality of preferred resources for the exercise of Aboriginal Interests; and
- Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

The analysis of potential changes associated with each of these four indicators during Project construction and operation is examined in the sections below in **Section 10.1.3.3.1** through **Section 10.1.3.3.4**. As indicated in those sections, not all potential changes may be experienced by all Schedule B Aboriginal Groups or in the same way. For example, some Aboriginal Groups may be expected to experience no effect or a negligible effect, while for others, the potential change may be anticipated to be measurable. For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected, while the following definitions were used to guide the characterization of an effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be minor (minimal or temporary modifications may be required to use preferred options), moderate (more frequent or longer term modifications may be required to use preferred options), or serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

In **Section 10.1.3.3.1** through **Section 10.1.3.3.4** below, potential changes in access to preferred locations for the exercise of Aboriginal Interests, in the availability or quality of preferred resources for the exercise of Aboriginal Interests, or in the quality of experience in exercising, or tied to the exercise of, Aboriginal Interests are analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests by Schedule B Aboriginal Groups in general. For a detailed breakdown of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests for each Schedule B Aboriginal Group, see **Section 10.1.3.8 Summary of the Aboriginal Interests Assessment by Aboriginal Group**.

10.1.3.3.1 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

As reviewed in **Section 10.1.3.2**, locations in or near the Project area linked to the exercise of Aboriginal Interests were identified by all Schedule B Aboriginal Groups. Project components and activities, as described in detail in **Section 1.1 Description of Proposed Project**, have the potential to interact with and adversely affect access to or patterns of use between traditional use locations identified by Aboriginal Groups that are or may be associated with the exercise of Aboriginal Interests. Specifically, three potential effects pathways on access have been identified, as follows:

- Potential changes in river hydraulics and morphology during and as a result of Tunnel removal could affect access to or use of preferred locations on the river for the exercise of Aboriginal Interests, such as fishing or other harvesting activities, if hydraulic or morphological effects altered the physical characteristics of these locations in a way that reduced or eliminated the ability to harvest at those locations.
- Potential changes in access to locations for the exercise of Aboriginal Interests (e.g., fishing, hunting/trapping, gathering, and related interests, such as cultural sites and transportation routes) may result from instream and upland Project construction activities that overlap locations associated with the exercise of Aboriginal Interests (see **Section 5.2 Marine Use, Table 5.2-6 Species Run Timings and Aboriginal and Commercial Fisheries Openings (in Number of Hours) in the Lower Fraser River** for an example of potential timing conflicts with Aboriginal fisheries).
- Potential changes in access to locations for the exercise of Aboriginal Interests may also result from footprint effects during Project operation.

Some of the specific concerns related to access raised by Aboriginal Groups during consultation with the Ministry included:

- Past and ongoing effects of the original highway and Tunnel construction on former access to and use of sloughs, creeks, and upland areas along the corridor;
- Past and ongoing effects of natural and anthropogenic changes on Fraser River access and use, including but not limited to closing off of side-channels and sloughs, alteration of shoreline, and ongoing dredging;
- Potential interference or displacement of fishing (e.g., gillnetting, which can occur daily), foreshore harvesting activities, and the ability to access the area from local marinas and boat launches as a result of marine traffic closures or obstructions related to Project activities;
- Potential Tunnel removal effects on existing fishing conditions related to river dynamics, to which fishers have become adapted, both upstream (e.g., Tilbury Island area) and downstream of the Tunnel (e.g., Duck, Barber, and Woodward Island complexes);
- Potential Tunnel removal effects to the river floor (i.e., creation of divets), river habitat, and ability to drop nets in preferred fishing spots (e.g., directly over the Tunnel);
- Potential Tunnel removal effects to shorelines, tidal wetlands, mudflats, drainage channel, and uplands of the South Arm Marshes Wildlife Management Area, downstream of the Highway 99 crossing, where plant harvesting occurs;
- Potential access effects due to the timing and duration of Tunnel removal, particularly in relation to specific runs (e.g., salmon, eulachon) and number of affected fishing seasons;
- Potential economic losses that could result from fishing access issues;
- Potential footprint effects on river foreshore and upland access as a result of Project component placement in upland areas that are currently accessible; and
- Ongoing effects on access as a result of increases in marine traffic volumes on the river, particularly as this relates to larger ships, which the Tunnel removal is perceived as facilitating.

Linked or Interrelated IC and VC Assessment Considerations

The IC and VC assessments presented in Part B of the Application were reviewed for relevance to the assessment of potential Project-related effects on access to locations for the exercise of Aboriginal Interests, and specifically **Section 4.1 River Hydraulics and River Morphology**, **Section 5.2 Marine Use**, **Section 5.3 Land Use**, and **Section 6.1 Heritage Resources**. The findings of these assessments are summarized in turn below.

As discussed in **Section 4.1 River Hydraulics and River Morphology**, potential Project-related changes as a result of Tunnel decommissioning (removal and post-removal) on Fraser River suspended sediment loads, current velocities, water levels, flow splits (i.e., into Ladner Reach and Canoe Pass), and morphology of the riverbed were assessed.

The Project has been designed with a clear-span crossing of the Fraser River South Arm, which avoids the potential for long-term effects on the hydraulics and morphology of the river. Potential Project-related effects are limited to those associated with Tunnel decommissioning and no long-term residual effects are expected after one to two freshets following Tunnel decommissioning.

Removal of Tunnel segments and overlying material has the potential to result in a temporary increase in suspended sediment volumes within and adjacent to the Tunnel alignment. Implementation of best practices and proven sediment control measures are expected to minimize such effects; however, a temporary increase in suspended sediment volume could persist in this area during and immediately following Tunnel removal activities. Following Tunnel decommissioning, a temporary lowering of the riverbed is expected to persist for one to two freshets between the Tunnel location and the Lulu Island-Delta watermain, owned by Metro Vancouver and located approximately 600m downstream. These construction-related adverse residual effects are considered to be of low magnitude in the context of relatively high turbidity of the river and dynamic riverbed conditions, which includes migrating sand dunes that are several metres high. The effects will be local in extent and short-term in duration, with an uncommon or occasional frequency. All potential effects are expected to be temporary and fully reversible. Construction-related changes in sediment volumes and temporary bed lowering are not expected to overlap temporally or spatially with similar effects of other projects or activities and result in cumulative effects.

Potential effects of the temporary change in river bed profile on the Lulu Island-Delta water main will be addressed through ongoing engagement and coordination with Metro Vancouver, and implementation of a monitoring and mitigation plan to be developed in conjunction with Metro Vancouver. Erosion and Sediment Control plans, developed as part of the CEMP, will be implemented during Tunnel removal to ensure potential effects on fish from elevated TSS levels or induced turbidity are avoided.

As identified in **Section 5.2 Marine Use**, the Project has been designed with a clear-span bridge across the Fraser River South Arm and Deas Slough, in a manner that avoids any potential impact on navigation, and no long-term residual effects on marine use are expected post-construction (see **Appendix 16.1 Reference Concept** for the proposed design of the new bridge).

During construction of the new bridge, specifically, component placement, and decommissioning of the Tunnel, the Project has the potential to temporarily affect marine navigation or other uses (including CRA fisheries) on the water in the vicinity of the crossing, where these activities and marine use overlap. Although such changes are expected to be minimized through the development and implementation of a Marine Access Management Plan, some effects are likely to persist during marine-based construction activities. These construction-related adverse residual effects are considered to be of low to moderate magnitude as access to the Fraser River South Arm will be maintained at all times during construction, with some restrictions such as tug assistance. Effects will be local, confined to the Fraser River South Arm, 2.5 km downstream and 5 km upstream of the Tunnel, and Deas Slough. Any effect on marine use will be short-term, limited to temporary increase in volume and frequency of marine traffic and occasional change in marine access during construction activities requiring marine-based vessels or equipment. All potential effects are expected to be temporary and fully reversible. Construction-related change in marine use is not expected to overlap temporally or spatially with similar effects of other projects or activities and result in cumulative effects.

To address potential Project-related effects during marine-based construction, a Marine Access Management Plan will be developed and implemented and will include communications protocols to establish and advise marine users of instream construction activities. Formation of a Marine Users Group, is proposed to support the development and implementation of the Marine Access Management Plan. This group would meet regularly over the course of construction to identify potential interactions and procedures for avoiding, reducing, or otherwise managing potential interactions. The Ministry is working with Aboriginal Groups to determine their preferences with respect to consultation on the development and implementation of the Marine Access Management Plan. The Ministry will work with Aboriginal Groups to identify potential interactions and procedures for avoiding, reducing or managing potential interactions with Aboriginal marine users.

(see **Section 5.2 Marine Use** for further details).

With regard to land access, **Section 5.3 Land Use** considered the Project's consistency with existing land use plans and designations and compatibility with adjacent land uses, as well as potential Project-related changes in area of existing land uses, disturbance to residential, commercial, and industrial land uses, disturbance to recreational uses near the new bridge, and change in regional growth patterns. Mitigation measures proposed by the land use assessment for potential effects include a combination of avoidance through Project design (i.e., largely keeping to within the right-of-way) and minimization of land user access effects during construction through incorporation of land use considerations into a Construction Traffic

Management Plan and incorporation of marine use considerations (regarding marine access from land-based facilities) into a Marine Access Management Plan, as identified in **Section 5.2 Marine Use**. In addition to the communications component of the Marine Access Management Plan identified in **Section 5.2 Marine Use**, **Section 5.3 Land Use** also identifies a communication component to the Construction Traffic Management Plan as a way for land users to identify priorities for timing, location, and options for access, as well as provision for the reconnection of trails (i.e., Island Tip Trail on Deas Island and Millennium Trail) that will be affected during construction. However, even with implementation of mitigation measures, construction activities in the Project alignment will likely result in some disturbance to adjacent land uses, primarily due to changes in access. With the majority of the LAA used for agriculture or having low-density development, only a limited number of land uses will be directly affected by construction activities. Shore-based marina facilities in Deas Slough may require temporary changes in scheduling. Access to recreational uses in certain areas may also need to be periodically restricted for short periods to protect the safety of users. Changes in land use are not readily distinguished from existing conditions, or such changes in use may be accommodated with minor changes in timing of activities. Recreational users will still be able to use areas outside of the restricted area, and restrictions will likely affect a relatively small number of users for a short period of time. The magnitude of construction-related residual effects is, therefore, considered low to moderate. The effects will be local in extent, frequent in terms of timing and short-term in duration, and are reversible.

The land use assessment predicts that residual effects to land users will be not significant. Project-related residual effects are reversible once construction is completed, and are therefore not considered likely to overlap with, and interact cumulatively with similar effects of other projects and activities.

Section 6.1 Heritage Resources notes that, while there are 14 recorded archaeological sites near the Project area (refer to **Figure 6.1-4**), Project-related effects to historical or archaeological heritage sites within the Project area are not expected, as no sites were identified in the course of fieldwork; however, an Archaeological and Heritage Resources Management Plan, including a chance-find procedure, and additional archaeological surveys to visit areas that were partially inaccessible during the field inventory (see **Figure 6.1-2**) are proposed. With regard to cultural sites that may not always coincide with locations that exhibit archaeological or historical material or features, including but not limited to spiritual sites and transportation routes, see the discussion in **Section 10.1.3.3.4**.

Summary of Potential Changes in Access to Locations for the Exercise of Aboriginal Interests

Potential changes in access to locations for the exercise of Aboriginal Interests by Schedule B Aboriginal Groups (as identified in **Section 10.1.3.2**) as a result of changes in river hydraulics or morphology are expected to be negligible (i.e., undetectable or unmeasurable) before additional mitigation for all Schedule B Aboriginal Groups, as it is not anticipated that Tunnel removal would result in measurable effects on the physical characteristics of preferred traditional use locations upstream or downstream of the crossing in a way that would reduce or eliminate the ability to access or use those locations in the way they are currently accessed and used at present or in the future.

Potential changes in access to instream locations for the exercise of Aboriginal Interests by Schedule B Aboriginal Groups (as identified in **Section 10.1.3.2**) during Project operation are also expected to be negligible before additional mitigation for all Schedule B Aboriginal Groups, as the bridge is designed to be clear span (i.e., no instream footprint).

Potential changes in access to upland locations for the exercise of Aboriginal Interests by Schedule B Aboriginal Groups (as identified in **Section 10.1.3.2**) resulting from Project footprint effects during operation are expected to be negligible before additional mitigation for all Schedule B Aboriginal Groups, as the footprint area required by bridge components and interchanges is expected to fall primarily within the existing Highway 99 right of way and is not expected to overlap with upland locations associated with the exercise of Aboriginal Interests (including but not limited to known archaeological, historical, or cultural sites, such as *λ'eqtines* or *Tl'uqtinus*, among other variations).

Potential changes in access to locations for the exercise of Aboriginal Interests by Schedule B Aboriginal Groups (as identified in **Section 10.1.3.2**) resulting from the overlap of instream construction activities and the exercise of Aboriginal Interests (e.g., fishing), should this overlap occur, are expected to be episodic and of short duration. Before mitigation, incremental Project construction-related effects on access to locations for the exercise of Aboriginal Interests could therefore be potentially disruptive (and therefore potentially measurable) for Schedule B Aboriginal Groups that have identified use of locations that may be subject to access interference or displacement as a result of instream Project construction activities.

Based on the information described in **Section 10.1.3.2** regarding past, present, and desired future use, it is expected these access effects could be experienced by all Schedule B Aboriginal Groups, but it is expected that these effects would be negligible for these groups except Musqueam Indian Band and Tsawwassen First Nation, given current reported access levels of these two groups relative to other Schedule B Aboriginal Groups in the South Arm of

the Fraser River. While it is acknowledged that other Schedule B Aboriginal Groups have reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Project design considerations and other measures identified in **Section 5.2 Marine Use** and **Section 5.3 Land Use** intended to avoid, reduce, or otherwise manage incremental access effects on use as a result of instream Project construction activities, including but not limited to participation (where desired) in a marine users group as part of the Marine Access Management Plan, are expected to largely address the incremental Project-related effects on access to locations for the exercise of Aboriginal Interests during construction that may be experienced by Musqueam Indian Band, Tsawwassen First Nation, and potentially other Schedule B Aboriginal Groups, should these Aboriginal Groups wish to participate in a marine users group or other consultation mechanisms involving other marine or land users. To specifically address potential effects on access to locations for the exercise of Aboriginal Interests, additional and separate consultative measures are identified below in **Section 10.1.3.4**.

10.1.3.3.2 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

As reviewed in **Section 10.1.3.2**, resources that occur in or transit through the Project area and that are linked to the exercise of Aboriginal Interests were identified by all Schedule B Aboriginal Groups.

Project components and activities, as described in detail in **Section 1.1 Description of Proposed Project**, have the potential to interact with and adversely affect the availability of resources associated with the exercise of Aboriginal Interests by changing species abundance or habitat, or by causing sensory disturbance, changes in behavior, or harm (physical injury or mortality) to fish (and fish habitat), marine mammals, terrestrial wildlife, or vegetation.

Some of the specific concerns regarding availability of resources raised by Aboriginal Groups during consultation with the Ministry included:

- Past and ongoing effects on fish habitat from river dredging;
- Past and ongoing effects on species availability and the ability to secure enough fish (e.g., salmon, eulachon, sturgeon) for a range of purposes (e.g., food, economic, health, social, and ceremonial), particularly when needs are anticipated to increase;
- Potential fish mortality from construction activities (e.g., pile driving, blasting);

- Potential Tunnel removal effects (e.g., water flow rates, sediment transport/concentrations) on salmon and eulachon runs and on sturgeon, which are year-round residents;
- Potential noise and vibration effects from construction activities on fish and marine mammals;
- Potential noise effects on eagles (a culturally important species) and their nesting areas, as well as ducks and other waterfowl;
- Potential light or other disturbance effects from the bridge on birds, fish, and wildlife (e.g., Deas Island a rare area of refuge for wildlife in the area);
- Potential bird and bat strikes with the new bridge; and
- Potential loss of native vegetation (e.g., cattail marsh, berries and rushes) and introduction of invasive species.

Linked or Interrelated IC and VC Assessment Considerations

The assessments presented in Part B of the Application were reviewed for relevance to the assessment of potential Project-related effects on access to locations for the exercise of Aboriginal Interests, and specifically **Section 4.4 Fish and Fish Habitat**, **Section 4.6 Marine Mammals**, **Section 4.7 Vegetation** and **Section 4.8 Terrestrial Wildlife**. The results of these assessments are summarized below according to the Aboriginal Interest with which they are most closely associated (i.e., fishing, hunting/trapping, gathering).

Fishing

Section 4.4 Fish and Fish Habitat examined potential Project-related effects to fish or changes in fish habitat quality or quantity. The assessment focused on species of CRA value or conservation concern, namely: (1) salmon (Chinook, chum, coho, pink, sockeye); (2) sturgeon (green, white); (3) eulachon; (4) trout (coastal cutthroat, rainbow steelhead); and (5) char (Dolly Varden, bull trout). Measures to address identified Project-related effects to fish include Project siting and design (e.g., limiting work to within the right of way, use of a clear-span bridge over the Fraser River); a Fish and Fish Habitat Management Plan within the CEMP and OEMP (which will consider least-risk timing windows, underwater noise, and turbidity/TSS levels) and an Erosion and Sediment Control Plan (also included within the CEMP and OEMP); habitat enhancement at Green Slough and Deas Slough; and habitat offsetting for habitat loss through a Fish Habitat Offsetting Plan. These measures are expected to be largely effective at addressing potential Project-related effects; however, a residual effect from crushing or entrainment of fish resulting in physical injury or direct mortality could occur as a result of Project construction activities. The effect, which is considered of low likelihood (or unlikely) to

occur, is determined to be not significant, as it is not expected to affect the population integrity of any of the fish sub-components. No cumulative effects are anticipated. Monitoring will be conducted to ensure mitigation measures identified in **Section 4.4** are implemented and expected outcomes, in terms of avoiding or minimizing potential Project-related adverse effects to fish and fish habitat, are achieved.

Hunting/Trapping

Underwater noise generated during Project construction activities was assessed in **Section 4.6 Marine Mammals** for potential effects on marine mammals, and specifically in relation to harbour seals. Project operation activities are not anticipated to generate underwater noise, and are therefore not expected to result in adverse effects on marine mammals. Mitigation measures related to Project-construction underwater noise effects on harbour seals (Marine Mammal Management Plan of the CEMP and underwater noise monitoring) are expected to prevent physical injury and minimize the potential for behavioural disturbance of marine mammals. No residual Project-related effects are anticipated, and the Project is not expected to contribute to cumulative effects on marine mammals; however, with regard to sea lions, the Ministry will work with DFO as required to determine the potential need for monitoring and follow-up programs to ensure that the measures identified in **Section 4.6** are also effective at avoiding or minimizing Project-related effects on sea lions.

As indicated in **Section 4.8 Terrestrial Wildlife**, Project-related activities could lead to terrestrial wildlife habitat loss, habitat alteration (as a result of sensory disturbance from noise or changes in water quality), and/or mortality during construction and operation. Focal wildlife species identified for the assessment include upland birds (e.g., great blue heron, barn owl, olive-sided flycatcher, common nighthawk, barn swallow, and bald eagle), riverine birds (i.e., double-crested cormorant, crackling goose, tundra swan, Caspian tern, and western grebe), and small mammals (i.e., three species of shrew and southern red-backed vole). Mitigation measures identified in the wildlife assessment to address potential Project construction or operation effects include Project siting and design considerations; best management practices and environmental management plans within the CEMP and OEMP, including provisions of the Terrestrial Vegetation and Wildlife Management Plan (e.g., timing windows, pre-construction surveys, salvage and relocation), Erosion and Sediment Control Plan, and Fish and Fish Habitat Management Plan; habitat enhancement, and habitat offsetting. After the implementation of mitigation, residual effects are expected to include habitat loss for upland birds (i.e., barn swallow nesting habitat) during Project construction and direct mortality to barn owl during Project operation; however, these residual effects are considered not significant, as affected wildlife are expected to remain self-sustaining in the assessment area.

They are also considered of low likelihood to occur, and no cumulative effects are anticipated. Monitoring will be conducted to ensure mitigation measures identified in **Section 4.8** are implemented and expected outcomes in terms of avoiding or minimizing effects on terrestrial wildlife, specifically barn swallow and barn owl, are achieved.

Gathering

Section 4.7 Vegetation identifies the potential for both temporary effects on at-risk ecosystems (i.e., cattail marsh) in the Project area as a result of construction activities, as well as permanent footprint effects from the installation of some Project components. Project operation is not expected to affect at-risk ecosystems.

Project-related effects on vegetation that cannot be avoided through Project design and implementation considerations, such as the loss of cattail marsh adjacent to River Road and Green Slough due to unavoidable footprint effects, are expected to be fully addressed through a Terrestrial Vegetation and Wildlife Plan and Invasive Species Management Plan within the CEMP, habitat enhancement, and habitat offsetting measures.

As the Project is not expected to result in residual effects on vegetation, the Project is therefore not anticipated to contribute to cumulative effects on at-risk ecosystems. Monitoring will be conducted during and after construction to ensure mitigation measures identified in **Section 4.7** are implemented and expected outcomes in terms of avoiding or minimizing effects on vegetation, specifically at-risk ecosystems, are achieved. Post-construction monitoring will focus on the progress of the functioning of the habitat created to offset potential footprint effects on at-risk ecosystems (i.e., cattail marsh).

Summary of Potential Changes in Availability of Resources for the Exercise of Aboriginal Interests

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish sub-components are expected to also be effective at avoiding, reducing, or otherwise managing potential effects on the availability of resources for the exercise of Aboriginal Interests related to fishing. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect the population integrity of any of the fish sub-components, potential residual effects as a result of Project construction activities, were they to occur, would not be expected to measurably affect the availability of fish resources for the exercise of Aboriginal Interests associated with those resources. Project construction or operation activities would not therefore be expected to measurably affect, incrementally or cumulatively, the availability of fish resources for the exercise of Aboriginal Interests associated with those resources.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments to address Project-related effects on marine mammals and terrestrial wildlife are expected to also be effective at avoiding, reducing, or otherwise managing effects on the availability of resources for the exercise of Aboriginal Interests related to hunting/trapping. Further, residual Project effects on upland birds (i.e., barn swallow, barn owl) identified in the wildlife assessment are not anticipated to affect these birds at the population level. Potential Project-related effects on marine mammals and terrestrial wildlife are therefore not expected to measurably affect, incrementally or cumulatively, the availability of these wildlife resources for the exercise of Aboriginal Interests associated with those resources.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to also be effective at avoiding, reducing, or otherwise managing effects on the availability of resources for the exercise of Aboriginal Interests related to gathering, specifically through offsetting for loss of cattail marsh, revegetation with native plants of traditional importance, and management of invasive species. Project construction or operation activities would not therefore be expected to measurably affect, incrementally or cumulatively, the availability of vegetation resources for the exercise of Aboriginal Interests associated with those resources.

Based on the above, Project-related effects on the exercise of Aboriginal Interests related to potential changes in the availability of resources (i.e., fish and fish habitat, marine mammals, terrestrial wildlife, or vegetation) would be expected to be negligible after the implementation of mitigation identified in Part B of the Application in relation to these resources; however, additional consultative measures to specifically address Aboriginal Group concerns related to potential effects on the availability of resources associated with the exercise of Aboriginal Interests are identified below in **Section 10.1.3.4**.

10.1.3.3.3 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

As reviewed in **Section 10.1.3.2**, resources that occur in or transit through the Project area linked to the exercise of Aboriginal Interests were identified by all Schedule B Aboriginal Groups.

Project components and activities, as described in detail in **Section 1.1 Description of Proposed Project**, have the potential to interact with and adversely affect the quality of resources linked to the exercise of Aboriginal Interests. Potential effects on resource quality could be experienced by traditional users through direct changes to the quality of the physical resource (i.e., water), or indirectly through changes to biological resources (e.g., traditional or “country” foods) that may be affected by changes in water or air quality.

Some of the specific concerns regarding the quality of resources raised by Aboriginal Groups during consultation with the Ministry included:

- Past and ongoing effects of natural and anthropogenic changes on the overall health of the Fraser River and its carrying capacity for further change;
- Potential Tunnel removal effects on the quality of fish (e.g., if driven out from where they are supposed to be by Project construction activities and then return degraded);
- Potential pollution/contamination effects on resources from Tunnel removal or stormwater runoff from bridge;
- Potential human health effects from consumption of polluted/contaminated resources; and
- Potential effects on water quality for certain cultural practices (e.g., bathing and other spiritual activities) as a result of Project activities.

Linked or Interrelated IC and VC Assessment Considerations

The assessments presented in Part B of the Application were reviewed for relevance to the assessment of potential Project-related effects on the quality of resources for the exercise of Aboriginal Interests, and specifically **Section 4.2 Sediment and Water Quality**, **Section 4.4 Fish and Fish Habitat**, **Section 4.6 Marine Mammals**, **Section 4.8 Terrestrial Wildlife**, **Section 4.7 Vegetation**, **Section 4.9 Air Quality**, and **Section 7.1 Human Health**. In addition, key findings of the HIA (Section 7.2) undertaken to support Project planning were used, where appropriate, to support the assessment of potential effects on Aboriginal Interests. The results of these assessments are summarized below.

As discussed in **Section 4.2 Sediment and Water Quality**, the Project has been designed with appropriate stormwater runoff collection and management features that avoid any direct road runoff into the Fraser River, and no residual effects on water or sediment quality are expected post-construction. Implementation of best practices and proven sediment and erosion control measures are expected to avoid any potential effects on water and sediment quality during Project construction; however a minor increase in turbidity and total suspended sediment (TSS) levels could persist in the immediate vicinity of construction activities during Tunnel removal.

This residual effect is considered to be of low magnitude, given the relatively high turbidity of the river and characteristics of bed sediments in the Project area, which are consistent with sediments transported in the Fraser River in general. Effects will be local in extent, short-term in duration, with an uncommon or occasional frequency, and fully reversible. Construction-related increase in turbidity and TSS levels is not expected to overlap temporally or spatially with similar effects of other projects or activities and result in cumulative effects.

Erosion and Sediment Control plans, developed as part of the CEMP, will be implemented during Tunnel removal to ensure potential effects on fish from elevated TSS levels or induced turbidity are avoided. The effectiveness of measures undertaken as part of these plans will be evaluated through monitoring over the construction phase.

Section 4.4 Fish and Fish Habitat indicates that residual effects to fish from exposure to elevated suspended sediment levels are not expected following the implementation of mitigation, including measures outlined in **Section 4.2 Sediment and Water Quality**. For marine mammals, only underwater noise was evaluated for potential Project-related effects on these animals in **Section 4.6 Marine Mammals**; however, given the sediment and water quality and fish and fish habitat assessment results, marine mammal exposure to contaminants as a result of Project-related activities would not be expected.

With regard to terrestrial resources, **Section 4.9 Air Quality** indicates that a qualitative assessment of Project-related changes to air quality during Project construction activities was undertaken, as detailed information on construction equipment will not be confirmed until the final design is complete. However, because potential incremental changes to air quality associated with highway construction are well understood and can be addressed through the application of mitigation measures that have been demonstrated to be effective, residual effects on air quality during construction are expected to be minimal. Specific measures to address construction related effects on air quality will be included in an Air Quality and Dust Control Management Plan within the CEMP. Once the Project is operational, measures for managing vehicle emissions and road dust are expected to contribute to an improvement over existing air quality conditions. While air quality effects on terrestrial resources are not explicitly addressed in **Section 4.7 Vegetation** or **Section 4.8 Terrestrial Wildlife**, effects on these resources as a result of exposure to airborne contaminants are not anticipated given the results of the air quality assessment.

Similarly, while **Section 7.1 Human Health** does not address potential exposure to contaminants through consumption of edible aquatic or terrestrial resources, the uptake of contaminants in edible resources as a result of Project activities would not be expected given

the results of the water quality and air quality assessments. This prediction is supported by the findings of the health impact assessment, undertaken to support Project planning, summarized in **Section 7.2 Health Impact Assessment**.

Summary of Potential Changes in Quality of Resources for the Exercise of Aboriginal Interests

Mitigation measures identified in the assessments of sediment, water, and air quality to address potential Project-related effects are expected to be effective at avoiding, reducing, or otherwise managing effects on the quality of resources for the exercise of Aboriginal Interests related to traditional use of water for cultural purposes and the consumption of edible resources. Potential Project-related effects on the exercise of Aboriginal Interests related to potential changes in the quality of resources would therefore be expected to be negligible after the implementation of mitigation identified in Part B of the Application in relation to these resources; however, additional consultative measures to specifically address Schedule B Aboriginal Group concerns related to potential effects on the quality of resources associated with the exercise of Aboriginal Interests are identified below in **Section 10.1.3.4**.

10.1.3.3.4 Changes in Quality of Experience in Exercising, or Linked to the Exercise of, Aboriginal Interests

As described in **Section 10.1.3.2** and reviewed above in **Section 10.1.3.3.1** through **Section 10.1.3.3.3**, locations and resources that occur in or transit through the Project area and that are linked to the exercise of Aboriginal Interests were identified by all Schedule B Aboriginal Groups. Project components and activities, as described in detail in **Section 1.1 Description of Proposed Project**, have the potential to interact with and adversely affect the the quality of experience in exercising, or tied to the exercise of, Aboriginal Interests in relation to these locations and resources. Two potential pathways for these effects are examined in this section:

- Quality of Experience in Exercising Aboriginal Interests -- Direct sensory disturbance to traditional users (e.g., through Project-related changes in air quality, noise or vibration levels, or visual quality) that do not flow through a biological resource VC (e.g., fish, vegetation, wildlife); and/or
- Quality of Experience Tied to the Exercise of Aboriginal Interests - Indirect changes in cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – as a result of changes in access to or use of locations or the availability or quality of resources.

To the extent that Project components and activities are not expected to result in measurable effects on access to locations or the availability or quality of resources for the exercise of Aboriginal Interests following the implementation of mitigation (as described above in **Section 10.1.3.3.1** through **Section 10.1.3.3.3**), potential indirect effects on the quality of experience or cultural heritage tied to the use of those locations and resources would also not be expected as a result of those indirect pathways; however, as indicated in **Section 10.1.3.3.1**, a potential measurable temporary effect on access as a result of instream construction activities may be expected for Musqueam Indian Band and Tsawwassen First Nation, potentially resulting in a measurable indirect effect on the quality of experience (i.e., cultural heritage) tied to the traditional use of affected river locations could also occur.

Traditional users may experience direct sensory disturbance in the exercise of Aboriginal Interests as a result of Project-related emissions (i.e., air, noise, vibration) and/or as a result of changes in visual quality, which can result in disturbance to the cultural landscape. These potential adverse effects may be experienced independently of potential effects on access to locations or the availability or quality of resources reviewed above in **Section 10.1.3.3.2** and **Section 10.1.3.3.3**. These potential adverse effects on quality of experience are analyzed in turn below.

Disturbance from Potential Changes in Air Quality or Noise or Vibration Levels

As reviewed in **Sections 10.1.3.2** and **Section 10.1.3.3.1**, use of locations in or near the Project Area linked to the exercise of Aboriginal Interests was reported by Schedule B Aboriginal Groups. Traditional users of these locations could be disturbed directly by air, noise, or vibration emissions during Project construction or operation.

Some of the specific concerns regarding the air, noise, and vibration emissions on the exercise of Aboriginal Interests raised by Aboriginal Groups during consultation with the Ministry included:

- Past and ongoing effects of noise increases over time since the highway and Tunnel were built;
- Potential noise effects from increased marine traffic, particularly large vessels, and noise or vibration effects from bridge traffic; and
- Potential noise effects on resources relied upon for the exercise of Aboriginal Interests (see **Section 10.1.3.3.2**, above, for consideration of these potential effects).

Linked or Interrelated IC and VC Assessment Considerations for Potential Changes in Air Quality or Noise and Vibration Levels

The assessments presented in Part B of the Application were reviewed for relevance to the assessment of potential Project-related effects on the exercise of Aboriginal Interests due to potential disturbance from air, noise, or vibration emissions during Project construction or operation, and specifically **Section 4.9 Air Quality**, **Section 4.10 Atmospheric Noise**, **Section 5.3 Land Use**, and **Section 7.1 Human Health**. The results of these assessments are summarized below.

As discussed in **Section 4.9 Air Quality**, Project-related reduction in idling due to congestion and consequent reduction in vehicle emissions is expected to contribute to an improvement in air quality, and no Project-related adverse residual effects on air quality are expected post construction. Potential risk associated with inhalation of COPCs in air for agricultural, residential, and recreational receptors, as well as oral/dermal exposure to COPCs in soil, plants, and livestock for agricultural receptors, were still considered as part of the health effects assessment, but no adverse health effects as a result of changes to air quality from Project-related emissions were identified (**Section 7.1 Human Health**).

The types of air emissions expected during Project construction (e.g., from construction equipment) are different than those associated with highway traffic, and Project construction is expected to have some influence on local air quality. However, because potential incremental changes to air quality associated with highway construction are well-understood and can be addressed through the application of mitigation measures that have been demonstrated to be effective, adverse residual effects of construction on air quality are expected to be low in magnitude, and confined to active construction areas. Such effects will be temporary, of short-duration, and fully reversible. Construction-related increase in air emission levels is not expected to overlap temporally or spatially with similar effects of other projects or activities and result in cumulative effects.

As described in **Section 4.10 Atmospheric Noise**, with the application of mitigation measures (e.g. noise barriers) in accordance with the Ministry's Noise Policy, post-construction ambient noise levels at most residential and institutional receptors along the Project alignment are predicted to be lower than current levels. This long-term operational residual effect of the Project on noise conditions at residential and institutional receptors are considered to be positive, and of negligible to low magnitude. Once the new bridge becomes operational, noise levels within Deas Island Regional Park, specifically in proximity to the bridge approach, will increase, but will remain below levels that warrant mitigation for residences, schools, and places of worship.

During construction, mitigation measures and best practices, including equipment and activity restrictions, appropriate scheduling of construction activities, noise monitoring, and community communication, will be implemented to minimize potential Project-related effects on ambient noise conditions. However, frequent construction noise will be experienced in areas near active construction sites. The magnitude of residual construction noise will vary from low to high, depending on receptor location relative to construction site, and nature of construction activity. Effects will be short-term during construction of interchanges etc., and of moderate term during pile installation for the new bridge. During other construction activities, effects of lower magnitude will be experienced occasionally to frequently at receptor sites along the corridor for short durations. All construction-related effects on atmospheric noise will be temporary and fully reversible. Project-related changes in atmospheric noise levels are not expected to overlap temporally or spatially with similar effects of other projects or activities and result in cumulative effects.

As discussed in **Section 7.1 Human Health**, potential Project-related effects on human health associated with changes in noise or vibration from Project construction activities (i.e., stress and annoyance, sleep disturbance, speech interference) at sensitive receptor sites are expected to be avoided or minimized through mitigation measures identified in **Section 4.10 Atmospheric Noise**, as referenced in the previous paragraph. The measures identified in the noise assessment for Project operation, such as noise barriers, are also expected to address the minimal increases in noise levels during that phase of the Project that could lead to stress and annoyance. The increase in average nighttime noise levels with the Project compared to existing conditions is not expected to be perceptible, and therefore not expected to incrementally affect sleep disturbance compared to existing conditions. With regard to average daytime noise levels that could exceed the speech comprehension threshold, the overall increase in noise levels as a result of Project operation over existing conditions is anticipated to be minimal (generally less than 5 dBA) and therefore not perceptible by the majority of affected receptors. Project operation is also not expected to substantially influence ground-borne vibration levels experienced by sensitive human receptors. No further mitigation is therefore proposed by the human health assessment beyond that proposed in **Section 4.10 Atmospheric Noise**.

An overview of the results of **Section 5.3 Land Use** are presented above in **Section 10.1.3.3** in relation to changes in access. In addition to potential Project-related access effects on residential, commercial, industrial, and recreational users, the land use assessment predicts potentially measurable noise-related effects on recreational users during Project construction

and operation, and visual quality effects on recreational users during Project operation. Residual effects as a result of noise and visual quality changes are also expected following the implementation of mitigation identified in **Section 4.10 Atmospheric Noise** and **5.5 Visual Quality**; however, these residual effects are not expected to change the level of recreational activities of this user group and are considered not significant.

Disturbance to the Cultural Landscape

As reviewed in **Section 10.1.3.2**, tangible, semi-tangible, and intangible cultural heritage sites and places in the Project Area that are linked to the exercise of Aboriginal Interests, including the Fraser River itself, were reported by Aboriginal Groups. Some of these sites and places are identified in **Table 10.1-1 Halkomelem Place Names in the Vicinity of the Project** (as well as , **Appendix 10-A, Figure 10-1**). These sites and places include an area on the north side of the Fraser River that has been described by Aboriginal Groups as “opposite” Deas Island and/or Tilbury Island (e.g., *Áəq̓tinəs*, *Tl’uq̓tinus*, and other variations), and an area on the south side of the Fraser River adjacent to Deas Island (e.g., *Pətxənéməx*, *pətxəneməx^w*, *Pulhxuneewmuhw*, and other variations). Table 10.01-1 describes *Tl’uq̓tinus* as being located on the south shore of Lulu Island, spanning from opposite Deas Island to Tilbury Island, and potentially extending from Woodward’s Landing (at the foot of No. 5 Road) to Ewen’s Cannery (on the west end of Lion Island), in the area of the Tunnel crossing.

Some of the specific concerns regarding tangible (e.g., archaeological resources), semi-tangible, and intangible cultural heritage raised by Aboriginal Groups during consultation with the Ministry included:

- Potential impacts to the quality of experience while using the Fraser River for cultural purposes (e.g., transportation, transmission of knowledge to younger generations) due to permanent alteration of the viewscape;
- Past impacts on cultural and archaeological sites as a result of anthropogenic changes and importance of preventing new impacts to cultural and archaeological sites and the cultural landscape;
- Need for thorough archaeological/heritage assessments, particularly but not only at interchanges and Deas Island, and protecting cultural heritage that has been passed down over thousands of years; and
- Importance of Aboriginal Group participation in assessments and reviewing archaeological reports and chance-find procedures.

Linked or Interrelated IC and VC Assessment Considerations for Disturbance to Cultural Landscape

The assessments presented in Part B of the Application were reviewed for relevance to the assessment of potential Project-related effects on the exercise of Aboriginal Interests as a result of potential disturbance to the cultural landscape, and specifically **Section 5.3 Land Use**, **Section 5.5 Visual Quality** and **Section 6.1 Heritage Resources**. The results of these assessments are summarized below.

The findings of **Section 5.3 Land Use** related to visual quality are summarized in the previous section related to air quality and noise and vibration levels. No specific mitigation measures are proposed in the land use assessment to manage potential Project-related visual quality effects on recreational users beyond the measure identified in **Section 5.5 Visual Quality**.

As outlined in **Section 5.5 Visual Quality**, potential Project-related effects on visual quality are not expected as a result of Project construction. During Project operation, visual quality within 1 km of the proposed bridge is expected to change, namely at Viewpoint 4 (Tunnel Access Road), Viewpoint 6 (Captain's Cove Marina), Viewpoint 9 (Millennium Trail), Viewpoint 10 (east of Captain's Cove Marina), and Viewpoint 14 (Millennium Trail beside Captain's Cove). At a distance of 1 km or greater, the bridge piers and deck will appear to merge with the natural and anthropogenic landscape, and the main visual features will be the bridge towers. Based on the visual resources assessment, visual quality is therefore not expected to change at locations beyond 1 km. This would include visual quality at Viewpoint 5, 11, 12, and 13, which are at setbacks between 1 km and 6 km from the proposed bridge (respectively, at Wellington Point Park near the entrance to Canoe Pass, at the foot of No. 5 Road, at the foot of No. 3 Road, and on Westham Island along Canoe Pass). Residual effects on visual conditions within 1 km are, however, expected as a result of Project operation, as mitigation measures (i.e., vegetation buffers) are not expected to fully reduce the effect of the new bridge, which will be noticeable compared to existing conditions (i.e., the Tunnel, a submerged feature); however, these effects are considered not significant, as the area around the Project has already been affected by moderate to high levels of human development, the visual environment is considered resilient to the incremental addition of a bridge, and the incremental residual change would not be expected to be experienced at locations beyond 1 km of the new bridge alignment. The likelihood of the effect occurring is considered moderate, but it is not considered likely to combine with the residual effects of other certain and reasonably foreseeable projects and activities that will be carried out, as these projects or activities do not appear to include structures or components that would be visible from the locations where Project-related changes in visual conditions are expected (refer to **Section 5.5 Visual Quality** for details).

The visual assessment notes that its findings are subjective as viewer perceptions and opinions on having a new bridge as part of the viewscape, and the aesthetics of the new bridge itself, would vary widely.

As discussed above in **Section 10.1.3.3.1, Section 6.1 Heritage Resources** reports that, while there are 14 recorded archaeological sites near the Project area (see **Figure 6.1-4**), Project-related effects to historical or archaeological (tangible) heritage sites within the Project area are not expected, as no sites were identified in the course of fieldwork; however, an Archaeological and Heritage Resources Management Plan, including a chance-find procedure, and additional archaeological surveys to visit areas that were partially inaccessible during the field inventory (see **Figure 6.1-2**) are proposed.

Summary of Potential Changes in the Quality of Experience in Exercising or Linked to the Exercise of Aboriginal Interests

Disturbance from Potential Changes in Air Quality or Noise or Vibration Levels

As reviewed above, Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality. For Project construction, potential air quality and vibration effects are expected to be mitigated to levels that will not affect human receptors. Consequently, Project-related air quality or vibration effects on the quality of experience in exercising Aboriginal Interests are either not expected or would be expected to be negligible with the implementation of mitigation measures identified in **Section 4.9 Air Quality** and **Section 4.10 Atmospheric Noise**.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to largely address incremental noise changes related to Project construction and operation activities (which are relied upon in **Section 7.1 Human Health**), would also be expected to largely address this potential incremental Project-related effect to the quality of experience in the exercise of Aboriginal Interests over existing conditions; however, at locations where the exercise of Aboriginal Interests overlap or are in proximity to known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible (e.g., in and around Deas Island), and in relation to which other noise (e.g., boat engine noise) may not mask the incremental Project-related noise increase, changes in noise levels as a result of Project operation could conceivably have a measurable and permanent effect on the quality of experience at those locations for some but likely not all Schedule B Aboriginal Groups, by an unknown factor. To address this uncertainty and Schedule B Aboriginal Group concerns related to potential residual noise effects on the quality of experience while exercising Aboriginal Interests, additional consultative measures are identified below in **Section 10.1.3.4**.

Disturbance to the Cultural Landscape

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, the location of these sites may not always coincide, or coincide completely, with locations that have intangible cultural value or meaning to Aboriginal Groups (e.g., spiritual or storied sites, named places). Physical alterations to the landscape, irrespective of whether it results in impacts to archaeological or historical sites, may still affect how this landscape is experienced culturally.

For similar reasons, while **Section 5.5 Visual Quality** predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge (i.e. after the addition of vegetation buffers), the addition of a new feature to this landscape may affect the quality of experience (i.e., cultural heritage) tied to the exercise of Aboriginal Interests both within and beyond 1 km.

Based on these considerations, mitigation measures proposed in **Section 5.5 Visual Quality** and **6.1 Heritage Resources** are not expected to address a potential incremental and permanent Project-related effect to the quality of experience tied to the exercise of Aboriginal Interests that may be associated with the introduction of a new prominent feature to the cultural landscape. Given, however, that this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be, before additional mitigation, minimally but permanently disruptive for Schedule B Aboriginal Groups, all of whom have identified a historical connection to and continued or desired use of sites or places that help define the cultural landscape in the Project area. Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed below in **Section 10.1.3.4**.

10.1.3.4 Mitigation Measures

This section identifies mitigation measures proposed to avoid, reduce, or otherwise manage potential adverse effects of the Project on the exercise of Aboriginal Interests described in **Section 10.1.3.3**, in a manner consistent with the methods described in **Section 3.5 Mitigation Measures** of the Application. The Ministry has considered the following opportunities identified by Schedule B Aboriginal Groups to date in proposing mitigation measures to address potential Project-related effects on Aboriginal Interests:

- Opportunities for reestablishing the original hydrodynamics of the area;

- Opportunities for enhancement/restoration of habitat that supports fishing, creation of shading/protective areas for fish, or other measures resulting in net gain rather than only “no net loss”;
- Opportunities to restore the shoreline of the river (e.g., marshes, cattail ecosystems);
- Opportunities to incorporate innovative design elements into the Project (e.g., rain gardens on the new bridge, dedicated commercial lanes);
- Opportunities to incorporate Aboriginal heritage into the bridge design, signage, and naming, and to involve Aboriginal Groups in that process, or otherwise publicly recognizing Aboriginal Group traditional territories and histories in the Project area; and
- Opportunities for Aboriginal Groups to benefit economically from the Project (e.g., employment and business opportunities).

Mitigation measures identified in Part B of the Application were reviewed in **Section 10.1.3.3** for their effectiveness at also addressing potential Project-related effects on the exercise of Aboriginal Interests. As described in **Section 10.1.3.3**, these measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation, except potentially in the following cases:

- Project construction:

Potential temporary direct effect on access related to instream construction activities and a potential temporary indirect effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access, particularly for Musqueam Indian Band and Tsawwassen First Nation based on higher reported levels of current use

Potential temporary direct effect on quality of experience related to construction-related noise and a potential temporary indirect effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance

- Project operation:

Potential permanent direct effect on quality of experience related to traffic noise and a potential indirect effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

To address these potential Project-related effects – in addition to relevant mitigation measures identified in Part B for ICs and VCs linked to the exercise of Aboriginal Interests (as reviewed in **Section 10.1.3.3**) – ongoing consultation between the Ministry and Schedule B Aboriginal Groups is proposed during Application Review and subsequent to the issuance of an EAC, should the Project be approved. Plans for ongoing consultation following Application submission are laid out in **Section 10.1.2 Consultation Activities**. As part of those plans, the Ministry will continue to consult Schedule B Aboriginal Groups to facilitate their review of construction-related plans and designs and their involvement in Project components of interest, such as environmental enhancement and mitigation.

As described in **Section 12.0 Management Plans**, a CEMP will be prepared prior to the initiation of Project construction to provide guidance on actions and activities that will be carried out during that phase of the Project, and to identify measures to reduce the risk of occurrence of incidents that could affect the environment and reduce any effects that are unavoidable. A series of sub-plans within the CEMP will address activity-specific mitigation measures. Sub-plans that will include measures that are considered to be also effective at avoiding, reducing, or otherwise managing potential adverse effects of the Project on the exercise of Aboriginal Interests during Project construction were reviewed in **Section 10.1.3.3**. These include but are not necessarily limited to the following:

- Air Quality and Dust Control Management Plan
- Archaeological and Heritage Resources Management Plan
- Erosion and Sediment Control Plan
- Fish and Fish Habitat Management Plan
- Marine Mammal Management Plan
- Noise Management Plan
- Terrestrial Vegetation and Wildlife Management Plan
- Traffic Management Plan
- Marine Access Management Plan

As also described in **Section 12.0 Management Plans**, an OEMP will be developed prior to commencement of the operations phase of the Project. The OEMP will describe the environmental management measures and best management practices that will be in place throughout Project operation, and will address operation and maintenance activities that may adversely affect environmental, social, economic, heritage, or health components. Like the CEMP, the OEMP will include sub-plans to address activity-specific mitigation measures. Elements of the OEMP that are considered to be also effective at avoiding, reducing, or

otherwise managing potential adverse effects of the Project on the exercise of Aboriginal Interests during Project operation were identified in **Section 10.1.3.3**. Elements of the OEMP include but are not necessarily limited to the following:

- Management of stormwater and surface water runoff and maintenance of stormwater management features and facilities;
- Fish and Fish Habitat management, including if required a Fish Habitat Offsetting Plan; and
- Vegetation and Wildlife management plans.

To facilitate the inclusion of Aboriginal Interests considerations of Schedule B Aboriginal Groups into the effective management of potential Project construction and operation effects, the Ministry will consult affected Schedule B Aboriginal Groups on the development of plans contained within the CEMP and OEMP. For further details on the CEMP and OEMP, refer to **Section 12.0**.

As described in **Section 13.0 Monitoring and Follow-Up Programs**, an Environmental Monitoring Plan will be developed to guide implementation of the CEMP, OEMP, and associated management plans and monitoring programs. Monitoring programs that are considered to be also effective at avoiding, reducing, or otherwise managing potential adverse effects of the Project on the exercise of Aboriginal Interests were reviewed in **Section 10.1.3.3**. These programs are anticipated to include but not limited to the following:

- Air quality and noise monitoring program
- Water quality monitoring program
- Underwater noise monitoring program
- Wildlife monitoring program
- Fish and fish habitat monitoring program

As with the CEMP and OEMP, the Ministry will consult affected Schedule B Aboriginal Groups on the development of monitoring and follow-up programs to facilitate consideration and inclusion of their Aboriginal Interests. For further details on the Environmental Monitoring Plan, refer to **Section 13.0**.

After consideration of the measures identified by linked or interrelated SC and VC assessments, including the CEMP, OEMP, and Environmental Monitoring Plan relevant to those assessments, including consultation with Schedule B Aboriginal Groups on their development and implementation, the need for additional mitigation related to the quality of experience in exercising, or tied to the exercise of, Aboriginal Interests was identified in **Section 10.1.3.3**.

To specifically address a potentially measurable incremental Project-related effect on the quality of experience (i.e., cultural heritage) tied to the exercise of Aboriginal Interests that may be associated with the introduction of a new prominent feature to the cultural landscape, the Ministry proposes to work with affected Schedule B Aboriginal Groups to develop and implement a Cultural Heritage Management Plan, either separate from or as a subcomponent of the Archaeological and Heritage Resources Management Plan, to recognize the cultural heritage (e.g., named places, stories) of Schedule B Aboriginal Groups associated with the location of the new bridge. During consultation with the Ministry, Schedule B Aboriginal Groups raised suggestions to address cultural heritage such as incorporating Coast Salish themes into the new bridge design, giving the new bridge a traditional name, and/or creating viewpoints or kiosks along the alignment that describe or display Coast Salish history and artwork, among other potential considerations. The Ministry will discuss cultural heritage with Schedule B Aboriginal Groups.

10.1.3.5 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4**, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

10.1.3.6 Outstanding Aboriginal Interests Issues Raised by Aboriginal Groups

As indicated in **Section 10.1.2.13 Process for Resolving Outstanding Issues Raised by Aboriginal Groups**, the Ministry acknowledges that some issues, concerns, or interests raised by Aboriginal Groups during the engagement and consultation process to date were not fully addressed prior to submission of the Application. A summary of the Ministry's perspective on the status of each Aboriginal Group's Aboriginal Interests issues (e.g., resolved, ongoing resolution, referred to agency, etc.) is provided in **Section 10.3 Issue Summary Table**.

10.1.3.7 Publicly Available Project Arrangements or Agreements with Aboriginal Groups

The Ministry is continuing to consult with each Schedule B Aboriginal Group to address issues that are specific to each Aboriginal Group. To date, the Ministry has undertaken to:

- Provide capacity funding to support meaningful participation in consultation activities with the Ministry and in the regulatory process, including the preparation of traditional use and knowledge studies to inform the Application;
- Provide opportunities for Aboriginal Groups to participate in fieldwork and studies; and
- Continue discussions with affected Aboriginal Groups related to Project benefits, both non-economic and economic, including training, employment, contracting, and other opportunities.

At this time, there are no publicly available details regarding arrangements or agreements between the Ministry and Aboriginal Groups. Such arrangements or agreements, where completed, typically remain confidential. For further details on the Ministry's completed and planned Aboriginal consultation activities and outcomes in relation to the Project, refer to **Section 10.1.2**.

10.1.3.8 Summary of the Aboriginal Interests Assessment by Aboriginal Group

Cowichan Tribes

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Cowichan Tribes at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Cowichan Tribes has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Cowichan Tribes has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including at and about the reported location of *Tl'uqtinus*.

Based on the analysis potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by the Cowichan Tribes are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Cowichan Tribes, except in the following potentially measurable cases:

- Project construction:
Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Cowichan Tribes regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of a Cultural Heritage Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Cowichan Tribes as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Cowichan Tribes is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Halalt First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Halalt First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Halalt First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Halalt First Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including at and about the reported location of *Tl'uqtinus*.

Based on the analysis potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by the Halalt First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Halalt First Nation, except in the following potentially measurable cases:

- Project construction:

Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:

Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Halalt First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Halalt First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Halalt First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Hwlitsum

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Hwlitsum at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Hwlitsum has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Hwlitsum has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including seasonal fishing at *Tl'uqtinus*.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Hwlitsum are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Cowichan Tribes, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

 Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Hwlitsum regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Hwlitsum is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Katzie First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Katzie First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Katzie First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Katzie First Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, such as the waterways within the Fraser River estuary that support Katzie First Nation subsistence and socio-economic ties between Katzie First Nation and downstream Aboriginal groups on the coast.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Katzie First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Katzie First Nation, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

 Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Katzie First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of a, Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Katzie First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Katzie First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Kwantlen First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Kwantlen First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Kwantlen First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Kwantlen First Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including what Kwantlen First Nation report as past control over and use of, among other areas, the South Arm of the Fraser River to Deas Slough.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Kwantlen First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Kwantlen First Nation, except in the following potentially measurable cases:

- Project construction:

Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:

Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Kwantlen First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Kwantlen First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Kwantlen First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Lake Cowichan First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Lake Cowichan First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Lake Cowichan First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Lake Cowichan First Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by the Lake Cowichan First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Lake Cowichan First Nation, except in the following potentially measurable cases:

- Project construction:

Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:

Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Lake Cowichan First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Lake Cowichan First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Lake Cowichan First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Lyackson First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Lyackson First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Lyackson First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Lyackson First Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including at or about the reported location of *Tl'uqtinus*.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by the Lyackson First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Lyackson First Nation, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

 Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Lyackson First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Lyackson First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Lyackson First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Musqueam Indian Band

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Musqueam Indian Band at locations or in relation to resources that may be potentially affected by Project construction or operation, including Musqueam Indian Band's proven Aboriginal right to fish for FSC purposes pursuant to *R. v. Sparrow* (see **Section 10.1.3.1**), is relatively high. Musqueam Indian Band has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Musqueam Indian Band has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including at or about but not limited to the reported location of *Zuqtinus* or *λ'əqətines*.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Musqueam Indian Band are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | <p>Construction - Potential temporary direct (minor to moderate) effect on access related to instream construction activities</p> <p>Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses</p> |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Musqueam Indian Band, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor to moderate) effect on access related to instream construction activities and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access

Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance

- Project operation:

Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise and a potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Musqueam Indian Band regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Musqueam Indian Band as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Musqueam Indian Band is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Penelakut Tribe

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Penelakut Tribe at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Penelakut Tribe has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Penelakut Tribe has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including at or about the reported location of *Tl'uq̓tinus*.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by the Penelakut Tribe are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Penelakut Tribe, except in the following potentially measurable cases:

- Project construction:

Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:

Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Penelakut Tribe regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Penelakut Tribe as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Penelakut Tribe is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Semiahmoo First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Semiahmoo First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Semiahmoo First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Semiahmoo First Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including fishing at the reported location of *Tl'ektines*.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Semiahmoo First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Semiahmoo First Nation, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

 Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Semiahmoo First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Semiahmoo First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Semiahmoo First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Squamish Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Squamish Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Squamish Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of Aboriginal Interests. Squamish Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including fishing directly in the South Arm of the Fraser River for sockeye based on family ties with other Aboriginal groups (i.e., Musqueam Indian Band).

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Squamish Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Squamish Nation, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

 Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Squamish Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Squamish Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Squamish Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Stz'uminus First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Stz'uminus First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Stz'uminus First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Stz'uminus First Nation has identified a desire to regain or increase, based on past use patterns and levels, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including at or about the reported location of *Tl'uqtinus*.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by the Stz'uminus First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Stz'uminus First Nation, except in the following potentially measurable cases:

- Project construction:

Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:

Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Stz'uminus First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Stz'uminus First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Stz'uminus First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Tsawwassen First Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Tsawwassen First Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively high. Tsawwassen First Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of Aboriginal Interests. Tsawwassen First Nation has stressed that its treaty rights pursuant to the TFNFA are not site specific, and that the current exercise of Aboriginal Interests pursuant to the TFNFA does not necessarily dictate the full extent of locations and resources in relation to which treaty rights may be exercised by Tsawwassen First Nation in the future.

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Tsawwassen First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | <p>Construction - Potential temporary direct (minor to moderate) effect on access related to instream construction activities</p> <p>Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses</p> |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access</p> <p>Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses</p> |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Tsawwassen First Nation, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor to moderate) effect on access related to instream construction activities and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access

Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance

- Project operation:

Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise and a potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Tsawwassen First Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Tsawwassen First Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Tsawwassen First Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Tsleil-Waututh Nation

As indicated in **Section 10.1.3.2**, the current exercise of Aboriginal Interests by Tsleil-Waututh Nation at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low. Tsleil-Waututh Nation has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Tsleil-Waututh Nation has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including resource harvesting at and traveling the South Arm of the Fraser River based on kinship ties with other Aboriginal groups (i.e., Musqueam Indian Band, Tsawwassen First Nation).

Based on the analysis of potential effect pathways on the exercise of Aboriginal Interests presented in **Section 10.1.3.3**, the potential Project-related effects and level of effect predicted in relation to the exercise of Aboriginal Interests by Kwantlen First Nation are assessed as follows.

Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at avoiding, reducing, or otherwise managing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Tseil-Waututh Nation, except in the following potentially measurable cases:

- Project construction:
 Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

 Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

As indicated in **Section 10.1.3.4**, additional measures to address the above-noted effects include ongoing consultation with Tsleil-Waututh Nation regarding proposed measures, management plans, and monitoring programs related to the IC and VC assessments in Part B, the development of an Archaeological and Heritage Resources Management Plan, and the negotiation of a potential Project-specific agreement. With the implementation of these measures, residual effects on the exercise of Aboriginal Interests by Tsleil-Waututh Nation as a result of the Project are not expected. A summary of the results of the assessment on the exercise of Aboriginal Interests by Tsleil-Waututh Nation is presented in relationship to linked IC and VC assessments in **Section 10.3 Issue Summary Table, Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

10.2 Other Matters of Concern to Aboriginal Groups

This section of the Application provides a list of other matters of concern raised by Schedule B Aboriginal Groups in consultation with the Ministry that pertain to potential environmental, social, economic, heritage, and health effects of the Project that have not already been considered in **Section 10.1.3 Aboriginal Interests Assessment**. These other matters of concern are listed in **Table 10.2-1 Other Matters of Concern to Aboriginal Groups**.

For each matter of concern listed in **Table 10.2-1** below, relevant IC and VC assessments in Part B of the Application and the assessment presented in **Section 10.1.3** were reviewed to identify applicable measures to avoid, reduce, or otherwise manage the effects of the Project associated with the concern. Applicable or additional measures for each matter of concern are proposed in **Table 10.2-1**.

Table 10.2-1 Other Matters of Concern to Aboriginal Groups

| Concern | Aboriginal Group(s) | Proposed Mitigation Measures |
|---------------------------------------|--|---|
| Environmental | | |
| Contaminated sites | Cowichan Nation Alliance Semiahmoo First Nation Squamish Nation Tsawwassen First Nation | Section 12.0 Management Plans <ul style="list-style-type: none"> • Contaminated Sites and Sediment Plan |
| Potential accidents and malfunctions | All | Section 8.0 Accidents and Malfunctions <ul style="list-style-type: none"> • Measures to avoid or minimize potential effects from accidents and malfunctions including: Project design considerations as well as spill contingency and emergency response measures within the CEMP Section 12.0 Management Plans <ul style="list-style-type: none"> • CEMP <ul style="list-style-type: none"> ▫ Emergency Response and Spill Contingency Plan ▫ Waste Management Plan ▫ Health and Safety Plan • OEMP |
| Climate change/extreme weather events | Cowichan Nation Alliance Tseil-Waututh Nation | Section 9.0 Effects of the Environment on the Project <ul style="list-style-type: none"> • Adherence to engineering design standards, including those relating to seismic, extreme weather, flooding, and climate change considerations, to ensure that potential effects of the environment will not affect the safety or functionality of the proposed infrastructure. |

| Concern | Aboriginal Group(s) | Proposed Mitigation Measures |
|---|--|--|
| Socio-Economic | | |
| Effects of increased traffic, urbanization, and industrialization, and unleashing of “pent up demand” | Cowichan Nation Alliance Hwlitsum Lyackson First Nation Musqueam Indian Band Semiahmoo First Nation Tsawwassen First Nation | Section 5.3 Land Use <ul style="list-style-type: none"> N/A – Project not expected to contribute to overall regional growth trends under current land use regime Section 5.1 Traffic <ul style="list-style-type: none"> The proposed highway improvements will address existing and anticipated traffic safety concerns. |
| Potential spread of social problems, including drug and sex trafficking, to more areas in the Lower Mainland due to economic change | Lyackson First Nation | Sections 10.0 – Aboriginal Consultation 11.0 – Public Consultation <ul style="list-style-type: none"> Future consultation including that taking place during future stages of design focusing on addressing safety and security considerations. |
| New bridge creating areas of increased criminal activity and attracting a shadow population/marginalized groups | Lake Cowichan First Nation Lyackson First Nation | Sections 10.0 – Aboriginal Consultation 11.0 – Public Consultation <ul style="list-style-type: none"> Future consultation including that taking place during future stages of design focusing on addressing safety and security considerations. |
| Heritage | | |
| Downstream effects on archaeological sites from Tunnel decommissioning | Lyackson First Nation | Section 4.1 River Hydraulics and River Morphology <ul style="list-style-type: none"> N/A – Tunnel removal not expected to affect river flow or sedimentation patterns are expected to be negligible or minor and not requiring mitigation consideration |

| Concern | Aboriginal Group(s) | Proposed Mitigation Measures |
|---|---|--|
| Health | | |
| Suicide attempts from new bridge | Katzie First Nation Lake Cowichan First Nation Lyackson First Nation Tsleil-Waututh Nation | <p>Section 1.0 – Overview of Project and Proponent</p> <ul style="list-style-type: none"> The Project design includes provisions for safety fencing. <p>Sections 10.0 – Aboriginal Consultation 11.0 – Public Consultation</p> <ul style="list-style-type: none"> Future consultation, involving policing agencies, emergency response service providers and others, during future stages of design that focus on addressing safety and security considerations. |
| Emergency response times due to Highway 99 border traffic | Semiahmoo First Nation | <p>Sections 10.0 – Aboriginal Consultation 11.0 – Public Consultation</p> <ul style="list-style-type: none"> Future consultation, involving policing agencies, emergency response service providers and others, during future stages of design that focus on addressing safety and security considerations. |
| Potential for falling snow and ice from new bridge | Katzie First Nation Hwlitsum | <p>Section 12.0 Management Plans</p> <ul style="list-style-type: none"> OEMP |

10.2.1 Residual Effects to Other Matters of Concern

The Ministry's perspective on how other matters of concern have been addressed is reflected in the mitigation measures presented above in **Table 10.2-1**. In the Ministry's view, the measures identified are expected to be effective at addressing the listed concerns, particularly in light of the Ministry's plans to continue consultation with Schedule B Aboriginal Groups on management planning and monitoring (per **Section 10.1.3.4 Mitigation Measures**). As no measurable or detectable residual effects related to these matters of concern would be expected following the implementation of identified measures, they are not further assessed. It is acknowledged that Aboriginal Groups may have different perspectives on the effectiveness of measures to address potential effects on the listed concerns. Through ongoing consultation, the Ministry will seek and consider input from Aboriginal Groups on proposed mitigation measures and will continue to work with these groups to address any outstanding Project-related concerns

10.3 Issue Summary Table

The results of the analysis presented in **Section 10.1.3 Aboriginal Interests Assessment** and **Section 10.2 Other Matters of Concern to Aboriginal Groups**, including the findings of the assessments of ICs and VCs associated with the exercise of Aboriginal Interests or other matters of concern, are summarized in **Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern**.

Comments provided to the Ministry by Schedule B Aboriginal Groups regarding their Aboriginal Interests and other matters of concern related to the Project are presented in **Appendix B Key Issues and Concerns**. These comments have been considered in the development of **Section 10.0 Aboriginal Consultation**, portions of which were reviewed by Aboriginal Groups prior to submission of the Application (i.e., community profiles presented in **Section 10.1.1 Background Information**; traditional territory and consultation area maps presented in **Appendix 10-A, Figure 10-2** through **Figure 10-10**; and summaries of past, present, and desired future use presented in **Section 10.1.3.2 Existing Conditions**). Based on these comments and ongoing consultation between the Ministry and Aboriginal Groups, including in relation to the findings of the IC and VC chapters, the Ministry has provided its perspective on the degree to which the issues related to Aboriginal Interests or other matters of concern to Aboriginal Groups are resolved in **Table 10.3-1**.

Table 10.3-1 Summary Table of the Results of Aboriginal Consultation related to Aboriginal Interests/Other Matters of Concern

| PART B | | | | | | PART C | | | | |
|---|---|----------------|--|------------------|--------------|---------------------|--|--|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Environmental | | | | | | | | | | |
| River Hydraulics and River Morphology (Section 4.1) | <ul style="list-style-type: none"> Increase in volume of suspended sediment during Tunnel decommissioning activities Riverbed lowering between the Tunnel alignment and Lulu Island-Delta water main after Tunnel removal | • Construction | <ul style="list-style-type: none"> Mitigation of effects from turbidity or elevated levels of total suspended solids (as in Section 4.4 Fish and Fish Habitat) Lulu Island-Delta Water Main Monitoring and Management | • None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Extreme weather events | As in Section 9.0 Effects of the Environment on the Project | Resolved |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Extreme weather events | As in Section 9.0 Effects of the Environment on the Project | Resolved |
| | | | | | | Hwilitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|--|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|----------------------------------|----------------------|---|---|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Downstream effects on archaeological sites from Tunnel decommissioning | N/A – Potential changes in river flow and sedimentation patterns expected to be negligible or minor as a result of Tunnel removal and not requiring mitigation consideration | Resolved |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) | Construction/operation: Negligible effect on access to river locations for traditional use | Consultation | Ongoing resolution |
| | | | | | Asserted Aboriginal Rights/Title | | Negligible effect on quality of experience tied to the traditional use of river locations | | | |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | Other Matters of Concern | | Extreme weather events | As in Section 9.0 Effects of the Environment on the Project | | |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Extreme weather events | As in Section 9.0 Effects of the Environment on the Project | Resolved |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Fishing Right Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Tsleil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on access to river locations for traditional use Negligible effect on quality of experience tied to the traditional use of river locations | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Climate change | As in Section 9.0 Effects of the Environment on the Project | N/A |

| PART B | | | | | | PART C | | | | |
|---|---|---|--|------------------|--------------|---------------------|--|---|--|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Sediment and Water Quality (Section 4.2) | <ul style="list-style-type: none"> Sediment generation Sediment re-suspension Adverse effects on ambient water quality | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Project design Best management practices and environmental management Control of suspended sediment during Tunnel decommissioning Control of suspended sediment during Project construction in and adjacent to Deas and Green sloughs Water quality monitoring during construction | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Extreme weather events | As in Section 9.0 Effects of the Environment on the Project | Resolved |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Extreme weather events | As in Section 9.0 Effects of the Environment on the Project | Resolved |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|----------------------------------|------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | Asserted Aboriginal Rights/Title | | | | | |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | Other Matters of Concern | | Extreme weather events | | | |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | Other Matters of Concern | | N/A | | | |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|--|---|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Extreme weather events | As in Section 9.0 Effects of the Environment on the Project | Resolved |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|-------------------------------------|--|---|---|--|-----------------|-----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsleil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on quality of water used for cultural purposes Negligible effect on quality of experience tied to use of water for cultural purposes | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Climate change | As in Section 9.0 Effects of the Environment on the Project | Resolved |
| Fish and Fish Habitat (Section 4.4) | <ul style="list-style-type: none"> Physical injury or mortality to fish through crushing or entrainment Physical injury or mortality to fish through exposure to underwater noise during construction Behavioral changes due to increase in underwater noise levels during construction Injury or mortality due to exposure to elevated Levels of total suspended solids | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Avoid effects through Project design Minimize effects through: <ul style="list-style-type: none"> Project design BMPs and environmental management Timing windows Mitigation of underwater noise effects Mitigation of effects from turbidity or elevated levels of total suspended solids | Physical injury or mortality to fish through crushing or entrainment: <ul style="list-style-type: none"> Direction: adverse Magnitude: low Extent: site-specific Duration: transient-term Reversibility: reversible Frequency: rare Likelihood: low Confidence: high | Not significant | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Resolved |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|--|---------------|---|------------------|--------------|---------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | <ul style="list-style-type: none"> Effects of changes in ambient water quality Fish habitat alteration Changes in fish habitat quantity | | <ul style="list-style-type: none"> Erosion and sediment control Environmental monitoring Habitat enhancement Habitat offsetting | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | | Other Matters of Concern | Potential accidents and malfunctions As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|---------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matter of Concern | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------------|--|---|---|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Fishing Right Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on availability fish resources for traditional use Negligible effect on quality of fish resources for traditional use Negligible effect on quality of experience tied to the traditional use of fish resources | Consultation | Ongoing resolution |
| | | | | | | | | Climate change | As in Section 9.0 Effects of the Environment on the Project | Resolved |
| | | | | | | | | Other Matters of Concern Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|------------------------------|--|--|---|------------------|--------------|---------------------|---|---|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Marine Mammals (Section 4.6) | <ul style="list-style-type: none"> Underwater noise In-air noise Vessel strikes | <ul style="list-style-type: none"> Construction | <ul style="list-style-type: none"> Marine mammal management Underwater noise monitoring | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution | |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammals | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|--|---|---|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammal resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution Ongoing resolution |
| | | | | | | Tsleil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on availability of marine mammal resources for traditional use Negligible effect on quality of marine mammal resources for traditional use Negligible effect on quality of experience tied to the traditional use of marine mammals | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matter of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|--------------------------|---|---|---|------------------|--------------|---------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Vegetation (Section 4.7) | <ul style="list-style-type: none"> Overlap between at-risk ecosystems and Project components | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Minimize potential effects through Project design Best management practices and environmental management Terrestrial vegetation and wildlife management Invasive species management Habitat enhancement Habitat offsetting | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|--|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Musqueam Indian Band | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------|--|--|---|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights and Title | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|---|--------------------------|--|---|---|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Right to Gather Plants | Construction/operation: Negligible effect on availability of vegetation resources for traditional use | Consultation | Ongoing resolution |
| | | | | | Tsawwassen First Nation Right to Practice | | Negligible effect on quality of vegetation resources for traditional use | | | |
| | | | | | Tsawwassen First Nation Culture | | Negligible effect on quality of experience tied to the traditional use of vegetation resources | | | |
| | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution | |
| | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution | |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------|---|--|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on availability of vegetation resources for traditional use Negligible effect on quality of vegetation resources for traditional use Negligible effect on quality of experience tied to the traditional use of vegetation resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|------------------------------------|--|---|--|--|-----------------|---------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Terrestrial Wildlife (Section 4.8) | <ul style="list-style-type: none"> Habitat loss Habitat alteration (sensory disturbance and water quality) Wildlife mortality | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Minimize effects through Project design Best management practices and environmental management Habitat enhancement Habitat offsetting | Barn swallow habitat loss: <ul style="list-style-type: none"> Direction: adverse Magnitude: moderate Extent: specific Duration: transient-term Reversibility: reversible Frequency: rare Likelihood: low Confidence: moderate to high | Not significant | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | Other Matters of Concern | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution | |
| | | | | Potential accidents and malfunctions | | | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution | | |
| | | | | Barn owl mortality: <ul style="list-style-type: none"> Direction: adverse Magnitude: negligible Effects: specific in extent Duration: long-term Reversibility: reversible Frequency: uncommon Likelihood: low Confidence: moderate to high | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | Lake Cowichan First Nation | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Musqueam Indian Band | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites Potential accidents and malfunctions | As in Section 12.0 Management Plans As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution Ongoing resolution |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|--|---|---|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Right to Harvest Wildlife Tsawwassen First Nation Right to Harvest Migratory Birds Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Contaminated sites | As in Section 12.0 Management Plans | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |
| | | | | | | Tsleil-Waututh Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on availability of terrestrial wildlife resources for traditional use Negligible effect on quality of terrestrial wildlife resources for traditional use Negligible effect on quality of experience tied to the traditional use of terrestrial resources | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Potential accidents and malfunctions | As in Section 8.0 Accidents and Malfunctions As in Section 9.0 Effects of the Environment on the Project As in Section 12.0 Management Plans | Ongoing resolution |

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|------------------------------|--|---|---|------------------|--------------|---------------------|--|---|--------------------------------|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Air Quality (Section 4.9) | <ul style="list-style-type: none"> Risks to human health from exposure to air emissions | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Minimize effects through Project design Air Quality and Dust Control Management Plan Measures for vehicle emissions during Project operation Measures for road dust during Project operation | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen Fishing Right Tsawwassen First Nation Right to Harvest Wildlife Tsawwassen First Nation Right to Harvest Migratory Birds Tsawwassen First Nation Right to Gather Plants Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: No or negligible adverse effect on quality of experience while engaged in or tied to traditional use as a result of changes in air quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|-------------------------------------|--|---|--|------------------|--------------|---------------------|--|--|--------------------------------|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Atmospheric Noise (Section 4.10) | <ul style="list-style-type: none"> Noise from construction activities other than pile driving Noise from pile driving Ground-borne vibration from pile driving Residential receptors Passive parks Schools and places of worship | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Noise Management Plan Application of the Ministry's 2014 Noise Policy | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| Other Matters of Concern | N/A | N/A | N/A | | | | | | | |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|--|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No to negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|--|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|--|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|--|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen Fishing Right Tsawwassen First Nation Right to Harvest Wildlife Tsawwassen First Nation Right to Harvest Migratory Birds Tsawwassen First Nation Right to Gather Plants Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: No, negligible, or measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes in noise No or negligible direct effect on quality of experience while engaged in or tied to traditional use as a result of changes in ground-borne vibration | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|--------------------------|--|---|--|------------------|--------------|---------------------|---------------------------------------|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| Socio-Economic | | | | | | | | | | |
| Marine Use (Section 5.2) | <ul style="list-style-type: none"> Interaction with marine traffic during construction Interaction with marine traffic during operations | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> New bridge vertical and horizontal clearance Navigation protection during construction Marine Access Management Plan | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction: Measurable effect on access to instream locations for traditional use Measurable effect on quality of experience tied to access of instream locations for traditional use Operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matter of Concern | N/A | N/A | N/A |
| | | | | | | Tsawwassen First Nation | Tsawwassen Fishing Right Tsawwassen Right to Practice Tsawwassen First Nation Culture | Construction: Measurable effect on access to instream locations for traditional use Measurable effect on quality of experience tied to access of instream locations for traditional use Operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|---------------------------|---|---|--|---|-----------------|-----------------------|--|---|--------------------------------|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsleil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on access to instream locations for traditional use Negligible effect on quality of experience tied to access of instream locations for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | Resolved |
| Land Use (Section 5.3) | <ul style="list-style-type: none"> Consistency with land use plans and designations Compatibility with adjacent land uses | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Minimize effects through Project design Incorporate land use considerations | Disturbance to residential, commercial and industrial land uses: <ul style="list-style-type: none"> Direction: adverse Magnitude: low | Not significant | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|---------------------|---|---|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------------------|-----------------------|---|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Potential spread of social problems, including drug and sex trafficking, to more areas in the Lower Mainland due to economic change | N/A – Project not expected to contribute to overall regional growth trends under current land use regime As in Sections 10 Aboriginal Consultation and 11 Public Consultation | Ongoing resolution |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | Other Matters of Concern | | Effects of increased traffic, urbanization, and industrialization, and unleashing of “pent up demand” | Potential spread of social problems, including drug and sex trafficking, to more areas in the Lower Mainland due to economic change | N/A – Project not expected to contribute to overall regional growth trends under current land use regime As in Sections 10 Aboriginal Consultation and 11 Public Consultation | Ongoing resolution |
| | | | | | | | New bridge creating areas of increased criminal activity and attracting a shadow population/marginalized groups | | | |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------------|---|---|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Musqueam Indian Band | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matter of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | | Other Matters of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|--|---|--|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Fishing Right Tsawwassen First Nation Right to Harvest Wildlife Tsawwassen First Nation Right to Harvest Migratory Birds Tsawwassen First Nation Right to Gather Plants Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Effects of increased traffic, urbanization, and industrialization, and unleashing of "pent up demand" | N/A – Project not expected to contribute to overall regional growth trends under current land use regime | Ongoing resolution |
| | | | | | | Tsleil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: Negligible effect on access to upland locations for traditional use Negligible effect on quality of experience tied to access of upland areas for traditional use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|---------------------------------|-------------------------------|---------------|---|---|-----------------|---------------------|--|---|-----------------------------------|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| Visual Quality (Section 5.5) | • Change in visual conditions | • Operation | • Minimize effects through Project design | <ul style="list-style-type: none"> • Direction: adverse • Magnitude: moderate • Extent: site-specific • Duration: long-term • Reversibility: partially reversible • Frequency: continuous • Likelihood: moderate • Confidence: high | Not significant | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | | |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | | |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|---------------------|---|---|-----------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|---|-----------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-----------------------|---|---|-----------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|------------------------|---|---|-----------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|-----------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

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|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|--|---|-----------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Fishing Right Tsawwassen First Nation Right to Harvest Wildlife Tsawwassen First Nation Right to Harvest Migratory Birds Tsawwassen First Nation Right to Gather Plants Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape Operation: Measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape | Cultural Heritage Management Plan | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------------------------|--|----------------|--|------------------|--------------|----------------------------|---------------------------------------|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| Heritage | | | | | | | | | | |
| Heritage Resources (Section 6.1) | Encountering previously unidentified archaeological and heritage resources during Project activities | • Construction | <ul style="list-style-type: none"> Archaeological and Heritage Resources Management Plan Additional archaeological surveys | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Downstream effects on archaeological sites from Tunnel decommissioning | See River Hydraulics and River Morphology | N/A |
| | | | | | | Musqueam Indian Band | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|--------------------------------|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen Right to Practice Tsawwassen First Nation Culture | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: See Land Use, Visual Quality | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------------------|--|---|---|------------------|--------------|----------------------------|---------------------------------------|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| Health | | | | | | | | | | |
| Human Health (Section 7.1) | <ul style="list-style-type: none"> Risk to human health from exposure to air emissions Risk to human health from change to noise or vibration levels | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> Air quality best management practices and mitigation measures (see Section 4.9 Air Quality) Noise and vibration mitigation measures (see Section 4.10 Atmospheric Noise) | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|--------------------------|--|---|---|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Fishing Right Tsawwassen First Nation Right to Harvest Wildlife Tsawwassen First Nation Right to Harvest Migratory Birds Tsawwassen First Nation Right to Gather Plants Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: See Air Quality, Atmospheric Noise | Consultation | Ongoing |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: See Air Quality, Atmospheric Noise | Consultation |
| | | | | | | Other Matters of Concern | | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | | | | | | |
|--|---|---|--|------------------|--------------|---------------------|---|---|--|--|--|--|--|--|----------|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) | | | | | |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | | | | | | |
| Health Impact Assessment (Section 7.2) | <ul style="list-style-type: none"> Exposure to airborne contaminants Noise Food and water consumption Greenhouse gas emissions Active and public transportation Traffic safety Accidents and malfunctions Connectivity and access Emergency response Safety and security Economic health effects Recreation and parks | <ul style="list-style-type: none"> Construction Operation | <ul style="list-style-type: none"> All potential effects identified are mitigated in other sections | None | N/A | Cowichan Tribes | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution | | | | | |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A | | | | | |
| | | | | | | Halalt First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution | | | | | |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A | | | | | |
| | | | | | | Hwlitsum | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution | | | | | |
| | | | | | | | Other Matters of Concern | Potential for falling snow and ice on new bridge | As in Section 12.0 Management Plans | N/A | | | | | |
| | | | | | | Katzie First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution | | | | | |
| | | | | | | | Other Matters of Concern | Suicide attempts from new bridge | N/A | Resolved | | | | | |
| | | | | | | | | | | | | | Potential for falling snow and ice on new bridge | As in Section 12.0 Management Plans | Resolved |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|----------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Kwantlen First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Lake Cowichan First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Suicide attempts from new bridge | N/A | Resolved |
| | | | | | | Lyackson First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Suicide attempts from new bridge | N/A | Resolved |
| | | | | | | Musqueam Indian Band | Proven Aboriginal Right to Fish (FSC) Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|---|---|--------------------------------|--|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Penelakut Tribe | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Semiahmoo First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Emergency response times due to Highway 99 border traffic | N/A | Resolved |
| | | | | | | Squamish Nation | Asserted Aboriginal Rights | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Stz'uminus First Nation | Asserted Aboriginal Rights/Title | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |

| PART B | | | | | | PART C | | | | |
|----------------|-------------------|---------------|---------------------|------------------|--------------|-------------------------|--|---|--------------------------------|---|
| Relevant SC/VC | Potential Effects | Project Phase | Proposed Mitigation | Residual Effects | Significance | Aboriginal Group | Aboriginal Interests (Section 10.1.3) | Potential Incremental Effect on Aboriginal Interests or Other Matters of Concern After Consideration of Proposed SC/VC Mitigation (i.e., no effect, negligible effect, measurable effect) | Additional Proposed Mitigation | Ministry's Perspective on Status of Issue (e.g., resolved, ongoing resolution, referred to agency, etc.) |
| | | | | | | | Other Matters of Concern (Section 10.2) | | | |
| | | | | | | Tsawwassen First Nation | Tsawwassen First Nation Fishing Right Tsawwassen First Nation Right to Harvest Wildlife Tsawwassen First Nation Right to Harvest Migratory Birds Tsawwassen First Nation Right to Gather Plants Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | N/A | N/A | N/A |
| | | | | | | Tseil-Waututh Nation | Asserted Aboriginal Rights | Construction/operation: See Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use, Land Use | Consultation | Ongoing resolution |
| | | | | | | | Other Matters of Concern | Suicide attempts from new bridge | N/A | Resolved |

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APPENDIX A

Figures



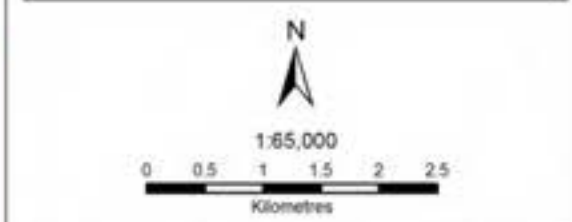
Legend

- Project Alignment
- Halkomelem Place Name Approximate Location
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

REFER TO SECTION 10.1.1 BACKGROUND INFORMATION, TABLE 10.1-1 HALKOMELEM PLACE NAMES IN THE VICINITY OF THE PROJECT FOR MORE INFORMATION

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS, Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

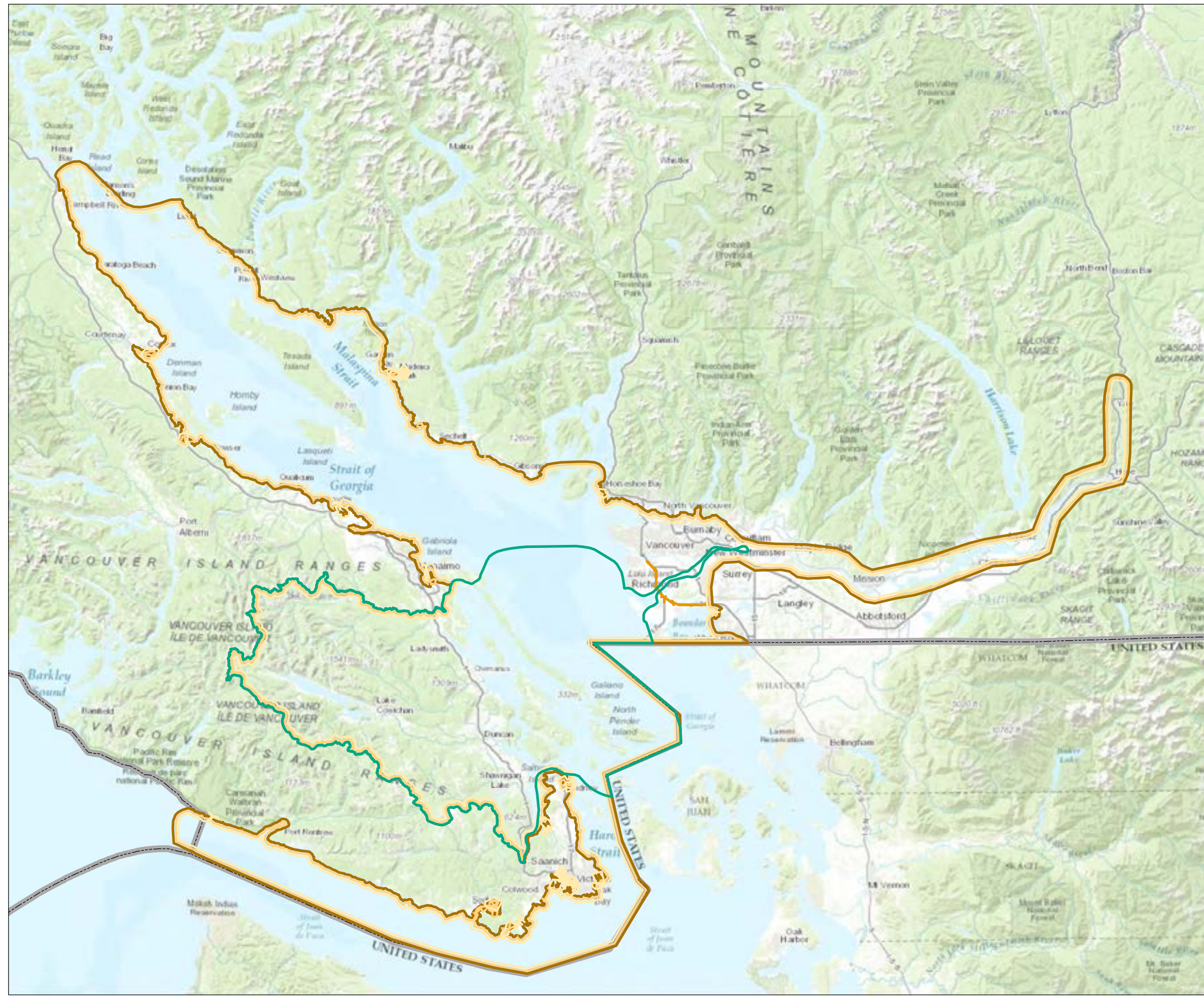
HALKOMELEM PLACE NAMES ALONG THE FRASER RIVER SOUTH ARM

Figure 10-1 | 18/05/2016

George Massey Tunnel Replacement Project | BC 2005 PLAN | B.C. on the Move

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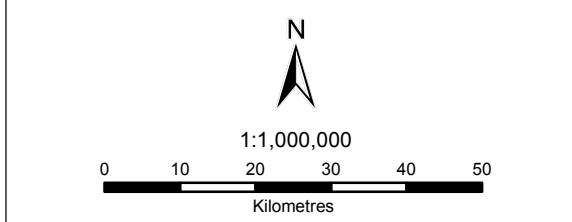
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Legend

-  Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory
-  Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



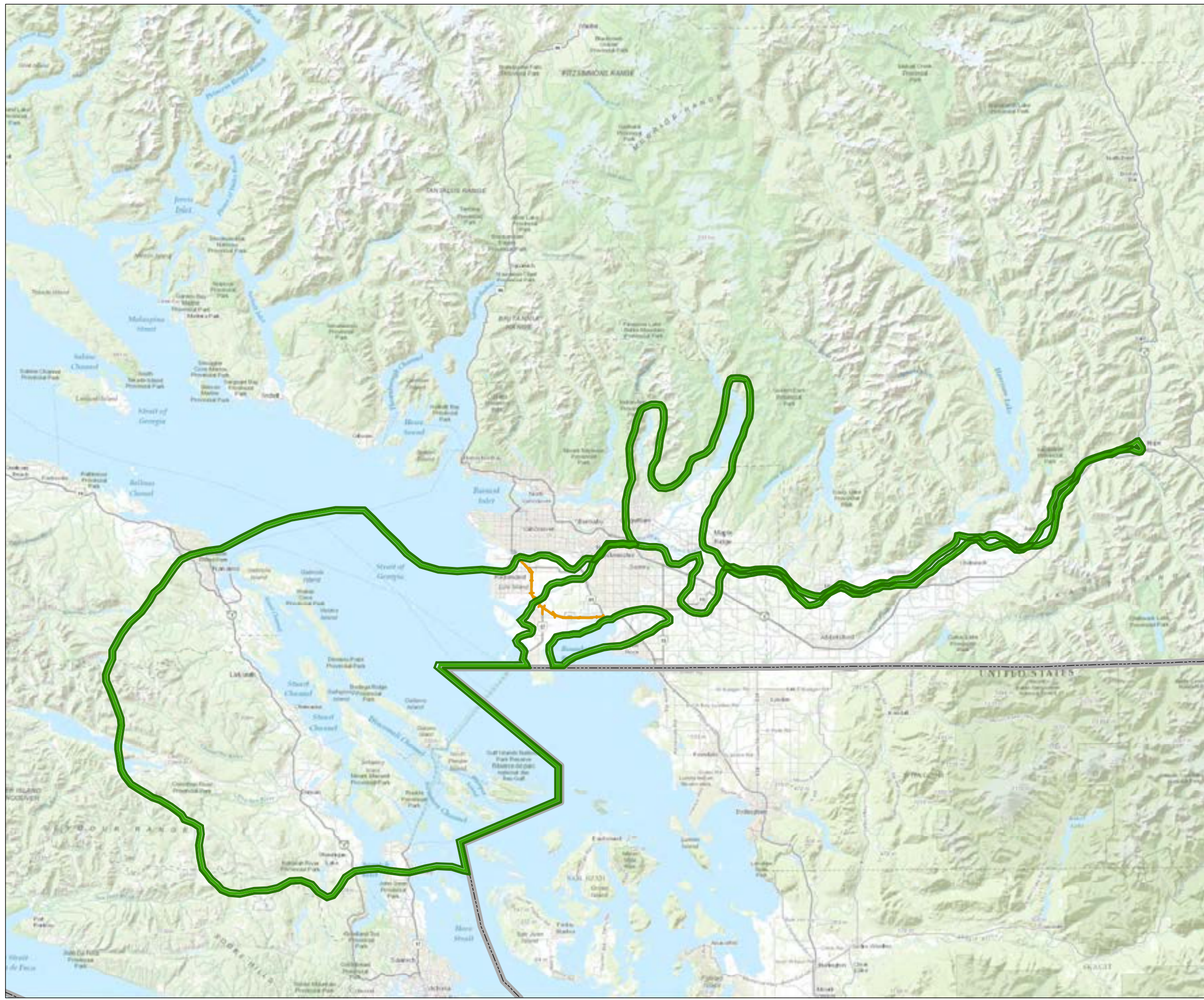
**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**HUL'QUMI'NUM TREATY GROUP
ASSERTED TRADITIONAL TERRITORY**




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| Figure 10-2 | 26/05/2016 |
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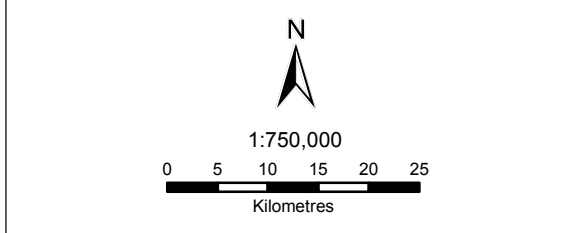


Legend

-  Hwlitsum Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES




Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



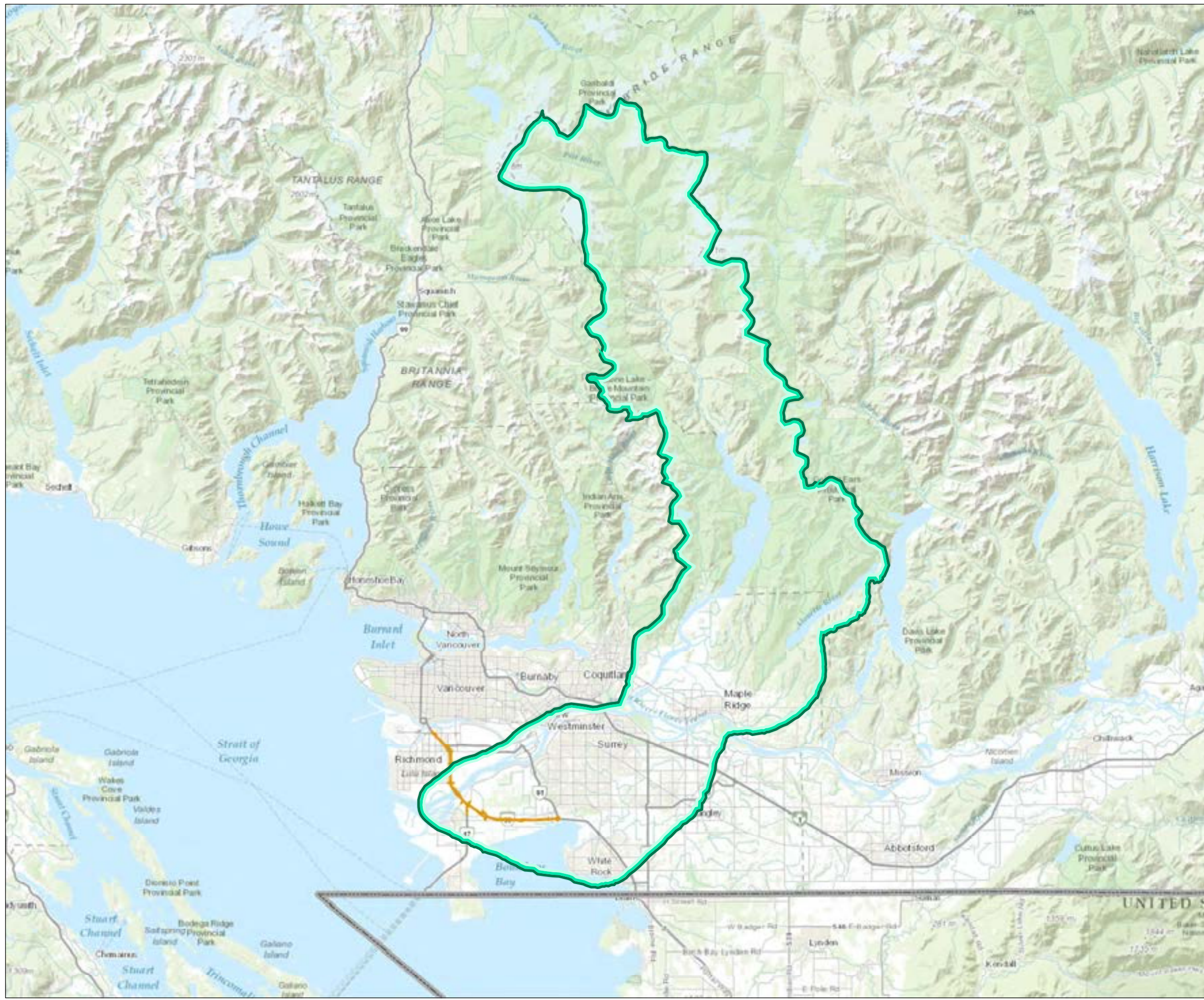
**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

HWLITSUM ASSERTED TRADITIONAL TERRITORY




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| Figure 10-3 | 26/05/2016 |
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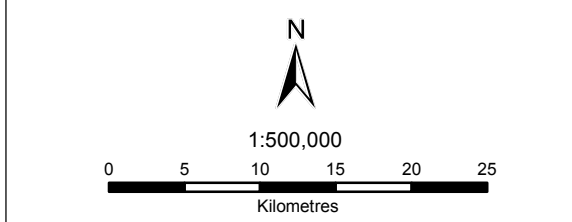


Legend

-  Katzie First Nation Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.




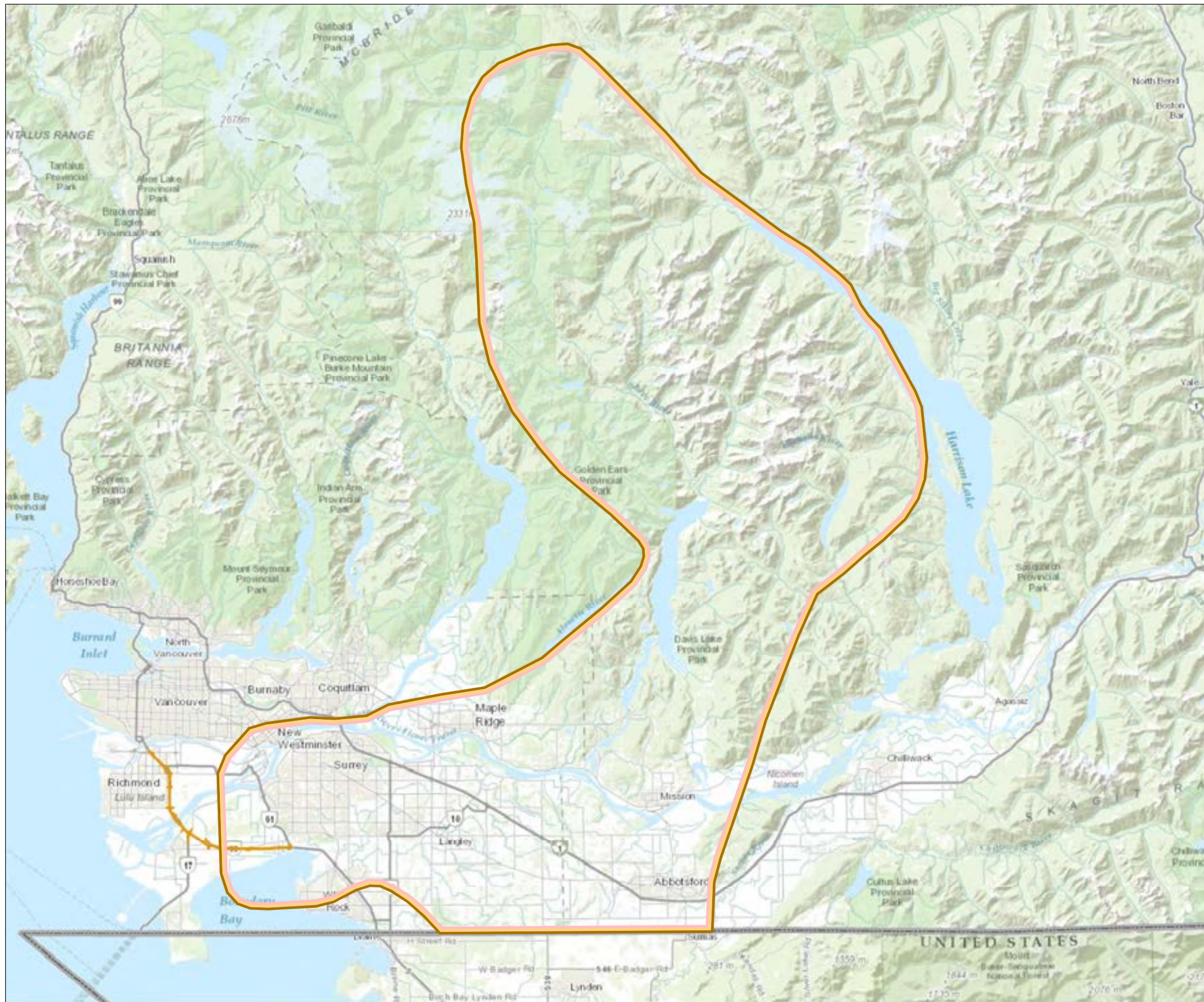
**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**KATZIE FIRST NATION
ASSERTED TRADITIONAL TERRITORY**




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| Figure 10-4 | 26/05/2016 |
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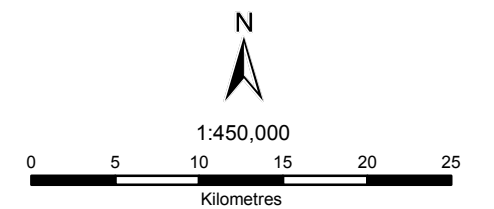


Legend

-  Kwantlen First Nation Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Kwantlen First Nation and BC (Province of British Columbia), 2012. Kwantlen First Nation Forest and Range Consultation and Revenue Sharing Agreement, April 10, 2012.

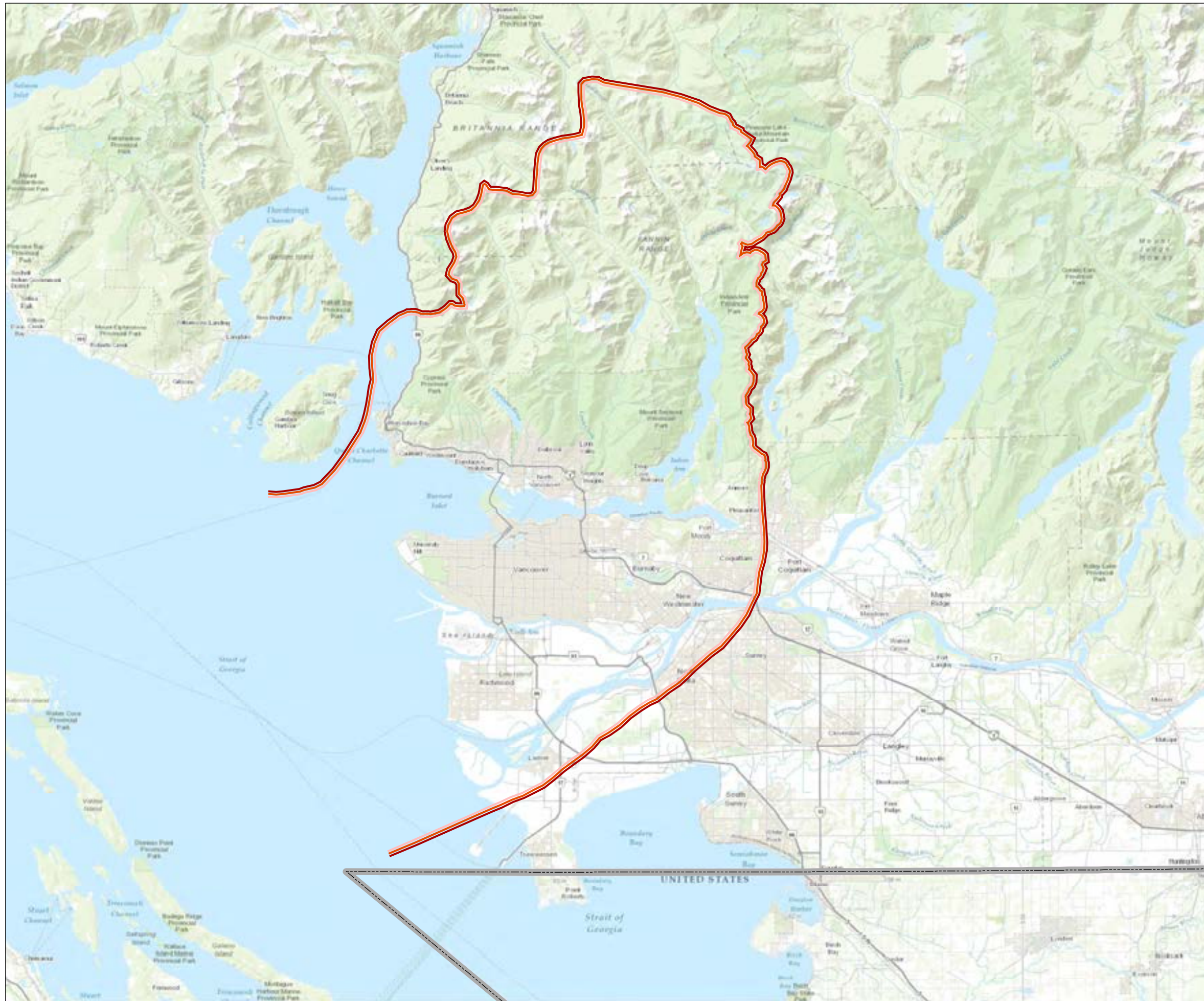


GEORGE MASSEY TUNNEL REPLACEMENT PROJECT




KWANTLEN FIRST NATION
ASSERTED TRADITIONAL TERRITORY

Figure 10-5

26/05/2016

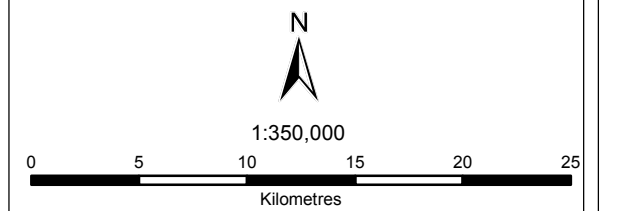


Legend

-  Musqueam Indian Band Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| MUSQUEAM INDIAN BAND ASSERTED TRADITIONAL TERRITORY | |
| Figure 10-6 | 26/05/2016 |
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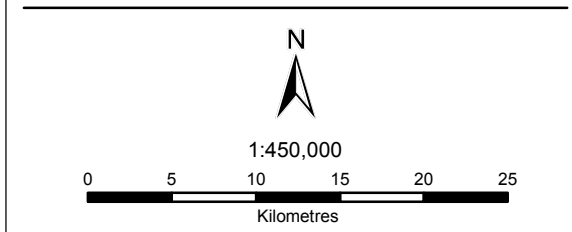


Legend

- Semiahmo First Nation Asserted Traditional Territory
- Project Alignment
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

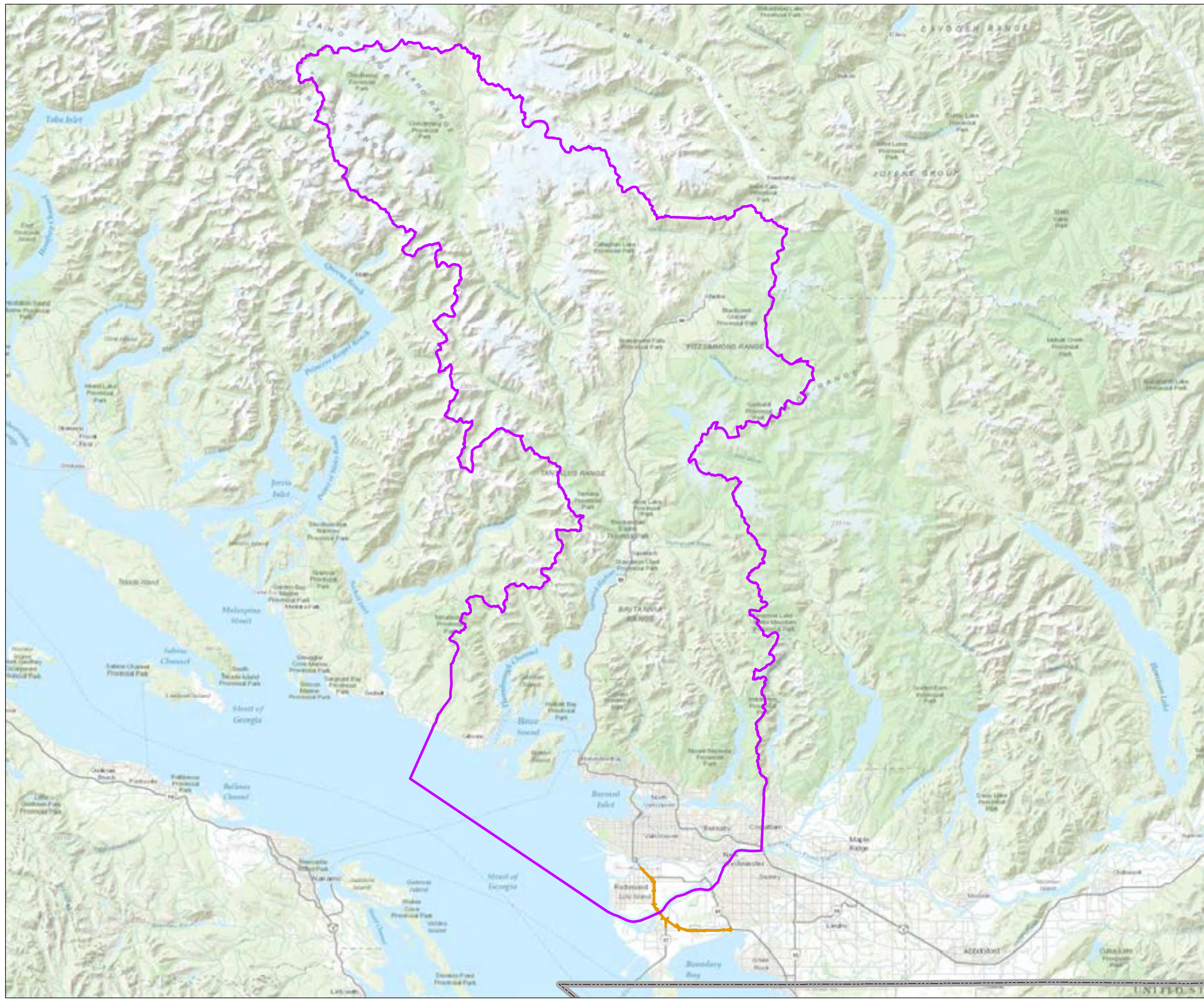


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SEMAHMO FIRST NATION
ASSERTED TRADITIONAL TERRITORY**

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| Figure 10-7 | 26/05/2016 |
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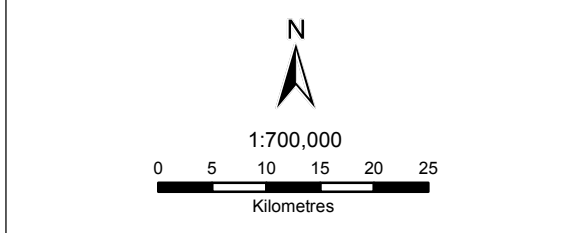


Legend

- Squamish Nation Asserted Traditional Territory
- Project Alignment
- Canada - U.S. Border

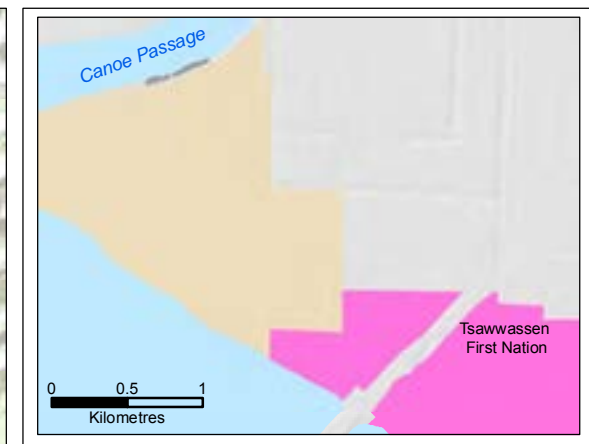
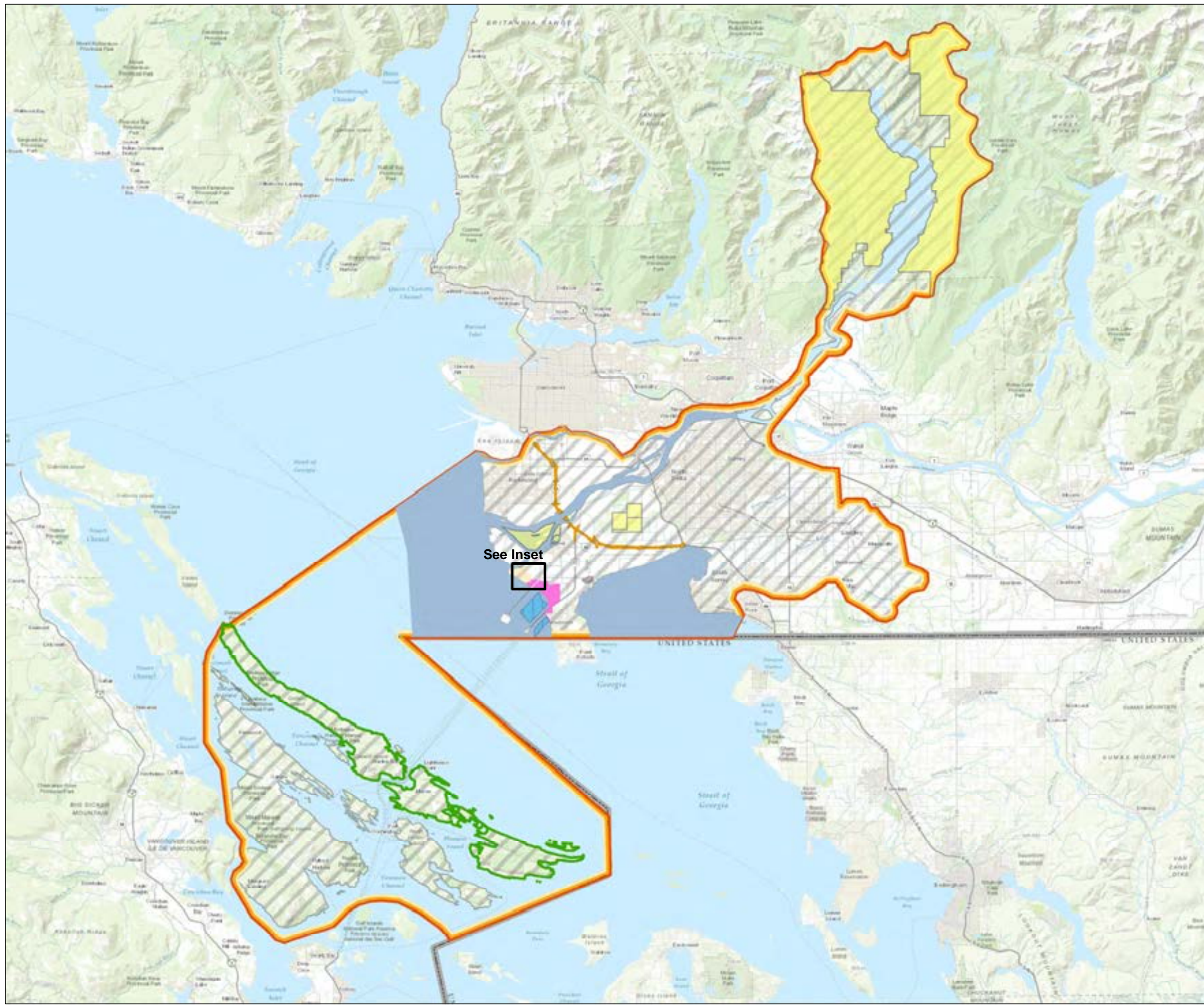
SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Squamish Nation Traditional Territory Boundary provided by Ministry by Squamish Nation during consultation on the Project.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| SQUAMISH NATION ASSERTED TRADITIONAL TERRITORY | |
| Figure 10-8 | 26/05/2016 |
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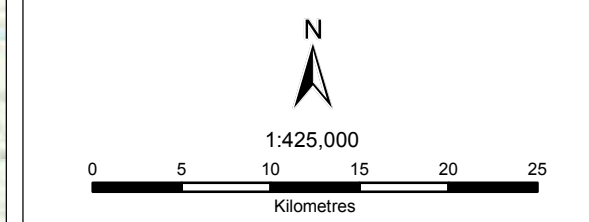
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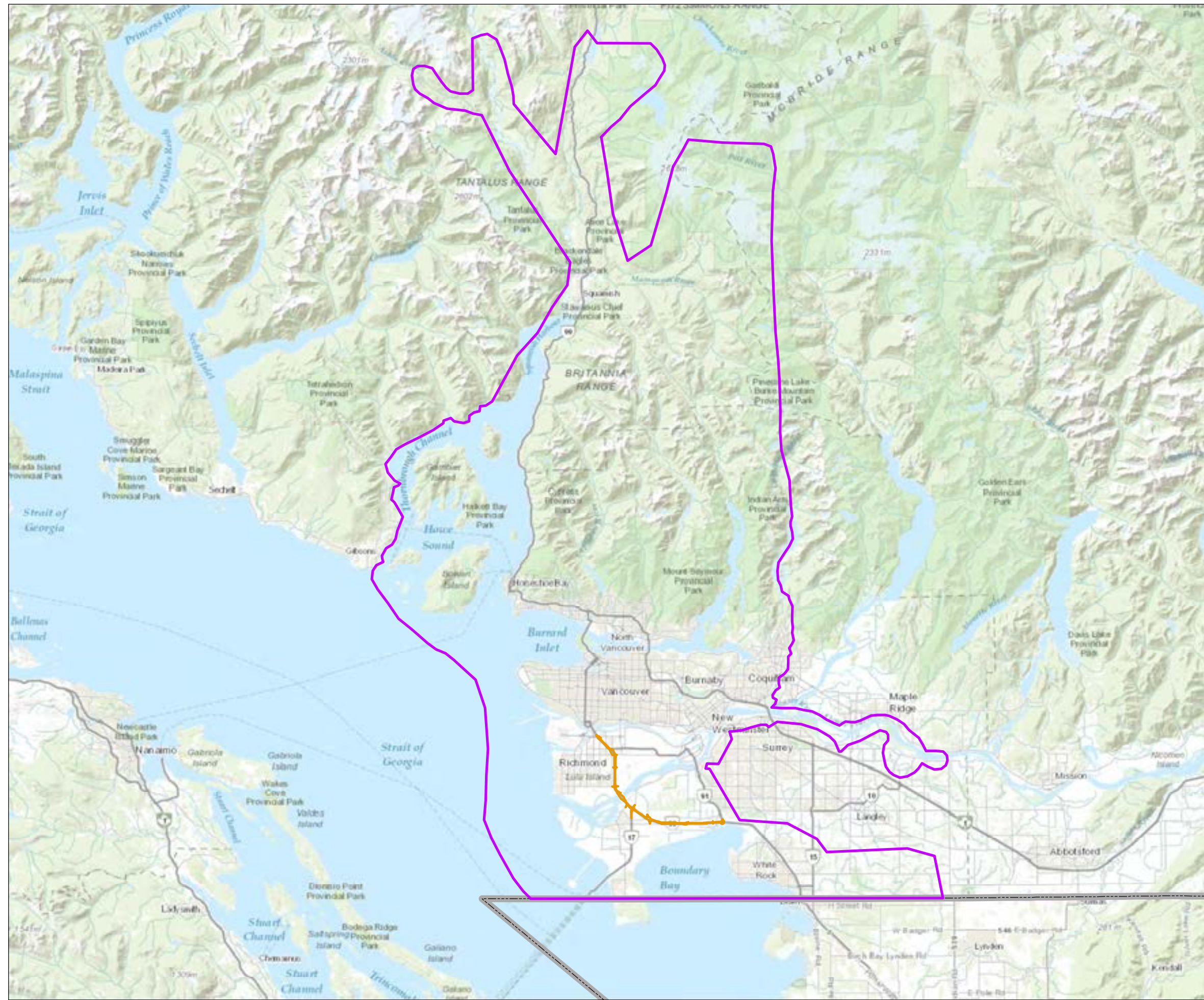
- Legend**
- Rights of Refusal Lands
 - Other Tsawwassen First Nation Lands
 - Tsawwassen First Nation Fishing Area
 - Tsawwassen First Nation Plant Gathering Area
 - Tsawwassen First Nation Lands
 - Tsawwassen First Nation Water Lots
 - Tsawwassen First Nation Traditional Territory
 - Tsawwassen Intertidal Bivalve Area
 - Tsawwassen Wildlife Harvest and Migratory Bird Harvest Area
 - Project Alignment
 - Canada - U.S. Border

SOURCES




Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TSAWWASSEN FIRST NATION TRADITIONAL TERRITORY | |
| Figure 10-9 | 26/05/2016 |
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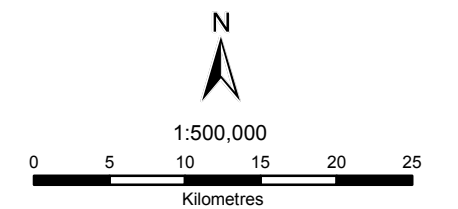


Legend

-  Tsleil-Waututh Nation Consultation Area
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



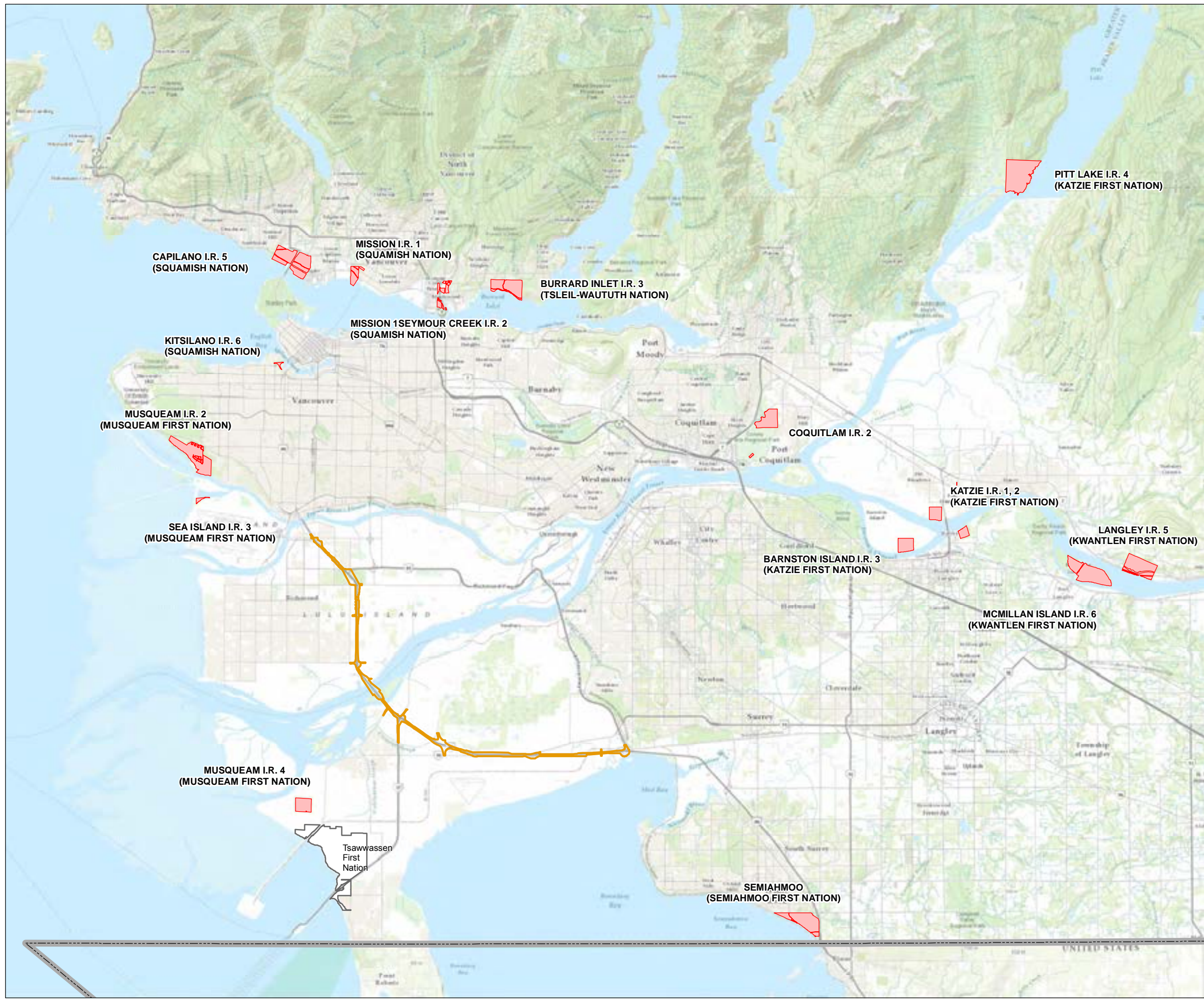
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

TSLEIL-WAUTUTH NATION

Figure 10-10

18/05/2016

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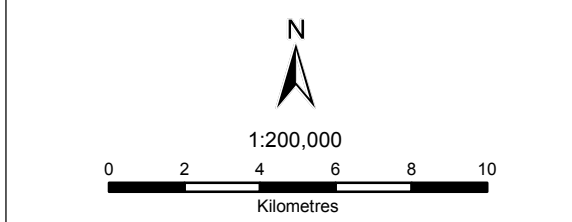
- Indian Reserves
- Project Alignment
- Canada - U.S. Border

Indian Reserves and First Nations:

- PITT LAKE I.R. 4 (KATZIE FIRST NATION)**
- MISSION I.R. 1 (SQUAMISH NATION)**
- MISSION 1 SEYMOUR CREEK I.R. 2 (SQUAMISH NATION)**
- BURRARD INLET I.R. 3 (TSLEIL-WAUTUTH NATION)**
- COQUITLAM I.R. 2**
- KATZIE I.R. 1, 2 (KATZIE FIRST NATION)**
- LANGLEY I.R. 5 (KWANTLEN FIRST NATION)**
- MCMILLAN ISLAND I.R. 6 (KWANTLEN FIRST NATION)**
- SEMIAHMOO (SEMIAHMOO FIRST NATION)**
- MUSQUEAM I.R. 2 (MUSQUEAM FIRST NATION)**
- SEA ISLAND I.R. 3 (MUSQUEAM FIRST NATION)**
- MUSQUEAM I.R. 4 (MUSQUEAM FIRST NATION)**
- MUSQUEAM I.R. 5 (SQUAMISH NATION)**
- KITSILANO I.R. 6 (SQUAMISH NATION)**
- TSAWWASSEN FIRST NATION**

SOURCES

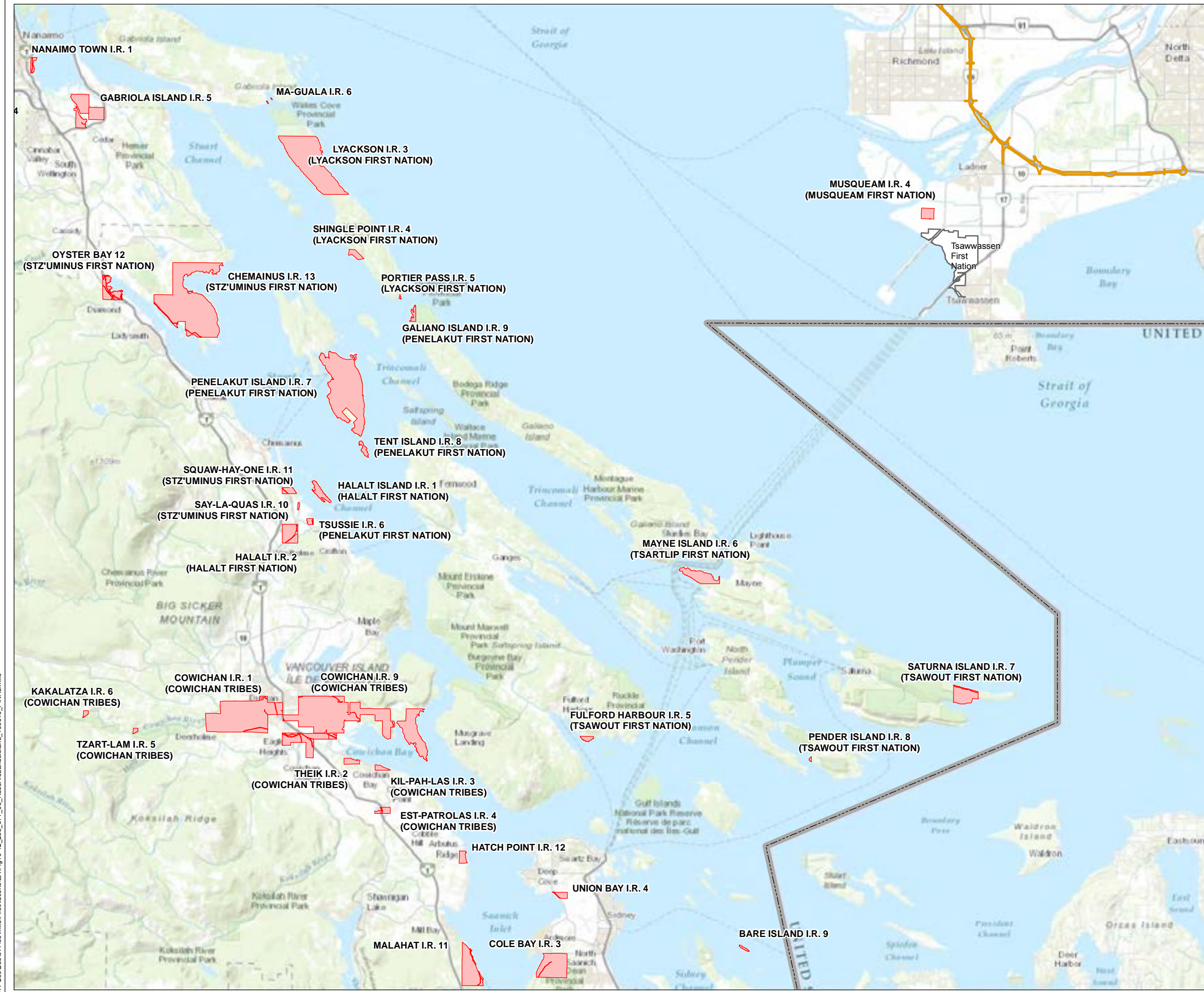
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

INDIAN RESERVES - SCHEDULE B ABORIGINAL GROUPS

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| Figure 10-11 | 19/05/2016 |
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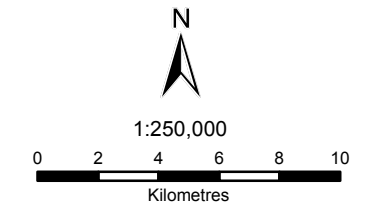


Legend

- Indian Reserves
- Project Alignment
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

INDIAN RESERVES -
SCHEDULE B ABORIGINAL GROUPS

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| Figure 10-12 | 19/05/2016 |
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APPENDIX B

Aboriginal Consultation Report 2

George Massey Tunnel
Replacement Project



BC JOB
PLAN

ABORIGINAL CONSULTATION REPORT 2

JULY 2016

Aboriginal Groups reviewed draft Aboriginal Consultation Report 2. Their comments were incorporated into the final Aboriginal Consultation Report, as appropriate.

ABORIGINAL CONSULTATION REPORT

George Massey Tunnel Replacement Project

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ABORIGINAL CONSULTATION REPORT

George Massey Tunnel Replacement Project

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EXECUTIVE SUMMARY

The B.C. Ministry of Transportation and Infrastructure (the Ministry) is proposing the George Massey Tunnel Replacement Project (GMT or Project) to address congestion, meet forecast population and employment growth, and ensure Highway 99 continues to serve regional, provincial, and national transportation needs.

The George Massey Tunnel (Tunnel) is an important link in the regional and provincial transportation system, serving an average of 80,000 vehicles each day and connecting to key gateways that fuel our national, provincial and regional economies. Since the Tunnel opened in 1959, Metro Vancouver's population has grown considerably and is forecast to keep growing by more than one million people over the next 30 years.

The Project involves replacing the Tunnel with a new bridge spanning the Fraser River South Arm and Deas Island, decommissioning the Tunnel, and improving Highway 99 from Bridgeport Road in the City of Richmond (Richmond) to Highway 91 in the Corporation of Delta (Delta). The general alignment of the Project will follow the existing Highway 99 corridor, including across the Fraser River.

The Ministry provided the draft Project Description and Keys Areas of Study and the draft Application Information Requirements (dAIR) to Schedule B Aboriginal Groups for review and comment prior to the project entering the EA process. Further opportunities for review and comment on these documents and specifically on the Valued Components and study area boundaries proposed in the documents, were provided to Schedule B Aboriginal Groups through the Environmental Assessment Office's (EAO) Working Group process and ongoing consultation with the Ministry.

In accordance with EAO's Section 11 Order and as outlined in the Project's Aboriginal Consultation Plan, the Ministry has prepared Aboriginal Consultation Report 2 (Consultation Report). This Consultation Report summarizes consultation activities undertaken to date with Aboriginal Groups to share information and elicit input in relation to the Project, up to the time the Application is submitted to EAO. This document is intended to build on Consultation Report 1 and provide more detailed, Aboriginal Group-specific information regarding consultation activities, their Aboriginal Interests, issues and concerns raised to date, and the Ministry's related responses or actions.

Aboriginal Consultation is ongoing and to date, more than 80 meetings have been held with Aboriginal Groups regarding the Project. These activities have been undertaken in accordance with the Aboriginal Consultation Plan (Consultation Plan), approved by EAO, which outlines and guides Aboriginal consultation activities to be undertaken by the Ministry to satisfy Aboriginal consultation requirements identified in EAO's Section 11

ABORIGINAL CONSULTATION REPORT

George Massey Tunnel Replacement Project

Order¹. The Consultation Plan describes commitments and efforts to ensure that Aboriginal consultation throughout the EA process is undertaken in a manner that respects the individual needs of Aboriginal communities, meets the Crown's duty to consult, and meets the Crown's duty to accommodate where appropriate.

The Ministry is committed to a meaningful consultation and engagement process for the Project and recognizes the importance of Aboriginal Groups' involvement and input into Project planning, design and implementation.

¹ The Section 11 and Aboriginal Consultation Plan for the Project are available on EAO's website at http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_430.html.

ACRONYMNS AND ABBREVIATIONS

| Term | Acronym/Abbreviation |
|---|----------------------|
| Aboriginal Consultation Plan | Consultation Plan |
| Aboriginal Consultation Report | Consultation Report |
| Application Information Requirements | AIR |
| Application for an Environmental Assessment Certificate | Application |
| B.C. Ministry of Transportation and Infrastructure | Ministry |
| British Columbia | B.C. |
| British Columbia <i>Environmental Assessment Act</i> | <i>EAA</i> |
| City of Richmond | Richmond |
| Corporation of Delta | Delta |
| Draft Application Information Requirements | dAIR |
| Environmental Assessment | EA |
| Environmental Assessment Certificate | EAC |
| Environmental Assessment Office | EAO |
| George Massey Tunnel | Tunnel |
| George Massey Tunnel Replacement Project | Project |
| High-Occupancy Vehicle | HOV |
| Lake Cowichan First Nation | Lake Cowichan |
| Lyackson First Nation | Lyackson |
| Musqueam Indian Band | Musqueam |
| People of the River Referrals Office | PRRO |
| Semiahmoo First Nation | Semiahmoo |
| Tsawwassen Final Agreement | TFA |
| Tsawwassen First Nation | Tsawwassen |
| Tsleil-Waututh Nation | Tsleil-Waututh |

1. INTRODUCTION

1.1 Project Overview

The Project will replace the Tunnel with a new 10-lane (8 lanes plus two dedicated transit/ high occupancy vehicle [HOV] lanes) bridge spanning the Fraser River South Arm, decommission the Tunnel, and improve Highway 99 from Bridgeport Road in Richmond to Highway 91 in Delta. Proposed improvements include replacing the Westminster Highway, Steveston Highway and Highway 17A interchanges, widening Highway 99 to accommodate dedicated HOV lanes, and providing a multi-use pathway on the bridge for cyclists and pedestrians to connect with the existing cycling and pedestrian networks on either side. Figure 1 illustrates the Project area.

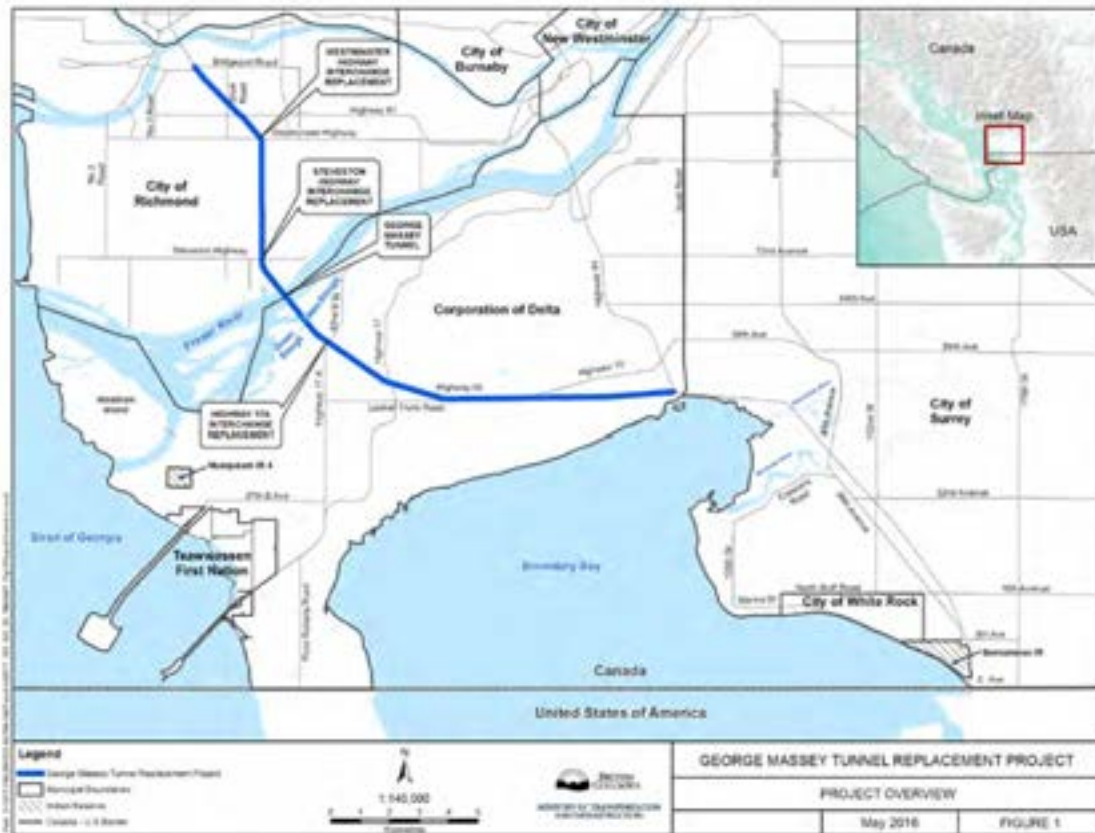


Figure 1 Project Area

The Project will have the same general alignment as the existing Highway 99 corridor and crossing of the Fraser River South Arm, linking Richmond and Delta in southwestern B.C.

1.2 Proponent Overview

The Project proponent is the B.C. Ministry of Transportation and Infrastructure working on behalf of the Province of British Columbia. If approved, the Environmental Assessment Certificate (EAC) and operational permits for the Project will be held by the Ministry.

1.3 Purpose of the Document

Section 15.3 of the Section 11 Order issued by EAO on March 7, 2016, requires that the Ministry submit Consultation Reports at the following points in time:

- Prior to EAO issuing the final Application Information Requirements to the Proponent;
- With submission of the Application for evaluation;
- No later than 100 days from beginning of Application Review stage; and
- At any time specified by the Project Assessment Lead.

This Consultation Report focuses on consultation undertaken prior to the Project entering the EA process as well as consultation during the pre-Application phase of the Project up until the submission of the Application for evaluation. The Initial Consultation phase, a period of early engagement and consultation outside of the EA process, ended with the filing of the Project Description and Key Areas of Study document in December 2015, which commenced the pre-Application phase of the EA process and the EA process itself. The Project is currently in the pre-Application phase of the EA Process, until EAO accepts the Ministry's Application for review following a 30-day screening of the Application, at which time it will enter the Application phase.

The purpose of this document is to build on information outlined in Aboriginal Consultation Report 1, which was provided to Aboriginal Groups in April 2016 for review and comment and submitted to EAO prior to issuing the final AIR. This document includes content specific to each of the Aboriginal Groups being consulted on the Project. This Consultation Report includes:

- Efforts undertaken to date by the Ministry to consult with each Aboriginal Group in relation to the Project;
- How the Ministry has complied with the Consultation Plan;

ABORIGINAL CONSULTATION REPORT

George Massey Tunnel Replacement Project

- Information and input received from each Aboriginal Group during consultation undertaken to date;
- Input from each Aboriginal Group regarding potential adverse effects of the proposed Project on their Aboriginal Interests² and
- Plans in relation to ongoing consultation on the proposed Project and any next steps with the specific Aboriginal Groups.

As a supplement to Aboriginal Consultation Report 1, this Consultation Report contains more detailed information regarding consultation activities. Building on the overview table of issues from Consultation Report 1, this document breaks out issues, concerns and the Ministry's response or actions to address these by each Aboriginal Group.

Pursuant to the Section 11 Order, a draft version of this report was shared with Aboriginal Groups listed in Schedules B of the Section 11 Order on May 27, 2016 for their review and comment. Aboriginal Groups were asked to provide their comments by June 17, 2016; however, any input received prior to June 29, 2016 was considered.

The Ministry considered comments from Aboriginal Group and, where appropriate, incorporated that feedback into this revised document. In consideration of the confidential nature of comments provided on the draft Consultation Plan and that specific consultation activities were planned for each Aboriginal Group, the Ministry responded directly to each group regarding their respective comments on the Aboriginal Consultation Plan.

Aboriginal Groups will be provided with a final copy of Aboriginal Consultation Report 2, along with an explanation of how their input has been considered and any resulting changes to the Report.

In accordance with the Section 11 Order, Aboriginal Consultation Report 2 was submitted to EAO for evaluation at the same time as the Application.

² Aboriginal Interests" means asserted or determined aboriginal rights, including title, and treaty rights.

2. ABORIGINAL CONSULTATION

2.1 Introduction

As outlined in Consultation Report 1, the Ministry is undertaking a four-phase consultation process with Aboriginal Groups that consists of initial Consultation, pre-Application Consultation, Application Review Consultation and Post EAC Consultation. These phases are outlined below.

To date more than 80 meetings have been held with Aboriginal Groups involved with the Project.

Table 1: Phases of Consultation with Aboriginal Groups

| | Consultation Phase | Overview | Duration/Status |
|---|------------------------------|---|---|
| 1 | Initial Consultation | Project development and planning up to submission of Project Description and Key Areas of Study document on December 16, 2015. Includes collection of baseline information, sharing of draft EA-related documents (i.e. Project Description and Areas of Study, dAIR) | To December 16, 2015 |
| 2 | Pre-Application Consultation | Period from the filing of the Project Description and Key Areas of Study to Application acceptance by EAO, including EAO's issuance of Section 11 Order, a 31 day public comment period on the Project description and Key Areas of Study document, development of the Application Information Requirements and collection of baseline information(may include submission of permit applications) | December 16 2015 – Acceptance of the Application by EAO (following screening of the Application). |

| | Consultation Phase | Overview | Duration/Status |
|---|--|--|-------------------------------------|
| 3 | Application review Consultation | Acceptance of the Application by EAO to the end of the Application Review stage (180 days). Application review will include a public comment period in a similar format as what was undertaken during pre-Application consultation. This Application review phase will be followed by the Minister's decision (up to 45 days), which could result in issuance of an Environmental Assessment Certificate (EAC) | Tentatively July 2016-February 2017 |
| 4 | Post Environmental Assessment Certificate (EAC) Consultation | Post EAC issuance to the date when all permit applications have been adjudicated and permits issued. | Tentatively March/April 2017 - 2022 |

2.2 Identification of Aboriginal Groups

On March 7, 2016, EAO issued an Order under Section 11 of the British Columbia *Environmental Assessment Act* which included the following Aboriginal Groups:

Schedule B Aboriginal Groups – Consultation and Invitation to Participate in Technical Working Group:

- Cowichan Tribes
- Halalt First Nation
- Katzie First Nation
- Kwantlen First Nation
- Lake Cowichan First Nation
- Lyackson First Nation
- Musqueam Indian Band
- Penelakut Tribe

- Hwlitsum³
- Semiahmoo First Nation
- Squamish Nation
- Stz'uminus First Nation
- Tsawwassen First Nation
- Tsleil-Waututh Nation

Schedule C Aboriginal Groups – Notification:

- People of the River Referrals Office

Prior to the Section 11 Order taking effect, the Ministry had received a deferral from the People of the River Referrals Office, which handles referrals for some member nations of the Stó:lō Tribal Council and Stó:lō Nation, as well as the six member nations of the Ts'elxweyeqw Tribe.

2.3 Summary of Consultation Activities with Cowichan Tribes

The following section summarizes consultation undertaken with Cowichan Tribes during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Cowichan Tribes and issues, concerns and interests raised to date. The Ministry considered Cowichan Tribes's input on the draft of this Consultation Report, and revised content where appropriate, and will share a final version of the Consultation Report with Cowichan Tribes.

Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation advised the Ministry that they would participate in the environmental assessment process as part of Cowichan Nation Alliance. As noted below, the Ministry provided information and funding directly to Cowichan Tribes. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribes represented Cowichan Nation Alliance in correspondence, meetings and fieldwork.

Initial Consultation Phase

The Ministry initiated consultation with Cowichan Tribes in early 2014.

In support of consultation during the Initial Consultation Phase the following Ministry-led

³ This reference to the Hwlitsum is not intended to signify any change in the position that the Province may have taken in other contexts in relation to the duty to consult with this group.

activities have been undertaken with Cowichan Tribes:

- Meetings with Cowichan Tribes Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of studies.

During initial discussions with Cowichan Tribes, and as demonstrated in the Consultation Plan and participation funding agreements with Cowichan Tribes, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Cowichan Tribes.

In addition to meetings, Cowichan Tribes participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Cowichan Tribes's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Cowichan Tribes during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Cowichan Tribes' input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the draft Aboriginal Consultation Plan, the Ministry met with Cowichan Tribes and walked through these draft documents. Focused discussions on

these documents were intended to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Cowichan Tribes

Between early 2014 and May 2016, the Ministry and Cowichan Tribes discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. Meetings and related activities undertaken with Cowichan Tribes in relation to the Project are outlined below.

At meetings with Cowichan Tribes during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Cowichan Tribes' past, current and future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Cowichan Tribes' Aboriginal Interests. The Ministry also sought to determine Cowichan Tribes' preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Cowichan Tribes, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Cowichan Tribes.
- Meetings were scheduled at a date and time convenient for Cowichan Tribes and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Cowichan

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Tribes include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|---|---|
| 2014-06-02 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • Hwlitsum | Travelodge Silver Bridge Inn | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-08-28 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • Hwlitsum • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-06 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan Tribes and Stz'uminus for Cowichan Nation Alliance • GMT • BC EAO | Stz'uminus Band Office Ladysmith, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2014-09-18 | Initial Consultation | <ul style="list-style-type: none"> • Halalt First Nation • GMT | Halalt First Nation 7973 Chemainus Road, RR 5 Chemainus, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-25 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2015-03-24 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT • Golder • BC Hydro | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary Presentation • Draft Application Information Requirements • Draft Application Information Requirements Presentation • Utilities Presentation |
| 2015-05-08 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Fish and Fish Habitat Presentation • Green Slough Conceptual Plan |

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| | | | | |
|------------|----------------------|---|---------------------------------------|---|
| | | <ul style="list-style-type: none"> Alliance GMT Northwest Hydraulics | | <ul style="list-style-type: none"> Green Slough Stone Columns, concept River Hydraulics and Morphology Presentation |
| 2015-07-27 | Initial Consultation | <ul style="list-style-type: none"> Cowichan Halalt Penelakut Stzuminus GMT BC Hydro | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> Agenda BCH Bridge Rendering with Hydro Towers BCH Transmission Relocation Presentation) Green Slough Concept Marine Use Presentation Traffic Update Presentation |
| 2015-08-26 | Initial Consultation | <ul style="list-style-type: none"> Cowichan Halalt Penelakut Stzuminus Lyackson | Project Tour | <ul style="list-style-type: none"> Discussed: Project components: decommissioning of Tunnel; Green Slough, Deas Slough, Indigenous plants, fish and fish habitat, enhancement opportunities. |
| 2015-11-10 | Initial Consultation | <ul style="list-style-type: none"> Cowichan, Penelakut and Halalt for Cowichan Nation Alliance GMT | Cowichan Boardroom Duncan, BC | <ul style="list-style-type: none"> Agenda Human Health Presentation Roll-out Map Draft Application Information Requirements Draft Project Description |
| 2016-02-05 | pre-Application | <ul style="list-style-type: none"> Cowichan Halalt Penelakut Stzuminus GMT BC EAO | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> GMT 2016-01-21 TWG1 EA Process Presentation GMT 2016-01-21 TWG1 Project Overview GMT 2016-01-21 TWG1 Key Areas of Study Presentation GMT 2016-01-21 TWG1 dAIR Presentation GMT 2015-01-21 TWG1 Figures to draft AIR GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation List of Project-related documents on the Project website |
| 2016-03-10 | pre-Application | <ul style="list-style-type: none"> Cowichan for Cowichan Nation Alliance Halalt First Nation | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> TWG2 Agenda TWG2 EA Process Presentation TWG2 Review of Comments Working Group Presentation TWG2 Spatial Boundaries of Proposed Areas of Study TWG2 Website Materials List |
| 2016-03-30 | pre-Application | <ul style="list-style-type: none"> Cowichan Tribes for Cowichan Nation Alliance | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> TWG2 Agenda TWG2 EA Process Presentation TWG2 Review of Comments |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| | | | | |
|------------|-----------------|---|-----------------|--|
| | | <ul style="list-style-type: none"> • GMT • BC EAO | | <p>Working Group Presentation</p> <ul style="list-style-type: none"> • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List • Business Case <p>Update on EA process CNA strength of claim & EAO analysis CNA review of draft documents Review of Working Group 2 discussion/presentations Procurement process</p> |
| 2016-04-27 | pre-Application | <ul style="list-style-type: none"> • Cowichan Tribes for Cowichan Nation Alliance • GMT | Conference call | <ul style="list-style-type: none"> • Draft Part C content • Draft Aboriginal Consultation Report 1 <p>Procurement Review of draft documents Input on mapping</p> |

As outlined in the Project’s Consultation Plan, the Ministry has been committed to sharing Project-related information with Cowichan Tribes as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Cowichan Tribes members as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Cowichan Tribes review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Cowichan Tribes in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Cowichan Tribes through letters, email and phone calls.

Letters sent to Cowichan Tribes during this consultation Phase include:

- Introductory letters notifying Cowichan Tribes of the Project and offering to meet regarding the proposed Project;

- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letters to Cowichan Tribes requesting review and comment on the draft Archaeological Overview Assessment.
- Project Description letters to Cowichan Tribes accompanying a draft copy of the Project Description and Key Areas of Study document requesting review and comment; and

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Cowichan Tribes;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Cowichan Tribes; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Cowichan Tribes;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Aboriginal Consultation Plan – Cowichan Tribes review and comment

From the beginning of consultation, the Ministry worked with Cowichan Tribes to develop a mutually acceptable consultation approach, including the manner in which Cowichan Tribes was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Cowichan Tribes, and specific input received during initial GMT consultation meetings with Cowichan Tribes. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Cowichan Tribes capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate,

incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Aboriginal Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Cowichan Tribes to the Ministry.
- Revision of Draft Consultation Plan
- Sharing of Revised Consultation Plan and a summary of responses to Cowichan Tribes's comments/input.
 - Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email.
 - Summary of comments/input provided by Cowichan Tribes and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request).

In consideration of the confidential nature of comments provided on the draft Consultation Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to Cowichan Tribes regarding their respective comments on the Consultation Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Cowichan Tribes on this matter, the Ministry is of the understanding that Cowichan Tribes and its members have no outstanding concerns or comments with respect to the Plan.

Comments were received from Cowichan Tribes on the Draft Consultation Plan via letter, October 30 2015. The Consultation Plan was revised, based on input received from all Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Cowichan Tribes identified the need for capacity funding to support Cowichan Tribes' involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Cowichan Tribes also identified the need for funding for a Cowichan Tribes Study. The Ministry and Cowichan Tribes worked together to finalize a funding agreement. This agreement specifies the activities covered under the agreements and Project/EA-related documents for Cowichan Tribes review and comment.

Involvement in Archaeological Component of the Project

From the outset of discussions, Cowichan Tribes identified the importance of the archaeological component of the Project and of Cowichan Tribes involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Cowichan Tribes for review and comment. The Ministry and its archaeologist met with Cowichan Tribes to present on this aspect of the Project. Cowichan Tribes participated in all archaeological fieldwork for the Project.

Cowichan Tribes commented on the Draft Heritage Resources Overview Assessment via letter June 25, 2015.

During Initial Consultation Phase, Cowichan Tribes provided input on the Project and commented on EA-related documents in meetings, via email, phone and letter.

Documents and formal comments received from Cowichan Tribes during this phase include:

- FLNRO Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Key Areas of Study (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Cowichan Tribes with funding for the submission of a Traditional Use Study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015
- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015

- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

Pre-Application Consultation Phase

The following section outlines consultation activities that the Ministry has undertaken with Cowichan Tribes during the pre-Application Phase. The approach was developed with input from Cowichan Tribes during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Cowichan Tribes, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Cowichan Tribes' Aboriginal Interests;
- Identified and provided, where possible, opportunities for Cowichan Tribes to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Cowichan Tribes;
- Continued to work with Cowichan Tribes to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Cowichan Tribes with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to support Cowichan Tribes in presenting information regarding their respective Aboriginal Interests and to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work

with Cowichan Tribes in an effort to finalize funding agreements for the Application Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Cowichan Tribes on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application; and
- Draft Consultation Report 1

The Ministry provided draft Part C content and mapping to Cowichan Tribes for review and comment by letters/emails (April 18, 2016). Cowichan Tribes provided comments on this draft via a letter/email (May 05, 2016) along with the Cowichan Tribes' Declaration (signed Jan 2016) and Schedule A and B maps.

In letters/emails of April 22, 2016, the Ministry provided draft Consultation Report 1 to Cowichan Tribes for review and comment prior to finalization and submission to EAO. Cowichan Tribes reviewed the draft and advised that they had no comments or requested changes (email May 05, 2015).

During this phase documents/information shared by Cowichan Tribes include:

- Environment Canada's Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Name (Working Group, March 10, 2016)

Cowichan Nation Alliance participated in the Working Group and commented on the Draft Application Information Requirements. The Ministry responded to the Working Group on comments received in relation to the dAIR.

Participation in Fieldwork

In April 2016, Cowichan Tribes was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. A Cowichan Nation Alliance representative from Penelakut Tribe participated in this work.

Materials shared with Cowichan Tribes during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussions of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| List of Project-related documents on the GMT Project website | A list of Project-related documents available in the Project document library on the Project website. |
| Health Impact Assessment (HIA) scoping document | Document outlining scope of the HIA and input being sought from Aboriginal groups/Working Group members. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Cowichan Tribes – pre-Application Phase

During the pre-Application Phase, the Ministry met three times with Cowichan Tribes (see list of meetings for details) and conducted a conference call in relation to Cowichan Tribes' interest in the procurement process and Project-related benefits and to discuss

comments on the draft Part C content and Aboriginal Consultation Report 1.

Cowichan Tribes communicated directly with EAO with respect to the EA process. EAO led two Working Group meetings. Halalt represented Cowichan Nation Alliance at the first Working Group meeting. Halalt and Cowichan Tribes represented Cowichan Nation Alliance at the second Working Group meeting. These meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

In addition, Cowichan Nation Alliance was offered and provided with two separate Working Group meetings which took place following EAO-led Working Group meetings. These were attended by Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation.

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Cowichan Tribes
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Cowichan Tribes and its members to address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Cowichan Tribes and its members
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Cowichan Nation Alliance members during this Phase include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Cowichan Tribes for review and comment.

Cowichan Tribes provided feedback on Aboriginal Consultation Report 2 via a Cowichan Nation Alliance letter of June 22, 2016, noting an error on page 159 that needed to be addressed in the revised document and requesting the table of meetings (pages 151-154) be modified to provide greater clarity with respect to meeting attendees. Aboriginal Consultation Report 2 has been revised to reflect this input.

Cowichan Tribes will be provided with a final copy of Aboriginal Consultation Report 2 along with an explanation of how their input has been considered and reflected in the final Aboriginal Consultation Report 2.

Concerns, Issues and Interests Raised by Cowichan Tribes

Consultation efforts to date, have sought to identify and address concerns and issues raised by Cowichan Tribes during the Initial Consultation and pre-Application Phases. The Ministry requested Cowichan Tribes' input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix C2.

2.4 Summary of Consultation Activities with Halalt First Nation

The following section summarizes consultation undertaken with Halalt First Nation during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Halalt First Nation and issues, concerns and interests raised to date. The Ministry considered Halalt First Nation's input on the draft of this Consultation Report, and revised content where appropriate, and will share a final version of the Consultation Report with Halalt First Nation.

Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation advised the Ministry that they would participate in the environmental assessment process as part of Cowichan Nation Alliance. As noted below, the Ministry provided information and funding directly to Halalt First Nation. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribes represented Cowichan Nation Alliance in correspondence, meetings and fieldwork.

Initial Consultation Phase

The Ministry initiated consultation with Halalt First Nation in early 2014.

In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Halalt First Nation:

- Meetings with Halalt First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of studies.

During initial discussions with Halalt First Nation, and as demonstrated in the Consultation Plan and participation funding agreements with Halalt First Nation, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Halalt First Nation.

Halalt First Nation was represented by Cowichan Nation Alliance in meetings and fieldwork. Halalt First Nation participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Halalt First Nation's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Halalt First Nation during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Halalt First Nation's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the draft Aboriginal Consultation Plan, the Ministry met with Halalt First Nation, represented by Cowichan Nation Alliance, and walked through these draft documents. Focused discussions on these documents were intended to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Halalt First Nation

Between early 2014 and May 2016, the Ministry and Halalt First Nation and Cowichan Nation Alliance discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. Meetings and related activities undertaken with Halalt First Nation or Cowichan Nation Alliance in relation to the Project are outlined below.

At meetings with Cowichan Nation Alliance during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Halalt First Nation's past, current and future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Halalt First Nation's Aboriginal Interests. The

Ministry also sought to determine Halalt First Nation’s preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed. Halalt First Nation confirmed that they would like to receive notifications directly; however, they would be represented by Cowichan Nation Alliance in correspondence, meetings and fieldwork.

In coordinating and conducting meetings with Cowichan Nation Alliance, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Cowichan Nation Alliance.
- Meetings were scheduled at a date and time convenient for Cowichan Nation Alliance and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Cowichan Nation Alliance include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--------------------------------------|---|
| 2014-06-02 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • Hwlitsum | Travelodge Silver Bridge Inn | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-08-28 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • Hwlitsum • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |

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|------------|----------------------|--|---|--|
| 2014-11-06 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan Tribes and Stz'uminus for Cowichan Nation Alliance • GMT • BC EAO | Stz'uminus Band Office Ladysmith, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2014-09-18 | Initial Consultation | <ul style="list-style-type: none"> • Halalt First Nation • GMT | Halalt First Nation 7973 Chemainus Road, RR 5 Chemainus, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-25 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2015-03-24 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT • Golder • BC Hydro | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary Presentation • Draft Application Information Requirements • Draft Application Information Requirements Presentation • Utilities Presentation |
| 2015-05-08 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT • Northwest Hydraulics | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Fish and Fish Habitat Presentation • Green Slough Conceptual Plan • Green Slough Stone Columns, concept • River Hydraulics and Morphology Presentation |
| 2015-07-27 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • GMT • BC Hydro | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • BCH Bridge Rendering with Hydro Towers • BCH Transmission Relocation Presentation) • Green Slough Concept • Marine Use Presentation • Traffic Update Presentation |
| 2015-08-26 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • Lyackson | Project Tour | <ul style="list-style-type: none"> • Discussed: Project components: decommissioning of Tunnel; Green Slough, Deas Slough, Indigenous plants, fish and fish habitat, enhancement opportunities. |
| 2015-11-10 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt | Cowichan Boardroom | <ul style="list-style-type: none"> • Agenda • Human Health Presentation |

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| | | | | |
|------------|-----------------|---|---|---|
| | | <ul style="list-style-type: none"> for Cowichan Nation Alliance • GMT | Duncan, BC | <ul style="list-style-type: none"> • Roll-out Map • Draft Application Information Requirements • Draft Project Description |
| 2016-02-05 | pre-Application | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • GMT • BC EAO | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • GMT 2016-01-21 TWG1 EA Process Presentation • GMT 2016-01-21 TWG1 Project Overview • GMT 2016-01-21 TWG1 Key Areas of Study Presentation • GMT 2016-01-21 TWG1 dAIR Presentation • GMT 2015-01-21 TWG1 Figures to draft AIR • GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation • List of Project-related documents on the Project website |
| 2016-03-10 | pre-Application | <ul style="list-style-type: none"> • Cowichan for Cowichan Nation Alliance • Halalt First Nation | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> • TWG2 Agenda • TWG2 EA Process Presentation • TWG2 Review of Comments Working Group Presentation • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List |
| 2016-03-30 | pre-Application | <ul style="list-style-type: none"> • Cowichan Tribes for Cowichan Nation Alliance • GMT • BC EAO | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • TWG2 Agenda • TWG2 EA Process Presentation • TWG2 Review of Comments Working Group Presentation • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List • Business Case <p>Update on EA process CNA strength of claim & EAO analysis CNA review of draft documents Review of Working Group 2 discussion/presentations Procurement process</p> |
| 2016-04-27 | pre-Application | <ul style="list-style-type: none"> • Cowichan Tribes for Cowichan Nation Alliance • GMT | Conference call | <ul style="list-style-type: none"> • Draft Part C content • Draft Aboriginal Consultation Report 1 <p>Procurement Review of draft documents Input on mapping</p> |

As outlined in the Project's Consultation Plan, the Ministry has been committed to sharing Project-related information with Cowichan Nation Alliance members as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Cowichan Nation Alliance members as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Cowichan Nation Alliance members' review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Cowichan Nation Alliance members in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Cowichan Nation Alliance members through letters, email and phone calls.

Letters sent to Halalt First Nation during this consultation Phase include:

- Introductory letters notifying Halalt First Nation of the Project and offering to meet regarding the proposed Project;
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letters to Halalt First Nation requesting review and comment on the draft Archaeological Overview Assessment.
- Project Description letters to Halalt First Nation accompanying a draft copy of the Project Description and Key Areas of Study document requesting review and comment; and

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Halalt First Nation;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Halalt First Nation; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Halalt First Nation;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Aboriginal Consultation Plan – Halalt First Nation review and comment

From the beginning of consultation, the Ministry worked with Halalt First Nation to develop a mutually acceptable consultation approach, including the manner in which Halalt First Nation was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Halalt First Nation, and specific input received during initial GMT consultation meetings with Cowichan Nation Alliance representatives. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Halalt First Nation's capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Cowichan Nation Alliance representatives to the Ministry.
- Revision of Draft Consultation Plan
- Sharing of Revised Consultation Plan and a summary of responses to Cowichan Nation Alliance's comments/input.
 - Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email.
 - Summary of comments/input provided by Cowichan Nation Alliance and corresponding action taken by the Ministry (i.e. revision to plan, comment

“noted”, request for further discussion regarding request).

In consideration of the confidential nature of comments provided on the draft Aboriginal Consultation Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to both Halalt First Nation and Cowichan Nation Alliance regarding their respective comments on the Aboriginal Consultation Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Halalt First Nation and Cowichan Nation Alliance on this matter, the Ministry is of the understanding that Halalt First Nation have no outstanding concerns or comments with respect to the Plan.

Comments were received from Cowichan Nation Alliance on the Draft Aboriginal Consultation Plan via letter, October 30 2015. The Consultation Plan was revised, based on input received from Cowichan Nation Alliance and other Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Halalt First Nation identified the need for capacity funding to support Halalt First Nation’s involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Halalt First Nation also identified the need for funding for a Halalt First Nation Study. The Ministry and Halalt First Nation worked together to finalize a funding agreement. This agreement specifies the activities covered under the agreement and Project/EA-related documents for Halalt First Nation’s review and comment.

Involvement in Archaeological Component of the Project

From the outset of discussions, Halalt First Nation identified the importance of the archaeological component of the Project and of Halalt First Nation’s involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Halalt First Nation for review and comment. The Ministry and its archaeologist met with Halalt First Nation to present on this aspect of the Project. Cowichan Nation Alliance representatives from Cowichan Tribes, Penelakut Tribe and Stzùminus First Nation participated in all archaeological fieldwork for the Project.

Cowichan Nation Alliance commented on the Draft Heritage Resources Overview Assessment via letter June 25, 2015.

During Initial Consultation Phase, Halalt First Nation and Cowichan Nation Alliance provided input on the Project and commented on EA-related documents in meetings, via email, phone and letter.

Documents and formal comments received from Halalt First Nation during this phase include:

- FLNRO Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Key Areas of Study (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Halalt First Nation with funding for the submission of a Traditional Use Study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015
- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 25, 2015
- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

Pre-Application Consultation Phase

The following section outlines consultation activities that the Ministry has undertaken with Halalt First Nation during the pre-Application Phase. The approach was developed with input from Halalt First Nation and Cowichan Nation Alliance during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Halalt First Nation, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project

consultation activities and the regulatory process;

- Provided relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Halalt First Nation's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Halalt First Nation and Cowichan Nation Alliance to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Halalt First Nation and Cowichan Nation Alliance;
- Continued to work with Halalt First Nation to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Halalt First Nation with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to support Halalt First Nation in presenting information regarding their Aboriginal Interests and to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Halalt First Nation in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Halalt First Nation on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application; and
- Draft Consultation Report 1

The Ministry provided draft Part C content and mapping to Halalt First Nation for review and comment by letters/emails (April 18, 2016). Cowichan Nation Alliance provided comments on this draft via a letter/email (May 05, 2016) along with the Cowichan Nation Alliance Declaration (signed Jan 2016) and Schedule A and B maps.

In letters/emails of April 22, 2016, the Ministry provided draft Consultation Report 1 to Halalt First Nation for review and comment prior to finalization and submission to EAO. Halalt First Nation and Cowichan Nation Alliance reviewed the draft and Cowichan Nation Alliance advised that they had no comments or requested changes (email May 05, 2015).

During the pre-Application Phase, documents/information shared by Halalt First Nation includes:

- Environment Canada’s Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Name (Working Group, March 10, 2016)

Cowichan Nation Alliance participated in the Working Group and commented on the Draft Application Information Requirements. The Ministry responded to the Working Group on comments received in relation to the dAIR.

Participation in Fieldwork

In April 2016, Halalt First Nation and Cowichan Nation Alliance were invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. A Cowichan Nation Alliance representative from Halalt First Nation participated in this work.

Materials shared with Halalt First Nation during the pre-Application Phase are outlined below:

| Document | Description |
|--|--|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO’s <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment |

| Document | Description |
|---|--|
| | Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussions of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| List of Project-related documents on the GMT Project website | A list of Project-related documents available in the Project document library on the Project website. |
| Health Impact Assessment (HIA) scoping document | Document outlining scope of the HIA and input being sought from Aboriginal groups/Working Group members. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Halalt First Nation – pre-Application Phase

During the pre-Application Phase, the Ministry met three times with Cowichan Nation Alliance (see list of meetings for details) and conducted a conference call in relation to Cowichan Nation Alliance' interest in the procurement process and Project-related benefits and to discuss comments on the draft Part C content and Aboriginal

Consultation Report 1.

Cowichan Nation Alliance attended two EAO-led Working Group meetings and communicated directly with EAO with respect to the EA process. Halalt represented Cowichan Nation Alliance at the first Working Group meeting. Halalt First Nations and Cowichan Tribes represented Cowichan Nation Alliance at the second Working Group meeting. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Cowichan Nation Alliance was offered and provided with two separate Working Group meetings which took place following EAO-led Working Group meetings. These were attended by Cowichan Tribes, Halalt First Nation, Halalt First Nation and Stz'uminus First Nation.

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Halalt First Nation and Cowichan Nation Alliance
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Halalt First Nation and

Cowichan Nation Alliance

- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Halalt First Nation and Cowichan Nation Alliance
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Halalt First Nation during this Phase include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Halalt First Nation for review and comment.

Halalt First Nation provided feedback on Aboriginal Consultation Report 2 via a Cowichan Nation Alliance letter of June 22, 2016, noting an error on page 159 that needed to be addressed in the revised document and requesting the table of meetings (pages 151-154) be modified to provide greater clarity with respect to meeting attendees. Aboriginal Consultation Report 2 has been revised to reflect this input.

Halalt First Nation will be provided with a final copy of Aboriginal Consultation Report 2 along with an explanation of how their input has been considered and reflected in the final Aboriginal Consultation Report 2.

Concerns, Issues and Interests Raised by Cowichan Nation Alliance

Consultation efforts to date, have sought to identify and address concerns and issues raised by Halalt First Nation and Cowichan Nation Alliance during the Initial Consultation and pre-Application Phases. The Ministry requested Halalt First Nation`s input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2`s Appendix A has been revised to reflect input received to date

and to include status and next steps. This table is also included in Part C as Appendix D2.

2.5 Summary of Consultation Activities with Katzie First Nation

The following section summarizes consultation undertaken with the Katzie First Nation (Katzie) during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Katzie and of the issues, concerns and interests raised to date.

Initial Consultation Phase

The Ministry initiated consultation with Katzie in early 2014. In support of consultation undertaken during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Katzie:

- Meetings with Katzie First Nation Chief and Council, staff and consultants;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of a Katzie First Nation Project-specific Study.

During initial discussions with Katzie, and as demonstrated in the Consultation Plan and Katzie/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Katzie.

In addition to meetings with Katzie representatives during the Initial Consultation Phase, Katzie was invited to participate in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Katzie's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

Discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Katzie during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Katzie's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the Draft Consultation Plan, the Ministry met with Katzie and walked through these draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Katzie First Nation

Between early 2014 and May 2016, the Ministry and Katzie discussed and exchanged Project-related information through emails, phone calls, and in-person meetings. Meetings and related activities undertaken with Katzie in relation to the Project are outlined below.

At meetings with Katzie during the Initial Consultation Phase, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Katzie's past, current and desired future use of the Project area for traditional purposes, and any concerns related to potential impacts on Katzie's Aboriginal Interests. The Ministry also sought to determine Katzie's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Katzie, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Katzie.
- Meetings were scheduled at a date and time convenient for Katzie and that facilitated the attendance of key representatives.

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- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Katzie include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--------------------------------|---|
| 2014-01-21 | Initial Consultation | <ul style="list-style-type: none"> • GMT | Katzie Administration Building | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • News Release 2013-09-20 Bridge Announcement |
| 2014-09-08 | Initial Consultation | <ul style="list-style-type: none"> • Katzie • GMT | Katzie Administration Building | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-07 | Initial Consultation | <ul style="list-style-type: none"> • Katzie • BC EAO • GMT | Katzie Administration Building | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2015-03-26 | Initial Consultation | <ul style="list-style-type: none"> • Katzie • GMT • Northwest Hydraulics | Katzie Administration Building | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary Presentation • Draft Application Information Requirements • Draft Application Information Requirements Presentation • Utilities Presentation |

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| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--------------------------------------|--|
| 2015-05-11 | Initial Consultation | <ul style="list-style-type: none"> Katzie GMT Project Northwest Hydraulics | Katzie Administration Building | <ul style="list-style-type: none"> Agenda Fish and Fish Habitat Presentation Green Slough Conceptual Plan Green Slough Stone Columns, concept River Hydraulics and Morphology Presentation |
| 2015-07-17 | Initial Consultation | <ul style="list-style-type: none"> Katzie GMT <p><u>2nd Half of Meeting:</u></p> <ul style="list-style-type: none"> BC Hydro | Katzie Administration Building | <ul style="list-style-type: none"> BCH Bridge Rendering with Hydro Towers BCH Transmission Relocation Presentation Green Slough Concept Marine Use Presentation Traffic Update Presentation |
| 2015-12-15 | Initial Consultation | <ul style="list-style-type: none"> Katzie GMT Semiahmoo Kwantlen | Kwantlen First Nation Administration | <ul style="list-style-type: none"> Project update Project Description, Project Definition Report and dAIR Procurement |
| 2016-04-13 | pre-Application | <ul style="list-style-type: none"> Katzie GMT Semiahmoo Kwantlen | Katzie Administration Building | <ul style="list-style-type: none"> Project update Project Description, Project Definition Report and dAIR Procurement |

As outlined in the Project's Consultation Plan, the Ministry has been committed to sharing Project-related information with Katzie First Nation as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Katzie as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Katzie's review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Katzie in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Katzie through letters, email and phone calls.

Letters sent to Katzie during this consultation Phase include:

- Introductory letter notifying Katzie of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Katzie representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;

Clarification of information and feedback shared by Katzie; and

- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Katzie
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Materials shared with Katzie are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Katzie review and comment

From the beginning of consultation, the Ministry worked with Katzie to develop a mutually acceptable consultation approach, including the manner in which Katzie was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or

minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Katzie, an established working relationship with Katzie, and specific input received during initial GMT consultation meetings with Katzie: The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Katzie/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Katzie to the Ministry.
- Revision of Draft Consultation Plan
- Sharing of Revised Consultation Plan and a summary of responses to Katzie's comments/input.
 - Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email.
 - Summary of comments/input provided by Katzie and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request).

In consideration of the confidential nature of comments provided on the draft Plan and that specific consultation activities were planned for each Aboriginal Group, the Ministry responded directly to each group regarding their respective comments on the Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Katzie on this matter, the Ministry is of the understanding that Katzie has no outstanding concerns or comments with respect to the Plan.

Katzie submitted comments on the Draft Aboriginal Consultation Plan in a November 20, 2015 letter/email. The Consultation Plan was revised, based on input received from Katzie and other Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Katzie identified the need for capacity funding to support Katzie's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Katzie also identified the need for funding for a Katzie Traditional Use Study. The Ministry and Katzie worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Katzie's review and comment. Katzie submitted a study entitled "George Massey Tunnel Replacement: Katzie First Nation Traditional Use Study".

Involvement in Archaeological Component of the Project

From the outset of discussions, Katzie identified the importance of the archaeological component of the Project and of their involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Katzie for review and comment. The Ministry and its archaeologist met with Katzie to present on this aspect of the Project. Katzie has participated in all archaeological fieldwork for the Project.

Pre-Application Consultation

The following section outlines consultation activities that the Ministry has undertaken with Katzie during the pre-Application Phase. The approach was developed with input from Katzie during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Katzie, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Katzie's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Katzie to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Katzie;
- Continued to work with Aboriginal Groups to identify potentially affected Aboriginal Interests;

- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Katzie with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan); to support Katzie in presenting information regarding their respective Aboriginal Interests and to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry is working with Katzie to finalize a funding agreement for the Application Review phase i.

Consultation on EA-related documents

During this phase, the Ministry consulted Katzie on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1; and
- Draft Consultation Report 2

Katzie provided comments on the draft Project Description and Key Areas of Study document via letter dated January 4, 2016.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Aboriginal Consultation Report 1 to Katzie for review and comment prior to finalization and submission to EAO indicating that feedback received by May 2, 2106, would be incorporated into the final version as appropriate. Katzie informed the Ministry that Katzie had no comments on draft Aboriginal Consultation Report 1.

Participation in fieldwork

In April 2016, Katzie participated in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment

Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation.

Materials shared with Katzie during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft summary with more detailed information of consultation undertaken to date on the Project. For review and comment. |

Meetings with Katzie First Nation

During the pre-Application Phase, the Ministry met twice with Katzie (see list of meetings for details). Katzie was invited to two EAO-led Working Group meetings. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process

- Project overview and update
- Key Areas of Study
- dAIR Overview
- Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Katzie representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Katzie
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Katzie
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Katzie during this Phase include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1

- Letter requesting review of Draft Aboriginal Consultation Report 2

Katzie informed the Ministry that Katzie had no comments on draft Part C content or Aboriginal Consultation Report 1.

On May 18, 2016, the Ministry received a letter from Katzie, Kwantlen and Semiahmoo First Nations expressing concern with the Project's procurement strategy and requesting further dialogue with respect to business opportunities. The three Nations communicated their continued concern with respect to the procurement strategy in a June 2016 Project update meeting, whereby they indicated that a response to their May 18, 2016 letter was required prior to their continued engagement on the Project. In a June 23, 2016 letter, Katzie, Kwantlen and Semiahmoo reiterated their concern with the Project's procurement strategy and that the EA and procurement process was advancing prior to their concerns being addressed. The Ministry acknowledges the concern expressed by the three Nations and will continue to work with Katzie, Kwantlen and Semiahmoo First Nations in an effort to address this and any other Project-related concerns.

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Katzie for review and comment. Katzie did not provide comments on Report 2 but reiterated that they have significant concern with the Project's procurement strategy and that the EA process is advancing prior to changes to this strategy.

Katzie will be provided with a final copy of the Consultation Report along with an explanation of how their input has been considered and any changes to the final Report 2 as a result of their feedback.

Concerns, Issues and Interests Raised by Katzie First Nation

Consultation efforts to date, have sought to identify and address concerns and issues raised by Katzie during the Initial Consultation and pre-Application Phases. The Ministry requested Katzie's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix D2.T

As noted in the above section, Katzie has expressed significant concern with the Project's procurement strategy. The Ministry is committing to working with Katzie to address this concern.

2.6 Summary of Consultation Activities with Kwantlen First Nation

The following section summarizes consultation undertaken with the Kwantlen First Nation (Kwantlen) during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Kwantlen and of the issues, concerns and interests raised to date. The Ministry considered Kwantlen's input on the draft of this Consultation Report and revised content where appropriate, and will share a final version of the Consultation Report with Kwantlen.

Initial Consultation Phase

The Ministry initiated consultation with Kwantlen in early 2014. In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Kwantlen:

- Meetings with Kwantlen First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission a Kwantlen First Nation Project-specific Study.

During initial discussions with Kwantlen, and as demonstrated in the Consultation Plan and Kwantlen/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Kwantlen.

In addition to meetings with Kwantlen representatives during the Initial Consultation Phase, Kwantlen was invited to participate in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Kwantlen's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Kwantlen during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Kwantlen's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the Draft Consultation Plan, the Ministry met with Kwantlen and walked through these draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Kwantlen First Nation

Between early 2014 and May 2016, the Ministry and Kwantlen discussed and exchanged Project-related information through emails, phone calls, and in-person meetings. Meetings and related activities undertaken with Kwantlen in relation to the Project are outlined below.

At meetings with Kwantlen during the Initial Consultation Phase, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Kwantlen's past, current and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Kwantlen's Aboriginal Interests. The Ministry also sought to determine Kwantlen's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Kwantlen, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Kwantlen.
- Meetings were scheduled at a date and time convenient for Kwantlen and that facilitated the attendance of key representatives.

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- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Kwantlen include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|----------------------------|---|
| 2014-01-22 | Initial Consultation | <ul style="list-style-type: none"> • Katzie • GMT | Kwantlen Band Admin Office | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • News Release 2013-09-20 Bridge Announcement |
| 2014-11-18 | Initial Consultation | <ul style="list-style-type: none"> • Katzie • GMT • BC EAO | Kwantlen Band Admin Office | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2015-03-31 | Initial Consultation | <ul style="list-style-type: none"> • Katzie • GMT • Golder • BC Hydro | Kwantlen Band Admin Office | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary Presentation • Draft Application Information Requirements • Draft Application Information Requirements Presentation • Utilities Presentation |
| 2015-05-22 | Initial Consultation | <ul style="list-style-type: none"> • Katzie • GMT | Kwantlen Band Admin Office | <ul style="list-style-type: none"> • Agenda • Fish and Fish Habitat Presentation • Green Slough Stone Columns, concept • Green Slough Conceptual Plan • River Hydraulics and Morphology Presentation |

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George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|-------------------------------|--|---|--|
| 2015-07-30 | Initial Consultation | <ul style="list-style-type: none"> Katzie GMT BC Hydro | Kwantlen First Nation Gabriel Lane Fort Langley, BC | <ul style="list-style-type: none"> Agenda BCH Bridge Rendering with Hydro Towers BCH Transmission Relocation Presentation) Green Slough Concept Marine Use Presentation Traffic Update Presentation |
| 2015-12-15 | Initial Consultation | <ul style="list-style-type: none"> Katzie GMT Semiahmoo Kwantlen | Kwantlen First Nation Administration | <ul style="list-style-type: none"> Project update Project Description, Project Definition Report and dAIR Procurement |
| 2016-01-21 | GMT Technical Working Group 1 | <ul style="list-style-type: none"> HFN Katzie Musqueam TSAWWASSEN Tsleil-Waututh | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> 01 GMT 2016-01-21 TWG1 EA Process Presentation 02 GMT 2016-01-21 TWG1 Project Overview 03 GMT 2016-01-21 TWG1 Key Areas of Study Presentation 04 GMT 2016-01-21 TWG1 dAIR Presentation 05 GMT 2016-01-21 TWG1 Figures to draft AIR 06 GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation 07 GMT 2016-01-21 TWG1 Agenda |
| 2016-02-29 | pre-Application | <ul style="list-style-type: none"> Kwantlen GMT | Kwantlen First Nation Administration | <ul style="list-style-type: none"> Revised Aboriginal Consultation Plan |
| 2016-03-10 | GMT Technical Working Group 2 | <ul style="list-style-type: none"> Halalt Katzie Musqueam Cowichan Nation Alliance Tsleil-Waututh | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> TWG2 Agenda TWG2 EA Process Presentation TWG2 Review of Comments Working Group Presentation TWG2 Spatial Boundaries of Proposed Areas of Study TWG2 Website Materials List |
| 2016-04-13 | pre-Application | <ul style="list-style-type: none"> Katzie GMT Semiahmoo Kwantlen | Katzie First Nation Administration | <ul style="list-style-type: none"> Project update Project Description, Project Definition Report and dAIR Procurement |

In addition to meetings with Kwantlen representatives during the Initial Consultation Phase, Kwantlen participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough

Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

As outlined in the Project's Consultation Plan, the Ministry has been committed to sharing Project-related information with Kwantlen as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Kwantlen as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Kwantlen's review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Kwantlen in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Kwantlen through letters, email and phone calls.

Letters sent to Kwantlen during this consultation Phase include:

- Introductory letter notifying Kwantlen of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Kwantlen representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;

- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Kwantlen; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Kwantlen;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Kwantlen review and comment

From the beginning of consultation, the Ministry worked with Kwantlen to develop a mutually acceptable consultation approach, including the manner in which Kwantlen was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Kwantlen, an established working relationship with Kwantlen, and specific input received during initial GMT consultation meetings with Kwantlen. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Kwantlen/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Kwantlen to the Ministry.
- Revision of Draft Consultation Plan
- Sharing of Revised Consultation Plan and a summary of responses to Kwantlen's

comments/input.

- Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email
- Summary of comments/input provided by Kwantlen and corresponding action taken by the Ministry (i.e. revision to plan, comment “noted”, request for further discussion regarding request)

In consideration of the confidential nature of comments provided on the draft Consultation Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to each group regarding their respective comments on the Consultation Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Kwantlen on this matter, the Ministry is of the understanding that Kwantlen has no outstanding concerns or comments with respect to the Plan.

Kwantlen provided comments on the Draft Consultation Plan in a letter/email of October 26, 2015 and the Ministry met with Kwantlen (February 29, 2016) to discuss how these comments had been considered in revising the Plan. The Consultation Plan was revised, based on input received from Kwantlen First Nation and other Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Kwantlen identified the need for capacity funding to support Kwantlen’s involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Kwantlen also identified the need for funding for a Kwantlen First Nation Traditional Use Study. The Ministry and Kwantlen worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Kwantlen’s review and comment. Kwantlen submitted a Study entitled Kwantlen Land Use and Occupation in the Vicinity of Highway 99.

Involvement in Archaeological Component of the Project

From the outset of discussions, Kwantlen identified the importance of the archaeological component of the Project and of their involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Kwantlen for review and comment. The Ministry and its archaeologist met with Kwantlen to present on this aspect of the Project. Kwantlen has participated in all archaeological fieldwork for the Project.

Pre-Application Consultation

The following section outlines consultation activities that the Ministry has undertaken with Kwantlen during the pre-Application Phase. The approach was developed with input from Kwantlen during the Initial Consultation Phase described above, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

During consultation with Kwantlen in the pre-Application phase the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Kwantlen's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Kwantlen to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Kwantlen;
- Continued to work with Kwantlen to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Kwantlen with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), and to support Kwantlen in presenting information regarding their respective Aboriginal Interests. Funding is also provided to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Kwantlen in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Kwantlen on the following Project-related documents:

- Draft Project Description and Key Areas of Study(Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application Draft Consultation Report 1

Draft Consultation Report 2 was also provided to Kwantlen for review and comment. Where appropriate, input received from Kwantlen and other Aboriginal Groups will be incorporated into the revised Report.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Kwantlen for review and comment prior to finalization and submission to EAO indicating that feedback received by May 2, 2106, would be incorporated into the final version as appropriate. Kwantlen provided feedback on Draft Consultation Report 1. Where appropriate, revisions were made to the draft based on Kwantlen’s input.

Participation in fieldwork

In April 2016, Kwantlen participated in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation.

Materials shared with Kwantlen during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO’s <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that |

| Document | Description |
|----------------------------------|--|
| | incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Kwantlen First Nation

During the pre-Application Phase, the Ministry met three times with Kwantlen (see list of meetings for details). Kwantlen has participated in two EAO-led Working Group meetings. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Kwantlen

representatives

- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Kwantlen
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Kwantlen
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. These documents include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Kwantlen reviewed and provided comments on draft Part C content. Where appropriate, revisions were made to the draft based on the input received.

On May 18, 2016, the Ministry received a letter from Kwantlen, Katzie and Semiahmoo First Nations expressing concern with the Project's procurement strategy and requesting further dialogue with respect to business opportunities. The three Nations communicated their continued concern with respect to the procurement strategy in a June Project update meeting, whereby they indicated that a response to their May 18, 2016 letter was required prior to their continued engagement on the Project. In a June 23, 2016 letter, Kwantlen, Katzie and Semiahmoo reiterated their concern with the Project's procurement strategy and that the EA and procurement process was advancing prior to their concerns being addressed. The Ministry acknowledges the concerns expressed by the three Nations and will continue to work with Kwantlen, Katzie and Semiahmoo First Nations to address this and any other Project-related concerns.

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of Aboriginal Consultation Report 2 was shared with Kwantlen for review and comment.

Kwantlen provided comments on June 27, 2016. The letter clearly outlines Kwantlen First Nation's concern over the inclusion of First Nations with weak strength of claims to the Lower Fraser River in consultation for the Project. In addition, Kwantlen emphasized that some Nations have stronger strength of claim than others and feels that this should be considered in the development of a consultation plan and involvement of First Nations in work and procurement opportunities. Kwantlen also expressed concern with Ministry's response to date regarding their procurement-related concerns and emphasized their lack of confidence in the Project's procurement approach resulting in benefits to Aboriginal groups. Kwantlen reiterated their concern regarding cumulative effects of all development on the lower Fraser and the need for a regional study to address this matter, noting that Kwantlen considers these to have "brushed over and were barely acknowledged" in the table contained in Aboriginal Consultation Report 2. These concerns are included in the table accompanying this report.

Kwantlen will be provided with a final copy of Aboriginal Consultation Report 2 along with an explanation of how their input has been considered and any changes to the final report as a result of their feedback.

Concerns, Issues and Interests Raised by Kwantlen First Nation

Consultation efforts to date have sought to identify and address concerns and issues raised by Kwantlen during the Initial Consultation and pre-Application Phases. The Ministry requested Kwantlen's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix F2.

As noted in the above section, Kwantlen has expressed significant concern with the Project's procurement strategy. The Ministry is committing to working with Kwantlen to address this concern.

2.7 Summary of Consultation Activities with Lake Cowichan First Nation

The following section summarizes consultation undertaken with the Lake Cowichan First Nation (Lake Cowichan) during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Lake Cowichan and of the issues, concerns and interests raised to date.

Initial Consultation Phase

The Ministry initiated consultation with Lake Cowichan in early 2014. In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Lake Cowichan:

- Meetings with Lake Cowichan First Nation Chief and Council, staff and consultants;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of a Lake Cowichan Project-related Study.

During initial discussions with Lake Cowichan, and as demonstrated in the Consultation Plan and Lake Cowichan/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Lake Cowichan.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Lake Cowichan's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Lake Cowichan during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Lake Cowichan's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the Draft Consultation Plan, the Ministry met with Lake Cowichan and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial

Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Lake Cowichan First Nation

Between early 2014 and May 2016, the Ministry and the Lake Cowichan discussed and exchanged Project-related information through emails, phone calls, and meetings. Meetings and related activities undertaken with Lake Cowichan in relation to the Project are outlined below. It is to be noted that Lyackson and Lake Cowichan have been working together on this Project and as such, meetings have been recorded to reflect this relationship.

At meetings with Lake Cowichan during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Lake Cowichan’s past, current and future desired use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Lake Cowichan’s Aboriginal Interests. The Ministry also sought to determine Lake Cowichan’s preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Lake Cowichan, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Lake Cowichan.
- Meetings were scheduled at a date and time convenient for Lake Cowichan and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

| Date | Consultation Round | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|------------------------------------|--|
| 2014-05-18 | Initial Consultation | <ul style="list-style-type: none"> • Lyackson • GMT | GMT Project Office 2030 – 11662 | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Round | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|---|--|
| | | | Steveston Highway Richmond, BC | <ul style="list-style-type: none"> Project Definition Phase Presentation |
| 2014-08-12 | Initial Consultation | <ul style="list-style-type: none"> Lyackson Lake Cowichan GMT | Lake Cowichan Admin Office Lake Cowichan, BC | <ul style="list-style-type: none"> Bridge Rendering Corridor Map Project Definition Phase Presentation |
| 2014-11-10 | Initial Consultation | <ul style="list-style-type: none"> Lyackson Lake Cowichan GMT BC EAO | Lyackson Office at Halalt | <ul style="list-style-type: none"> Agenda Bridge Rendering Corridor Map Environmental Overview Presentation Project Description and Key Areas of Study |
| 2015-03-24 | Initial Consultation | <ul style="list-style-type: none"> Lyackson Cowichan Nation Alliance GMT BC EAO | Lake Cowichan | <ul style="list-style-type: none"> Heritage Resources Assessment Summary Presentation Draft Application Information Requirements Draft Application Information Requirements Presentation Utilities Presentation |
| 2015-05-07 | Initial Consultation | <ul style="list-style-type: none"> Lyackson Lake Cowichan GMT | Lake Cowichan First Nation Office | <ul style="list-style-type: none"> Agenda Fish and Fish Habitat Presentation Green Slough Conceptual Plan Green Slough Stone Columns, concept River Hydraulics and Morphology Presentation |
| 2015-06-01 | Initial Consultation | <ul style="list-style-type: none"> Lyackson Lake Cowichan GMT Northwest Hydraulics | Lake Cowichan Administration Office Duncan, BC | <ul style="list-style-type: none"> Agenda Fish and Fish Habitat Presentation Green Slough Stone Columns, concept Green Slough Conceptual Plan River Hydraulics and Morphology Presentation |
| 2015-07-23 | Initial Consultation | <ul style="list-style-type: none"> Lyackson GMT BC Hydro | Lake Cowichan Admin Building Lake Cowichan | <ul style="list-style-type: none"> Agenda BCH Bridge Rendering with Hydro Towers BCH Transmission Relocation Presentation Green Slough Concept) Marine Use Presentation Traffic Update Presentation |
| 2015-08-26 | Initial Consultation | <ul style="list-style-type: none"> Lyackson Cowichan Nation Alliance | Project Tour | |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Round | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|--|---|
| | | <ul style="list-style-type: none"> Stz'uminus Halalt Penelekut GMT | | |
| 2015-11-12 | Initial Consultation | <ul style="list-style-type: none"> Lyackson Lake Cowichan GMT | Administration Building, Lake Cowichan | <ul style="list-style-type: none"> Agenda Human Health Presentation Roll-out Map Project update |
| 2016-01-07 | pre-Application | <ul style="list-style-type: none"> Lyackson Lake Cowichan GMT | Administration Building, Lake Cowichan | <ul style="list-style-type: none"> Draft concept package Project Description dAIR Project Definition Report Project Update |
| 2016-01-21 | pre-Application | <ul style="list-style-type: none"> Halalt Hwlitsum Kwantlen Lyackson Musqueam Tsawwassen Tsleil-Waututh | BCIT, 555 Seymour Street, Vancouver | <ul style="list-style-type: none"> GMT 2016-01-21 TWG1 EA Process Presentation GMT 2016-01-21 TWG1 Project Overview GMT 2016-01-21 TWG1 Key Areas of Study Presentation GMT 2016-01-21 TWG1 dAIR Presentation GMT 2015-01-21 TWG1 Figures to draft AIR GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation GMT 2016-01-21 TWG1 Agenda |
| 2016-02-25 | pre-Application | <ul style="list-style-type: none"> Lyackson Lake Cowichan GMT BC Hydro | Lake Cowichan | <ul style="list-style-type: none"> BC Hydro materials Package of GMT EA documents: dAIR, PD and PDR |
| 2016-03-10 | pre-Application | <ul style="list-style-type: none"> Halalt Kwantlen Lyackson Musqueam Cowichan Nation Alliance Tsleil-Waututh | BCIT, 555 Seymour Street Vancouver | <ul style="list-style-type: none"> TWG2 Agenda TWG2 EA Process Presentation TWG2 Review of Comments Working Group Presentation TWG2 Spatial Boundaries of Proposed Areas of Study TWG2 Website Materials List |
| 2016-04-27 | pre-Application | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT | GMT Project Office | <ul style="list-style-type: none"> Review of draft Consultation Report 1 Review of table with Lyackson and Lake Cowichan issues and concerns |

In addition to meetings with Lake Cowichan representatives during the Initial Consultation Phase, Lake Cowichan was invited to participate in a site visit which

focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, Deas Slough and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

As outlined in the Project's Consultation Plan, the Ministry has been committed to sharing Project-related information with Lake Cowichan as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Lake Cowichan as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Lake Cowichan First Nation's review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Lake Cowichan in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Lake Cowichan through letters, email and phone calls.

Letters sent to Lake Cowichan during this consultation Phase include:

- Introductory letter notifying Lake Cowichan First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Lake Cowichan representatives;
- Follow up to meetings or earlier communications;

- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Lake Cowichan; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Lake Cowichan;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Lake Cowichan review and comment

From the beginning of consultation, the Ministry worked with Lake Cowichan to develop a mutually acceptable consultation approach, including the manner in which Lake Cowichan was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Lake Cowichan, an established working relationship with Lake Cowichan, and specific input received during initial GMT consultation meetings with Lake Cowichan. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Lake Cowichan/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Lake Cowichan

to the Ministry.

- Revision of Draft Consultation Plan
- Sharing of Revised Consultation Plan and a summary of responses to Lake Cowichan's comments/input.
 - Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email
 - Summary of comments/input provided by Lake Cowichan and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request)

In consideration of the confidential nature of comments provided on the draft Plan and that specific consultation activities were planned for each Aboriginal Group, the Ministry responded directly to each group regarding their respective comments on the Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Lake Cowichan on this matter, the Ministry is of the understanding that Lake Cowichan has no outstanding concerns or comments with respect to the Plan.

Lake Cowichan did not comment on the Draft Consultation Plan and indicated that they had no concerns with the document. The Consultation Plan was revised, based on input received from Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Lake Cowichan identified the need for capacity funding to support Lake Cowichan's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Lake Cowichan also identified the need for funding for a Lake Cowichan First Nation Traditional Use Study. The Ministry and Lake Cowichan worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Lake Cowichan's review and comment. Lake Cowichan submitted a Study entitled *Ts'uubaasatx Interest: George Massey Tunnel*.

Involvement in Archaeological Component of the Project

From the outset of discussions, Lake Cowichan identified the importance of the archaeological component of the Project and of their involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Lake Cowichan for review and comment. The Ministry and its archaeologist met with Lake Cowichan to present on this aspect of the Project. Lake Cowichan was invited to

participate in all archaeological fieldwork for the Project.

Pre-Application Consultation

The following section outlines consultation activities that the Ministry has undertaken with Lake Cowichan during the pre-Application Phase. The approach was developed with input from Lake Cowichan during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

During the pre-Application phase consultation with Lake Cowichan, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Lake Cowichan's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Lake Cowichan to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Lake Cowichan;
- Continued to work with Aboriginal Groups to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Lake Cowichan with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), and to support Lake Cowichan in presenting information regarding their respective Aboriginal Interests. Funding is also provided to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended.

The Ministry will work with Lake Cowichan in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Lake Cowichan on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Draft Consultation Report 2 was also provided to Lake Cowichan for review and comment. Where appropriate, revisions to Consultation Report 2 will reflect comments received from Lake Cowichan and other Aboriginal Groups.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Lake Cowichan for review and comment prior to finalization and submission to EAO, indicating that feedback received by May 2, 2106, would be incorporated into the final version as appropriate. Lake Cowichan First Nation did not request changes to the draft document.

Participation in fieldwork

In April 2016, Lake Cowichan was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. Lake Cowichan did not participate in this fieldwork.

Materials shared with Lake Cowichan during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Lake Cowichan First Nation

During the pre-Application Phase, the Ministry met three times with Lake Cowichan representatives (see list of meetings for details). Lake Cowichan was invited to participate in the EAO-led Working Group. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process

- Project overview and update
- Key Areas of Study
- dAIR Overview
- Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Lake Cowichan representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Lake Cowichan
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Lake Cowichan
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Lake Cowichan include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1

- Letter requesting review of Draft Aboriginal Consultation Report 2

Lake Cowichan reviewed the draft Part C content but did not provide comments or request changes.

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Lake Cowichan for review and comment. Lake Cowichan did not provide comments on Report 2 prior to submission of the Final Report to EAO. The Ministry continues to welcome feedback from Lake Cowichan and will respond to any input received.

Lake Cowichan will be provided with a final copy of the Consultation Report.

Concerns, Issues and Interests Raised by Lake Cowichan First Nation

Consultation efforts to date, have sought to identify and address concerns and issues raised by Lake Cowichan during the Initial Consultation and pre-Application Phases. The Ministry has requested Lake Cowichan's input on a table accompanying both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Lake Cowichan's concerns, issues and interests are outlined in Appendix A and reflect any input received to date.

The Ministry requested Lake Cowichan's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix F2

2.8 Summary of Consultation Activities with Lyackson First Nation

The following section summarizes consultation undertaken with the Lyackson First Nation (Lyackson) during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Lyackson and of the issues, concerns and interests raised to date. The Ministry considered Lyackson's input on the draft of this Consultation Report and revised content where appropriate, and will share a final version of the Consultation Report with Lyackson.

Initial Consultation Phase

The Ministry initiated consultation with Lyackson in early 2014. In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Lyackson:

- Meetings with Lyackson staff and consultants;

- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of a Lyackson Study.

During initial discussions with Lyackson, and as demonstrated in the Consultation Plan and Lyackson/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Lyackson.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Lyackson's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Lyackson during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Lyackson's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the Draft Consultation Plan, the Ministry met with Lyackson and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Lyackson First Nation

Between early 2014 and May 2016, the Ministry and the Lyackson discussed and exchanged Project-related information through emails, phone calls, and in-person meetings. Meetings and related activities undertaken with Lyackson in relation to the Project are outlined below.

At meetings with Lyackson during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Lyackson’s past, current and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Lyackson’s Aboriginal Interests. The Ministry also sought to determine Lyackson’s preferences with respect to participation in Project consultation, EA review, and related activities.

During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed. It is to be noted that Lyackson and Lake Cowichan have been working together on this Project and as such, meetings have been recorded to reflect this relationship.

In coordinating and conducting meetings with Lyackson, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Lyackson.
- Meetings were scheduled at a date and time convenient for Lyackson and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Lyackson include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------|--------------------|-----------|------------------|---------------------|
|------|--------------------|-----------|------------------|---------------------|

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|---|--|
| 2014-05-18 | Initial Consultation | <ul style="list-style-type: none"> Lyackson GMT | GMT Project Office 2030 – 11662 Steveston Highway Richmond, BC | <ul style="list-style-type: none"> Bridge Rendering Corridor Map Project Definition Phase Presentation |
| 2014-08-12 | Initial Consultation | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT | Lake Cowichan Admin Office Lake Cowichan, BC | <ul style="list-style-type: none"> Bridge Rendering Corridor Map Project Definition Phase Presentation |
| 2014-11-10 | Initial Consultation | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT BC EAO | Lyackson Office Halalt | <ul style="list-style-type: none"> Agenda Bridge Rendering Corridor Map Environmental Overview Presentation Project Description and Key Areas of Study |
| 2015-03-24 | Initial Consultation | <ul style="list-style-type: none"> Cowichan Nation Alliance Lyackson GMT BC Hydro | Lake Cowichan | <ul style="list-style-type: none"> Heritage Resources Assessment Summary Presentation Draft Application Information Requirements Draft Application Information Requirements Presentation Utilities Presentation |
| 2015-05-07 | Initial Consultation | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT | Lake Cowichan Tribes' Office | <ul style="list-style-type: none"> Agenda Fish and Fish Habitat Presentation Green Slough Conceptual Plan Green Slough Stone Columns, concept River Hydraulics and Morphology Presentation |
| 2015-06-01 | Initial Consultation | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT Northwest Hydraulics | Lake Cowichan Administration Office Duncan, BC | <ul style="list-style-type: none"> Agenda Fish and Fish Habitat Presentation Green Slough Stone Columns, concept Green Slough Conceptual Plan River Hydraulics and Morphology Presentation |
| 2015-07-23 | Initial Consultation | <ul style="list-style-type: none"> Lyackson GMT Northwest Hydraulics | Lake Cowichan FN Admin Building Lake Cowichan | <ul style="list-style-type: none"> Agenda BCH Bridge Rendering with Hydro Towers BCH Transmission Relocation Presentation Green Slough Concept) Marine Use Presentation Traffic Update Presentation |
| 2015-08-26 | Initial | <ul style="list-style-type: none"> Cowichan Nation | Project Tour | <ul style="list-style-type: none"> |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|--|---|
| | Consultation | <ul style="list-style-type: none"> Alliance Stz'uminus Halalt Penelakut Lyackson GMT | | |
| 2015-11-12 | Initial Consultation | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT | Administration Building, Lake Cowichan | <ul style="list-style-type: none"> Agenda Human Health Presentation Roll-out Map Project update |
| 2016-01-07 | pre-Application | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT | Administration Building, Lake Cowichan | <ul style="list-style-type: none"> Draft concept package Project Description dAIR Project Definition Report Project Update |
| 2016-01-21 | pre-Application | <ul style="list-style-type: none"> Halalt Hwlitsum Lyackson Musqueam Tsawwassen Tsleil-Waututh GMT | BCIT, 555 Seymour Street, Vancouver | <ul style="list-style-type: none"> GMT 2016-01-21 TWG1 EA Process Presentation GMT 2016-01-21 TWG1 Project Overview GMT 2016-01-21 TWG1 Key Areas of Study Presentation GMT 2016-01-21 TWG1 dAIR Presentation GMT 2015-01-21 TWG1 Figures to draft AIR GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation GMT 2016-01-21 TWG1 Agenda |
| 2016-02-25 | pre-Application | <ul style="list-style-type: none"> Lake Cowichan Lyackson GMT BC Hydro | Lake Cowichan | <ul style="list-style-type: none"> BC Hydro materials Package of GMT EA documents: dAIR, PD and PDR |
| 2016-03-10 | pre-Application | <ul style="list-style-type: none"> Cowichan Nation Alliance Halalt Kwantlen Lyackson Musqueam Tsleil-Waututh | BCIT, 555 Seymour Street Vancouver | <ul style="list-style-type: none"> TWG2 Agenda TWG2 EA Process Presentation TWG2 Review of Comments Working Group Presentation TWG2 Spatial Boundaries of Proposed Areas of Study TWG2 Website Materials List |
| 2016-03-22 | pre-Application | <ul style="list-style-type: none"> Lyackson (Elders) GMT | Site Visit | <ul style="list-style-type: none"> Tour of Project alignment |
| 2016-04-27 | pre-Application | <ul style="list-style-type: none"> Lyackson GMT | GMT Project Office | <ul style="list-style-type: none"> Review of draft Consultation Report 1 Review of table with Lyackson and |

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George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------|--------------------|-----------|------------------|--|
| | | | | Lake Cowichan issues and concerns <ul style="list-style-type: none"> • Review of draft Part C content |

In addition to meetings with Lyackson representatives during the Initial Consultation Phase, Lyackson participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

As outlined in the Project’s Consultation Plan, the Ministry has been committed to sharing Project-related information with Lyackson as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Lyackson as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Lyackson’s review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Lyackson in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Lyackson through letters, email and phone calls.

Letters sent to Lyackson during this consultation Phase include:

- Introductory letter notifying Lyackson of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment

(document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Lyackson representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Lyackson; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Lyackson;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Lyackson Review and Comment

From the beginning of consultation, the Ministry worked with Lyackson to develop a mutually acceptable consultation approach, including the manner in which Lyackson was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Lyackson, an established working relationship with Lyackson, and specific input received during initial GMT consultation meetings with Lyackson. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Lyackson/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Lyackson to the Ministry.
- Revision of Draft Consultation Plan
- Sharing of Revised Consultation Plan and a summary of responses to Lyackson's comments/input.
 - Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email
 - Summary of comments/input provided by Lyackson and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request)

In consideration of the confidential nature of comments provided on the draft Plan and that specific consultation activities were planned for each Aboriginal Group, the Ministry responded directly to each group regarding their respective comments on the Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Lyackson on this matter, the Ministry is of the understanding that Lyackson has no outstanding concerns or comments with respect to the Plan. The Consultation Plan was revised, based on input received from Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Lyackson identified the need for capacity funding to support Lyackson's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Lyackson also identified the need for funding for a Lyackson First Nation Traditional Use Study. The Ministry and Lyackson worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Lyackson's review and comment. Lyackson submitted a Study entitled, Preliminary Lyackson Use and Occupancy Mapping Study for BC MOTI's George Massey Tunnel Replacement Project.

Involvement in Archaeological Component of the Project

From the outset of discussions, Lyackson identified the importance of the archaeological component of the Project and of their involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Lyackson for review and comment. The Ministry and its archaeologist met with Lyackson to present on this aspect of the Project. Lyackson was invited to participate in all archaeological fieldwork for the Project.

Pre-Application Consultation

The following section outlines consultation activities that the Ministry has undertaken with Lyackson during the pre-Application Phase. The approach was developed with input from Lyackson during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Lyackson, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Lyackson's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Lyackson to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Lyackson;
- Continued to work with Lyackson to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Lyackson with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), and to support

Lyackson in presenting information regarding their respective Aboriginal Interests. Funding is also provided to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Lyackson in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Lyackson on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Draft Content of Part C of the Environmental Assessment Application; and
- Draft Consultation Report 1
- Draft Consultation Report 2

Lyackson commented on the dAIR through the Working Group and provided comments on the draft content of Part C during an April 27, 2016 meeting with the Ministry. Changes to Part C were made based on Lyackson's input.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Lyackson for review and comment prior to finalization and submission to EAO indicating that feedback received by May 2, 2106, would be incorporated into the final version as appropriate. Lyackson met with the Ministry on April 27, 2016 to review the Consultation Report and confirmed that there were no comments on the Report.

Participation in fieldwork

In April 2016, Lyackson was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. Lyackson did not participate in the fieldwork.

Lyackson Elders Site Visit

At the request of Lyackson, the Ministry undertook a site visit with Lyackson elders. The site visit covered key Project components, provided an opportunity for mutual sharing of information and knowledge, and allowed for Lyackson representatives to ask questions about the Project.

Materials shared with Lyackson during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings

During the pre-Application Phase, the Ministry met three times with Lyackson (see list of meetings for details). Lyackson First Nation has participated in two EAO-led Working Group meetings. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study

- dAIR Overview
- Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Lyackson representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Lyackson
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Lyackson
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. These documents include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of Aboriginal Consultation Report 2 was shared with Lyackson for review and comment..

Lyackson will be provided with a final copy of Consultation Report 2 along with an explanation of how their input has been considered and any changes to the final Consultation Report 2 as a result of their feedback.

On June 22, 2016, Lyackson provided the following comments on Consultation Report 2. Schedule A: Key Issues and Concerns has been modified to reflect this input.

- Lyackson is keenly interested in employment, training, contracting and economic opportunities related to Lyackson as mentioned in the report.
- Lyackson is concerned by the statement on Cumulative Effects "there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests." Lyackson feels strongly that in order to conduct a fulsome assessment, the EAO must consider the cumulative effects. (there may be both a moral and a legal obligation to do so)
- Lyackson is concerned about the section on Accidents and Malfunctions. This section appears to focus exclusively on the construction phase, Lyackson's concerns are with the construction, operational and deconstruction - the full cycle of the project.
- Lyackson feels strongly that Saltwater wedge and marshes should be allowed to naturally occur, the marshes are critical habitat for fish for protection from predators, rest, and clear water to breathe. More sediment added to an already high sediment area makes this even more important.
- Lyackson objects to the additional burden of being charged Tolls, as it is inappropriate to put an added barrier on Lyackson to access their own village site, most already have the BC Ferries toll to get to the area.
- In addition, Lyackson did mention that there would be concerns regarding light pollution and how that would affect owls.

Concerns, Issues and Interests Raised by Lyackson First Nation

Consultation efforts to date, have sought to identify and address concerns and issues raised by Lyackson during the Initial Consultation and pre-Application Phases. The Ministry requested Lyackson's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix H2.

2.9 Summary of Consultation Activities with Musqueam Indian Band

The following section summarizes consultation undertaken with the Musqueam Indian Band (Musqueam) during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Musqueam and of the issues, concerns and interests raised to date.

Initial Consultation Phase

The Ministry initiated consultation with Musqueam Indian Band in early 2013. The following Ministry-led activities were undertaken with Musqueam during the Initial Consultation Phase:

- Meetings with Musqueam Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Project booth at Musqueam Aboriginal Day event; and
- Provision of capacity funding to support Musqueam's participation in consultation activities, including review of draft EA documents and submission of a Musqueam Project-related Study.

During initial discussions with Musqueam, and as demonstrated in the Consultation Plan and the Musqueam/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Musqueam.

In addition to meetings with Musqueam representatives during the Initial Consultation Phase, and at Musqueam's request, the Ministry conducted a Musqueam-only site visit by boat and land which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge and Deas Island, and anticipated works and enhancement opportunities for Green Slough.

At the request of Musqueam, representatives from the George Massey Tunnel Replacement Project had a booth at Musqueam's 2015 Aboriginal Day celebration. Community members and the general public were in attendance. The Ministry displayed Project materials and responded to questions from the public and from Musqueam community members.

In response to Musqueam's expressed interest in a community meeting/open house, the Ministry made multiple offers to conduct a community meeting/open house at Musqueam and will continue to seek Musqueam's input with respect to preferred consultation

activities during the Application Review Phase.

Consultation activities during this period were focused on the Project scope and schedule, proposed Studies/Valued Components, Musqueam's past, current and desired future use of the Project area, identification of potential impacts on Musqueam's Aboriginal Interests, and mitigation measures that may be used to avoid or minimize any adverse effects on those Interests.

Discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Musqueam during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials included in Aboriginal Consultation Report 1).

The Ministry sought Musqueam's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the Draft Aboriginal Consultation Plan, the Ministry met with Musqueam to discuss these documents to explain the scope and content, to respond to any initial questions and to elicit Musqueam's comments.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Musqueam

Between early 2013 and May 2016, the Ministry and the Musqueam discussed and exchanged Project-related information through emails, phone calls, and meetings. Meetings with Musqueam in relation to the Project are outlined below.

At meetings with Musqueam during the Initial Consultation Phase, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Musqueam's past, current and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related

to potential impacts on Musqueam’s Aboriginal Interests. The Ministry also sought to determine Musqueam’s preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Musqueam, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Musqueam.
- Meetings were scheduled at a date and time convenient for Musqueam and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

Meetings between the Ministry and Musqueam are outlined below.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|-------------|--|---|-----------------------------------|---|
| 2013-02-01 | <ul style="list-style-type: none"> • Initial Consultation | <ul style="list-style-type: none"> • Musqueam • GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> • Phase 1 and Phase 2 Discussion Guide |
| 2013-05-10 | <ul style="list-style-type: none"> • Initial Consultation | <ul style="list-style-type: none"> • Musqueam • GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> • Phase 2 Discussion Guide |
| 2014-01-20 | <ul style="list-style-type: none"> • Initial Consultation | <ul style="list-style-type: none"> • Musqueam • GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> • Bridge Rendering • GMT Corridor Map • News Release 2013-09-20 Bridge Announcement |
| 2014-05-09 | <ul style="list-style-type: none"> • Initial Consultation | <ul style="list-style-type: none"> • Musqueam • GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-08-22 | <ul style="list-style-type: none"> • Initial Consultation | <ul style="list-style-type: none"> • Musqueam • GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> • Bridge Rendering Corridor Map • Project Definition Phase Presentation |

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| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|--|---|--------------------------------------|--|
| 2014-11-03 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT BC EAO | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> Bridge Rendering Corridor Map Environmental Overview Presentation Project Description and Key Areas of Study |
| 2015-03-27 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT Golder BC Hydro | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> Draft Heritage Resources Overview Assessment (hard copy and electronic) Heritage Resources Assessment Summary Presentation Draft Application Information Requirements Draft Application Information Requirements Presentation Utilities Presentation |
| 2015-05-06 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT Northwest Hydraulics | Musqueam Indian Band Admin Building | <ul style="list-style-type: none"> Fish and Fish Habitat Presentation Green Slough Conceptual Plan Green Slough Stone Columns, concept River Hydraulics and Morphology Presentation |
| 2015-06-19 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Aboriginal Day Attendees Musqueam Community and Public | Musqueam Indian Band Cultural Centre | <ul style="list-style-type: none"> Bridge Rendering Corridor Map |
| 2015-08-10 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT | Musqueam Indian Band Admin Building | <ul style="list-style-type: none"> Agenda Marine Use Presentation Traffic Update Presentation Green Slough Conceptual Plan |
| 2015-09-15 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT BC Hydro | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> BCH Bridge Rendering with Hydro Towers BCH Desktop Review of Alternatives Green Slough Concept BCH Transmission Relocation Presentation |
| 2015-10-15 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> Agenda Human Health Presentation Rollout Map |

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George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|--|---|-----------------------------------|--|
| 2015-10-27 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT | Site tour | <ul style="list-style-type: none"> No materials |
| 2015-12-14 | <ul style="list-style-type: none"> Initial Consultation | <ul style="list-style-type: none"> Musqueam GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> Project Definition Report, Project Description (enhanced) Draft Application Information Requirements Project Concept |
| 2016-04-13 | <ul style="list-style-type: none"> pre-Application | <ul style="list-style-type: none"> Musqueam GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> Draft Application Information Requirements Table of Ministry's Responses to Musqueam Working Group Comments on the dAIR |
| 2016-05-10 | <ul style="list-style-type: none"> pre-Application | <ul style="list-style-type: none"> Musqueam GMT | Musqueam Indian Band Admin Office | <ul style="list-style-type: none"> No materials presented |

As outlined in the Project's Consultation Plan, the Ministry has been committed to sharing Project-related information with Musqueam as it becomes available. The Ministry considered providing early drafts of key EA documents to Musqueam as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Musqueam's' review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Musqueam in advance of the pre-Application Phase.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Musqueam

through letters, email and phone calls.

Letters sent to Musqueam during this consultation Phase include:

- Introductory letter notifying Musqueam of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Musqueam representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Musqueam; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Musqueam;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Musqueam Review and Comment

From the beginning of consultation, the Ministry worked with Musqueam to develop a mutually acceptable consultation approach, including the manner in which Musqueam was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Consultation Plan is informed by regulatory and legal requirements, the objective of enhancing or maintaining a positive, respectful and productive working relationship with Musqueam, an established working relationship with Musqueam, and specific input received during early consultation meetings with Musqueam. The Consultation Plan outlines consultation activities, agreed to by both parties, and specified under the Musqueam/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Consultation Plan:

- Email request for review and comment on the draft Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Musqueam to the Ministry.
- Revision of draft Consultation Plan
- Sharing of revised Consultation Plan and a summary of responses to Musqueam's comments/input.
 - Revised Consultation Plan and, for ease of reference, the original draft Consultation Plan provided via email
 - Summary of comments/input provided by Musqueam and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request)

Musqueam provided comments on the draft Consultation Plan via email on November 6, 2015. In consideration of the confidential nature of comments provided on the draft Consultation Plan and that specific consultation activities were planned for each Aboriginal Group, the Ministry responded directly to each group regarding their respective comments on the Aboriginal Consultation Plan. The Ministry provided a response to each Aboriginal Group with respect to all comments and requests, including those for which changes to the Consultation Plan were not undertaken. In addition, the Ministry offered to meet to discuss any outstanding concerns or questions. Musqueam has not responded to the Ministry's email (March 9, 2016) outlining changes to the Consultation Plan resulting from Musqueam's input and an offer to meet to discuss the Consultation Plan.

The Ministry is committed to working with Musqueam to determine how changes to the Application Review consultation activities outlined in the Consultation Plan may be revised to support effective and meaningful consultation with Musqueam.

Capacity Funding

During Initial Consultation meetings, Musqueam identified the need for capacity funding to support Musqueam's involvement in Project consultation activities, review of draft EA-related documents and participation in the pre-Application Phase of the EA Process. Musqueam also identified the need for funding for a Musqueam Traditional Use Study. The Ministry and Musqueam worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Musqueam's review and comment. On November 17, 2015, Musqueam submitted a Project-related study, "Salmon So Thick, That You Could Walk on Water: Preliminary Scope of Musqueam Components for the Environmental Impact Assessment of the Proposed George Massey Tunnel Replacement Project".

Involvement in Archaeological Component of the Project

From the outset of discussions, Musqueam identified the importance of the archaeological component of the Project and of Musqueam's involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Musqueam for review and comment, and the Ministry, and its archaeologist met with Musqueam to present on this aspect of the Project. Musqueam participated in archaeological fieldwork for the Project and, at Musqueam's request, a Musqueam Heritage Permit was obtained in advance of archaeological work being undertaken.

Pre-Application Consultation

The following section outlines consultation activities that the Ministry has undertaken with Musqueam during the pre-Application Phase. The approach was developed with input from Musqueam during the Initial Consultation Phase described above and in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines Aboriginal consultation requirements for the Ministry.

During the pre-Application Phase consultation with Musqueam, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Musqueam's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Musqueam to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Musqueam;
- Continued to work with Musqueam to seek to identify potentially affected

Aboriginal Interests;

- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Musqueam with respect to capacity funding for the Application Review Phase, with the aim of providing reasonable support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, and involvement in ongoing consultation activities (as specified in the Consultation Plan). It is also intended to support Musqueam in presenting information regarding their respective Aboriginal Interests, to ensure the consultation requirements pursuant to the Section 11 Order are met and that the Consultation Plan is implemented as intended. The Ministry has committed to providing funding for the Application Review phase and will work with Musqueam in this regard. Musqueam has requested that the Ministry address funding-related concerns and needs in the context of a Memorandum of Understanding. The Ministry is committed to working with Musqueam in this regard.

Consultation on EA-related documents

During this phase, Musqueam was consulted on the following Project-related documents:

- Project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Draft components of Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Musqueam was also provided with Draft Consultation Report 2 for review and comment.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Musqueam for review and comment prior to finalization and submission to EAO, indicating that feedback received by May 2, 2016, would be incorporated into the final version as appropriate. Musqueam requested an extension to provide comments on this draft document. Musqueam submitted comments on draft Consultation Report 1 related to content and format, and requested that a separate Musqueam-specific report be prepared that is reflective of Musqueam's perspective on consultation undertaken to date. The Ministry expects that the Aboriginal Group-specific summaries in this Report will address Musqueam's concerns related to the format and content of Aboriginal Consultation Report 1. Among the comments made

by Musqueam on draft Consultation Report 1 was a request that funding be addressed through a negotiated Memorandum of Understanding (MoU) between Musqueam and the Ministry. The Ministry has committed to working with Musqueam with respect to a MoU and, per Musqueam’s request, will address funding-related concerns in the context of those discussions..

Participation in fieldwork

In April 2016, Musqueam was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian and high-use areas and identify potential locations and options for mitigation. This work was undertaken in response to Working Group comments raised by Musqueam in relation to the dAIR. Musqueam did not participate in this fieldwork opportunity.

Materials shared with Musqueam during the pre-Application Phase are outlined below:

| Document | Description |
|---|--|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO’s <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016. The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Application Section C content | Draft components of Section C for review and comment by Schedule B Aboriginal groups: baseline summaries, mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Groups-specific information |

| Document | Description |
|----------|--|
| | on consultation undertaken to date on the Project. For review and comment. |

Meetings with Musqueam – pre-Application Phase

During the pre-Application Phase, the Ministry met twice with Musqueam (see list of meetings for details).

Musqueam attended two EAO-led Working Group meetings and engaged directly with EAO regarding the EA process. The Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date

- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Musqueam representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Musqueam

- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Musqueam
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier, including:

- Letter requesting review of Draft Part C content for the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

As previously noted, Musqueam commented on draft Consultation Report 1. Musqueam also submitted comments on draft Part C content. Where appropriate, the draft content has been revised to reflect the input received from Musqueam.

In March 2016, Musqueam submitted a letter to the Ministry in relation to the use of Musqueam information. The Ministry responded to Musqueam in a meeting on April 13, 2016 and via letter (April 20, 2016) addressing questions and concerns with respect to the appropriate use Musqueam information.

On May 19 2016, Musqueam submitted a draft MoU to the Ministry intended to define a positive and productive way forward on the Project. The Ministry is committed to working with Musqueam with respect to the draft MoU to continued consultation and to a positive, mutually respectful and productive working relationship on the Project. The Ministry and Musqueam have different perspectives regarding consultation undertaken to date. Musqueam has indicated that consultation during the Initial Consultation Phase and pre-Application phase was not meaningful. The Ministry disagrees with this view and remains committed to continued consultation with Musqueam during the Application Review Phase.

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of Aboriginal Consultation Report 2 was shared with Musqueam for review and comment. Aboriginal Groups were asked to provide their comments by June 17, 2016; however, any input received prior to June 29, 2016 was considered and, where appropriate, incorporated into the final Aboriginal Consultation Report 2. Musqueam did not provide comments on Aboriginal Consultation

Report 2; however, the Ministry continues to welcome Musqueam's feedback on the document and will respond to any input received.

Musqueam will be provided with a final copy of Aboriginal Consultation Report 2.

Concerns, Issues and Interests Raised by Musqueam

Consultation efforts to date, have sought to identify and address concerns and issues raised by Musqueam during the Initial Consultation and pre-Application Phases. The Ministry requested Musqueam's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix I2.

2.10 Summary of Consultation Activities with Penelakut Tribe

The following section summarizes consultation undertaken with Penelakut Tribe during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Penelakut Tribe and issues, concerns and interests raised to date. The Ministry considered Penelakut Tribe's input on the draft of this Consultation Report, and revised content where appropriate, and will share a final version of the Consultation Report with Penelakut Tribe.

Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation advised the Ministry that they would participate in the environmental assessment process as part of Cowichan Nation Alliance. As noted below, the Ministry provided information and funding directly to Penelakut Tribe. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribes represented Cowichan Nation Alliance in correspondence, meetings and fieldwork.

Initial Consultation Phase

The Ministry initiated consultation with Penelakut Tribe in early 2014.

In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Penelakut Tribe:

- Meetings with Penelakut Tribe Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;

- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of studies.

During initial discussions with Penelakut Tribe, and as demonstrated in the Consultation Plan and participation funding agreements with Penelakut Tribe, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Penelakut Tribe.

Penelakut Tribe was represented by Cowichan Nation Alliance in meetings and fieldwork. Penelakut Tribe participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Penelakut Tribe's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Penelakut Tribe during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Penelakut Tribe's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the draft Aboriginal Consultation Plan, the Ministry met with Penelakut Tribe, represented by Cowichan Nation Alliance, and walked through these draft documents. Focused discussions on these documents were intended to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Penelakut Tribe

Between early 2014 and May 2016, the Ministry and Penelakut Tribe or Cowichan Nation Alliance discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. Meetings and related activities undertaken with Penelakut Tribe or Cowichan Nation Alliance in relation to the Project are outlined below.

At meetings with Cowichan Nation Alliance during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Penelakut Tribe's past, current and future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Penelakut Tribe's Aboriginal Interests. The Ministry also sought to determine C Penelakut Tribe's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed. Penelakut Tribe confirmed that they would like to receive notifications directly; however, they would be represented by Cowichan Nation Alliance in correspondence, meetings and fieldwork.

In coordinating and conducting meetings with Cowichan Nation Alliance, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Cowichan Nation Alliance.
- Meetings were scheduled at a date and time convenient for Cowichan Nation Alliance and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Cowichan Nation Alliance include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|---|---|
| 2014-06-02 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • Hwlitsum | Travelodge Silver Bridge Inn | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-08-28 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • Hwlitsum • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-06 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan Tribes and Stzuminus for Cowichan Nation Alliance • GMT • BC EAO | Stz'uminus Band Office Ladysmith, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2014-09-18 | Initial Consultation | <ul style="list-style-type: none"> • Halalt First Nation • GMT | Halalt First Nation 7973 Chemainus Road, RR 5 Chemainus, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-14 | Initial Consultation | <ul style="list-style-type: none"> • Penelakut Tribe • GMT • BC EAO | 550-925 West Georgia Vancouver, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2014-11-25 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2015-03-24 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT • Golder • BC Hydro | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary Presentation • Draft Application Information Requirements • Draft Application Information Requirements Presentation • Utilities Presentation |
| 2015-05-08 | Initial | <ul style="list-style-type: none"> • Cowichan, | Cowichan Tribes | <ul style="list-style-type: none"> • Agenda |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| | | | | |
|------------|----------------------|---|---------------------------------------|---|
| | Consultation | Penelakut and Halalt for Cowichan Nation Alliance <ul style="list-style-type: none"> • GMT • Northwest Hydraulics | Boardroom Duncan, BC | <ul style="list-style-type: none"> • Fish and Fish Habitat Presentation • Green Slough Conceptual Plan • Green Slough Stone Columns, concept • River Hydraulics and Morphology Presentation |
| 2015-07-27 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • GMT • BC Hydro | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • BCH Bridge Rendering with Hydro Towers • BCH Transmission Relocation Presentation) • Green Slough Concept • Marine Use Presentation • Traffic Update Presentation |
| 2015-08-26 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • Lyackson | Project Tour | <ul style="list-style-type: none"> • Discussed: Project components: decommissioning of Tunnel; Green Slough, Deas Slough, Indigenous plants, fish and fish habitat, enhancement opportunities. |
| 2015-11-10 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT | Cowichan Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Human Health Presentation • Roll-out Map • Draft Application Information Requirements • Draft Project Description |
| 2016-02-05 | pre-Application | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • GMT • BC EAO | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • GMT 2016-01-21 TWG1 EA Process Presentation • GMT 2016-01-21 TWG1 Project Overview • GMT 2016-01-21 TWG1 Key Areas of Study Presentation • GMT 2016-01-21 TWG1 dAIR Presentation • GMT 2015-01-21 TWG1 Figures to draft AIR • GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation • List of Project-related documents on the Project website |
| 2016-03-10 | pre-Application | <ul style="list-style-type: none"> • Cowichan for Cowichan Nation Alliance • Halalt First Nation | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> • TWG2 Agenda • TWG2 EA Process Presentation • TWG2 Review of Comments Working Group Presentation • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List |
| 2016-03-30 | pre-Application | <ul style="list-style-type: none"> • Cowichan Tribes for | Cowichan Tribes | <ul style="list-style-type: none"> • TWG2 Agenda |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| | | | | |
|------------|-----------------|---|-------------------------|--|
| | | <ul style="list-style-type: none"> • Cowichan Nation Alliance • GMT • BC EAO | Boardroom Duncan, BC | <ul style="list-style-type: none"> • TWG2 EA Process Presentation • TWG2 Review of Comments Working Group Presentation • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List • Business Case <p>Update on EA process CNA strength of claim & EAO analysis CNA review of draft documents Review of Working Group 2 discussion/presentations Procurement process</p> |
| 2016-04-27 | pre-Application | <ul style="list-style-type: none"> • Cowichan Tribes for Cowichan Nation Alliance • GMT | Conference call | <ul style="list-style-type: none"> • Draft Part C content • Draft Aboriginal Consultation Report 1 <p>Procurement Review of draft documents Input on mapping</p> |

As outlined in the Project’s Consultation Plan, the Ministry has been committed to sharing Project-related information with Cowichan Nation Alliance members as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Cowichan Nation Alliance members as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Cowichan Nation Alliance members’ review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Cowichan Nation Alliance members in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Cowichan Nation Alliance members through letters, email and phone calls.

Letters sent to Penelakut Tribe during this consultation Phase include:

- Introductory letters notifying Penelakut Tribe of the Project and offering to meet regarding the proposed Project;
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letters to Penelakut Tribe requesting review and comment on the draft Archaeological Overview Assessment.
- Project Description letters to Penelakut Tribe accompanying a draft copy of the Project Description and Key Areas of Study document requesting review and comment; and

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Penelakut Tribe;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Penelakut Tribe; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Penelakut Tribe;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Aboriginal Consultation Plan – Penelakut Tribe review and comment

From the beginning of consultation, the Ministry worked with Penelakut Tribe to develop a mutually acceptable consultation approach, including the manner in which Penelakut Tribe was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Penelakut Tribe, and specific input received during initial GMT consultation meetings with Cowichan Nation Alliance representatives. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and

specified under the Penelakut Tribe's capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Consultation Plan:

- Email request for review and comment with the Draft Aboriginal Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Cowichan Nation Alliance representatives to the Ministry.
- Revision of Draft Consultation Plan
- Sharing of Revised Consultation Plan and a summary of responses to Cowichan Nation Alliance's comments/input.
 - Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email.
 - Summary of comments/input provided by Cowichan Nation Alliance and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request).

In consideration of the confidential nature of comments provided on the draft Aboriginal Consultation Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to both Penelakut Tribe and Cowichan Nation Alliance regarding their respective comments on the Aboriginal Consultation Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Penelakut Tribe and Cowichan Nation Alliance on this matter, the Ministry is of the understanding that Penelakut Tribe have no outstanding concerns or comments with respect to the Plan.

Comments were received from Cowichan Nation Alliance on the Draft Aboriginal Consultation Plan via letter, October 30 2015. The Consultation Plan was revised, based on input received from Cowichan Nation Alliance and other Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Penelakut Tribe identified the need for capacity funding to support Penelakut Tribe's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA

process. Penelakut Tribe also identified the need for funding for a Penelakut Tribe Study. The Ministry and Penelakut Tribe worked together to finalize a funding agreement. This agreement specifies the activities covered under the agreement and Project/EA-related documents for Penelakut Tribe's review and comment.

Involvement in Archaeological Component of the Project

From the outset of discussions, Penelakut Tribe identified the importance of the archaeological component of the Project and of Penelakut Tribe's involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Penelakut Tribe for review and comment. The Ministry and its archaeologist met with Penelakut Tribe to present on this aspect of the Project. Cowichan Nation Alliance representatives from Cowichan Tribes, Penelakut Tribe and Stz'uminus First Nation participated in all archaeological fieldwork for the Project.

Cowichan Nation Alliance commented on the Draft Heritage Resources Overview Assessment via letter June 25, 2015.

During Initial Consultation Phase, Penelakut Tribe and Cowichan Nation Alliance provided input on the Project and commented on EA-related documents in meetings, via email, phone and letter.

Documents and formal comments shared with Penelakut Tribe during this phase include:

- FLNRO Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Key Areas of Study (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Penelakut Tribe with funding for the submission of a Traditional Use Study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015
- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of

Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 25, 2015

- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

Pre-Application Consultation Phase

The following section outlines consultation activities that the Ministry has undertaken with Penelakut Tribe during the pre-Application Phase. The approach was developed with input from Penelakut Tribe and Cowichan Nation Alliance during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Penelakut Tribe, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Penelakut Tribe's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Penelakut Tribe and Cowichan Nation Alliance to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Penelakut Tribe and Cowichan Nation Alliance;
- Continued to work with Penelakut Tribe to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Penelakut Tribe with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to

support Penelakut Tribe in presenting information regarding their Aboriginal Interests and to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Penelakut Tribe in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Penelakut Tribe on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application; and
- Draft Consultation Report 1

The Ministry provided draft Part C content and mapping to Penelakut Tribe for review and comment by letters/emails (April 18, 2016). Cowichan Nation Alliance provided comments on this draft via a letter/email (May 05, 2016) along with the Cowichan Nation Alliance Declaration (signed Jan 2016) and Schedule A and B maps.

In letters/emails of April 22, 2016, the Ministry provided draft Consultation Report 1 to Penelakut Tribe for review and comment prior to finalization and submission to EAO. Penelakut Tribe and Cowichan Nation Alliance reviewed the draft and Cowichan Nation Alliance advised that they had no comments or requested changes (email May 05, 2015).

During the pre-Application Phase, documents/information shared by Penelakut Tribe includes:

- Environment Canada's Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part 1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Names (Working Group, March 10, 2016)

Cowichan Nation Alliance participated in the Working Group and commented on the Draft Application Information Requirements. The Ministry responded to the Working Group on comments received in relation to the dAIR.

Participation in Fieldwork

In April 2016, Penelakut Tribe and Cowichan Nation Alliance were invited to participate

in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. A Cowichan Nation Alliance representative from Penelakut Tribe participated in this work.

Materials shared with Penelakut Tribe during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussions of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| List of Project-related documents on the GMT Project website | A list of Project-related documents available in the Project document library on the Project website. |
| Health Impact Assessment (HIA) scoping document | Document outlining scope of the HIA and input being sought from Aboriginal groups/Working Group members. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: |

| Document | Description |
|----------------------------------|--|
| | baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Penelakut Tribe – pre-Application Phase

During the pre-Application Phase, the Ministry met three times with Cowichan Nation Alliance (see list of meetings for details) and conducted a conference call in relation to Cowichan Nation Alliance' interest in the procurement process and Project-related benefits and to discuss comments on the draft Part C content and Aboriginal Consultation Report 1.

Cowichan Nation Alliance attended two EAO-led Working Group meetings and communicated directly with EAO with respect to the EA process. Halalt represented Cowichan Nation Alliance at the first Working Group meeting. Halalt First Nations and Cowichan Tribes represented Cowichan Nation Alliance at the second Working Group meeting. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR

- Description and rationale of assessment areas

Cowichan Nation Alliance was offered and provided with two separate Working Group meetings which took place following EAO-led Working Group meetings. These were attended by Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation.

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Penelakut Tribe and Cowichan Nation Alliance
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Penelakut Tribe and Cowichan Nation Alliance
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Penelakut Tribe and Cowichan Nation Alliance
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Penelakut Tribe during this Phase include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Penelakut Tribe for review and comment.

Penelakut Tribe provided feedback on Aboriginal Consultation Report 2 via a Cowichan Nation Alliance letter of June 22, 2016, noting an error on page 159 that needed to be addressed in the revised document and requesting the table of meetings (pages 151-154) be modified to provide greater clarity with respect to meeting attendees. Aboriginal Consultation Report 2 has been revised to reflect this input.

Penelakut Tribe will be provided with a final copy of Aboriginal Consultation Report 2 along with an explanation of how their input has been considered and reflected in the final Aboriginal Consultation Report 2.

Concerns, Issues and Interests Raised by Cowichan Nation Alliance

Consultation efforts to date, have sought to identify and address concerns and issues raised by Penelakut Tribe and Cowichan Nation Alliance during the Initial Consultation and pre-Application Phases. The Ministry requested Penelakut Tribe's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix J2.

2.11 Summary of Consultation Activities with Semiahmoo First Nation

The following section summarizes consultation undertaken with the Semiahmoo First Nation (Semiahmoo) during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Semiahmoo and of the issues, concerns and interests raised to date.

Initial Consultation

The Ministry initiated consultation with Semiahmoo First Nation in early 2014. In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Semiahmoo First Nation:

- Meetings with Semiahmoo First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and for a Semiahmoo First Nation Traditional Use Study.

During initial discussions with Semiahmoo First Nation, and as demonstrated in the Consultation Plan and Semiahmoo/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Semiahmoo.

In addition to meetings with Semiahmoo representatives during the Initial Consultation Phase, Semiahmoo was invited to participate in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Semiahmoo's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Semiahmoo during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Semiahmoo's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

The Ministry met with Semiahmoo and walked through the draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Semiahmoo First Nation

Between early 2014 and May 2016, the Ministry and the Semiahmoo First Nation discussed and exchanged Project-related information through emails, phone calls, and

meetings. Meetings and related activities undertaken with Semiahmoo First Nation in relation to the Project are outlined below.

At meetings with Semiahmoo First Nation during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Semiahmoo's past, current and desired future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Semiahmoo's Aboriginal Interests. The Ministry also sought to determine Semiahmoo's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Semiahmoo, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Semiahmoo.
- Meetings were scheduled at a date and time convenient for Semiahmoo and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Semiahmoo include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

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| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--|--|
| 2013-12-02 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT • BC EAO | Semiahmoo First Nation Marine Drive White Rock, BC | <ul style="list-style-type: none"> • Phase 2 Discussion Guide |
| 2014-01-23 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT | Semiahmoo First Nation Marine Drive White Rock, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • News Release 2013-09-20 Bridge Announcement |
| 2014-08-25 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT | Semiahmoo First Nation Beach Road Semiahmoo | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-12-02 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT • BC EAO | Semiahmoo First Nation Marine Drive White Rock, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environment Overview Presentation • Project Description and Key Areas of Study |
| 2015-03-23 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT • Golder <p>Second half of meeting:</p> <ul style="list-style-type: none"> • BC Hydro | Semiahmoo First Nation Marine Drive White Rock, BC | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary • Draft Application Information Requirements • Draft Application Information Requirements Presentation Utilities Presentation |
| 2015-05-21 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT | Semiahmoo First Nation Beach Road Semiahmoo | <ul style="list-style-type: none"> • Agenda • Fish and Fish Habitat Presentation Green Slough Stone Columns, concept • Green Slough Conceptual Plan • River Hydraulics and Morphology Presentation |
| 2015-07-29 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT • BC Hydro | Semiahmoo First Nation Marine Drive White Rock, BC | <ul style="list-style-type: none"> • Agenda • BCH Bridge Rendering with Hydro Towers • BCH Transmission Relocation Presentation) • Green Slough Concept • Marine Use Presentation • Traffic Update Presentation |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|---|---|
| 2015-10-30 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT | Semiahmoo First Nation Beach Road Semiahmoo | <ul style="list-style-type: none"> • Agenda • Human Health Presentation • Roll-out Map • Discussion regarding Semiahmoo's letter of October 28, 2015 and the draft Aboriginal Consultation Plan |
| 2015-12-15 | Initial Consultation | <ul style="list-style-type: none"> • Semiahmoo • GMT • Kwantlen • Katzie | Kwantlen Administration | <ul style="list-style-type: none"> • Project update • Project Description, PDR and dAIR • Procurement |
| 2016-04-13 | pre-Application | <ul style="list-style-type: none"> • Semiahmoo • GMT • Kwantlen • Katzie | Katzie Administration | <ul style="list-style-type: none"> • Project update • Project Description, PDR and dAIR • Procurement |

In addition to meetings with Semiahmoo representatives during the Initial Consultation Phase, Semiahmoo participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

As outlined in the Project's Consultation Plan, the Ministry has been committed to sharing Project-related information with Semiahmoo First Nation as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Semiahmoo as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Semiahmoo First Nation's review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Semiahmoo in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Semiahmoo First Nation through letters, email and phone calls.

Letters sent to Semiahmoo during this consultation Phase include:

- Introductory letter notifying Semiahmoo First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Semiahmoo First Nation representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Semiahmoo; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Semiahmoo First Nation;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Semiahmoo Review and Comment

From the beginning of consultation, the Ministry worked with Semiahmoo to develop a mutually acceptable consultation approach, including the manner in which Semiahmoo was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Semiahmoo First Nation, an established working relationship with Semiahmoo, and specific input received during initial GMT consultation meetings with Semiahmoo First Nation. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Semiahmoo/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Aboriginal Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Aboriginal Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Semiahmoo First Nation to the Ministry.
- Revision of Draft Aboriginal Consultation Plan
- Sharing of Revised Aboriginal Consultation Plan and a summary of responses to Semiahmoo's comments/input.
 - Revised Aboriginal Consultation Plan and, for ease of reference, original Draft Aboriginal Plan provided via email
 - Summary of comments/input provided by Semiahmoo and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request)

In consideration of the confidential nature of comments provided on the draft Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to each group regarding their respective comments on the Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Semiahmoo, the Ministry is of the understanding that Semiahmoo First Nation has no outstanding concerns or comments with respect to the Plan.

The Consultation Plan was revised, based on input received from Semiahmoo First Nation and other Aboriginal Groups, and approved by EAO on April 6, 2016. Semiahmoo submitted a letter to the Ministry on October 28, 2015 indicating that funding was required for the duration of the Plan and requesting specific provisions in relation to Aboriginal participation in delivery of the Project.

Capacity Funding

During Initial Consultation meetings, Semiahmoo identified the need for capacity funding to support Semiahmoo's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Semiahmoo First Nation also identified the need for funding for a Semiahmoo First Nation Traditional Use Study. The Ministry and Semiahmoo worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Semiahmoo's review and comment. Although funding has been allocated, Semiahmoo has not yet submitted a Traditional Use Study.

Involvement in Archaeological Component of the Project

From the outset of discussions, Semiahmoo First Nation identified the importance of the archaeological component of the Project and of their involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Semiahmoo First Nation for review and comment. The Ministry and its archaeologist met with Semiahmoo First Nation to present on this aspect of the Project. Semiahmoo First Nation was invited to participate in all archaeological fieldwork for the Project.

Pre-Application Consultation

The following section outlines consultation activities that the Ministry has undertaken with Semiahmoo First Nation during the pre-Application Phase. The approach was developed with input from Semiahmoo during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Semiahmoo, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Semiahmoo First Nation's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Semiahmoo to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Semiahmoo First Nation;
- Continued to work with Aboriginal Groups to identify potentially affected Aboriginal

Interests;

- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Semiahmoo First Nation with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), and to support Semiahmoo in presenting information regarding their respective Aboriginal Interests. Funding is also provided to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Semiahmoo First Nation in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents:

During this phase, the Ministry consulted Semiahmoo First Nation on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Draft Consultation Report 2 was also provided to Semiahmoo First Nation for review and comment.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Semiahmoo for review and comment prior to finalization and submission to EAO and indicated that feedback received by May 2, 2016 would be incorporated into the final version as appropriate. Semiahmoo First Nation indicated that comments would not be provided due to concerns regarding the procurement process for the Project.

Participation in Fieldwork

In April 2016, Semiahmoo First Nation was invited to participate in river otter-related

fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. Semiahmoo did not participate in the fieldwork.

Materials shared with Semiahmoo First Nation during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Semiahmoo

During the pre-Application Phase, the Ministry met twice with Semiahmoo First Nation (see list of meetings for details). Semiahmoo First Nation has participated in the EAO-led Working Group. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Semiahmoo First Nation representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Semiahmoo First Nation
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Semiahmoo First Nation
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters

sent to Semiahmoo during this Phase include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Semiahmoo did not comment on draft Part C content or Consultation Report 1.

On May 18, 2016, the Ministry received a letter from Semiahmoo, Katzie and Kwantlen First Nations expressing concern with the Project's procurement strategy and requesting further dialogue with respect to business opportunities. The three Nations communicated their continued concern with respect to the procurement strategy in a June Project update meeting, whereby they indicated that a response to their May 18, 2016 letter was required prior to their continued engagement on the Project. In a June 23, 2016 letter, Semiahmoo, Katzie and Kwantlen reiterated their concern with the Project's procurement strategy and that the EA and procurement process was advancing prior to their concerns being addressed. The Ministry acknowledges the concerns expressed by the three Nations and will continue to work with Semiahmoo, Katzie and Kwantlen First Nations to address this and any other Project-related concerns.

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of Aboriginal Consultation Report 2 was shared with Semiahmoo for review and comment. Semiahmoo did not provide comments on Aboriginal Consultation Report 2, but reiterated that they have significant concern with the Project's procurement strategy and that the EA process is advancing prior to changes to this strategy. Semiahmoo will be provided with a final copy of Aboriginal Consultation Report 2.

Concerns, Issues and Interests Raised by Semiahmoo First Nation

Consultation efforts to date have sought to identify and address concerns and issues raised by Semiahmoo during the Initial Consultation and pre-Application Phases. The Ministry requested Semiahmoo's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix K2.

As noted in the above section, Semiahmoo First Nation has expressed significant concern with the Project's procurement strategy. The Ministry is committing to working with Semiahmoo to address this concern.

2.12 Summary of Consultation Activities with Squamish Nation

The following section summarizes consultation undertaken with the Squamish Nation during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Squamish Nation and of the issues, concerns and interests raised to date. The Ministry considered Squamish Nation's input on the draft of this Consultation Report, and revised content where appropriate, and will share a final version of the Consultation Report with Squamish Nation.

Initial Consultation Phase

The Ministry initiated consultation with Squamish Nation in early 2014. In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Squamish Nation:

- Meetings with Squamish Nation staff and consultants;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission a Squamish Nation report.

During discussions with Squamish Nation, and as demonstrated in the Consultation Plan and Squamish Nation/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Squamish Nation.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Squamish Nation's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

The Ministry offered to share presentations and present on topics of interest to Squamish, such as Fish and Fish Habitat, Archaeology and any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

In addition to meetings with Squamish Nation representatives during the Initial Consultation Phase, Squamish Nation was offered a site visit with a focus on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough. Squamish declined a site visit.

During the Initial Consultation Phase, the Ministry sought Squamish Nation's input on the

following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

The Ministry offered to meet with Squamish Nation and walk through these draft documents with the intention to explain the scope and content, to respond to any initial questions and to elicit input. Squamish Nation did not comment on these documents.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Squamish Nation

Between early 2014 and May 2016, the Ministry and the Squamish Nation discussed and exchanged Project-related information through emails, phone calls, and in-person meetings. Meetings and related activities undertaken with Squamish Nation in relation to the Project are outlined below.

At meetings with Squamish Nation during the Initial Consultation Phase, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Squamish Nation's past, current and future desired use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Squamish Nation's Aboriginal Interests.

The Ministry also sought to determine Squamish Nation's preferences with respect to participation in Project consultation, EA review, and related activities. During this Phase, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Squamish Nation, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Squamish Nation.
- Meetings were scheduled at a date and time convenient for Squamish Nation and that facilitated the attendance of key representatives.

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- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics discussed with Squamish Nation include: Archaeology/Heritage Resources, Marine Use, Fish and Fish Habitat, River Hydraulics and Morphology, Green Slough concept, Project Description and Key Areas of Study document and the Draft Application Information Requirements.

| Date | Consultation Phase | Aboriginal Group | Attendees | Materials Presented/topics |
|------------|----------------------|------------------|---|---|
| 2014-02-28 | Initial Consultation | Squamish | <ul style="list-style-type: none"> • Squamish • GMT | <ul style="list-style-type: none"> • Bridge Rendering FINAL • Corridor Map FINAL • News Release 2013-09-20 Bridge Announcement FINAL |
| 2014-07-09 | Initial Consultation | Squamish | <ul style="list-style-type: none"> • Squamish • GMT | <ul style="list-style-type: none"> • Overview of GMT Project • Discussion regarding Squamish Nation's interest in employment and training opportunities. |
| 2015-10-08 | Initial Consultation | Squamish | <ul style="list-style-type: none"> • Squamish • GMT | <ul style="list-style-type: none"> • Agenda FINAL • Fish and Fish Habitat Presentation FINAL • River Hydraulics and Morphology Presentation FINAL • Draft Application Information Requirements FINAL • GMT Overview Map – Stream Classification • GMT Rendering of Bridge Concept • GMT River Bathymetry |
| 2016-03-10 | pre-Application | Squamish | <ul style="list-style-type: none"> • Squamish • GMT | <ul style="list-style-type: none"> • Call. Discussion regarding consultation plan and funding. |

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| Date | Consultation Phase | Aboriginal Group | Attendees | Materials Presented/topics |
|------------|--------------------|------------------|---|---|
| 2016-03-15 | pre-Application | Squamish | <ul style="list-style-type: none"> • Squamish • GMT | <ul style="list-style-type: none"> • Discussion regarding Squamish Nation's concerns related to the Project: Fish, fish habitat and impacts of Aboriginal fisheries. Overview of EA documents and process, discussion regarding Consultation report. Offer of site visit with David Fierro – Squamish declined. • Project Definition Report December 2015 • Project Description and Key Areas of Study December 2015 • Draft Concept December 2015 • Draft AIR (2016 version, working group changes highlighted) • Utilities Presentation 2015 • Marine Use Presentation 2015 • Heritage Resource Assessment Summary Presentation 2015 • Human Health Presentation 2015 • Traffic Update Presentation 2015 • Fish and Fish Habitat Presentation 2015 • River Hydraulics and Morphology Presentation 2015 • Funding Agreement • Aboriginal Consultation Plan and table |
| 2016-03-30 | pre-Application | Squamish | <ul style="list-style-type: none"> • Squamish • GMT | <ul style="list-style-type: none"> • Conference call. Discussion regarding Squamish Project-related study. Confirmed scope and timing for submission. |

As outlined in the Project's Consultation Plan, the Ministry has been committed to sharing Project-related information with Squamish Nation as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Squamish Nation as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Squamish Nation's review and comment;

- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow for time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Squamish Nation in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Squamish Nation through letters, email and phone calls.

Letters sent to Squamish Nation during this consultation Phase include:

- Introductory letter notifying Squamish Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication may have been used for the following purposes:

- Coordination of meetings and other consultation activities with Squamish Nation representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Squamish Nation; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Squamish Nation;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Squamish Nation review and comment

The Ministry has worked with Squamish Nation with respect to determining a mutually acceptable consultation approach, including the manner in which Squamish Nation is to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) are to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Squamish Nation, and specific input received during initial discussions with Squamish Nation. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Squamish Nation/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Aboriginal Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Aboriginal Consultation Plan
- Sharing of Revised Aboriginal Consultation Plan

Based on feedback received to date and discussion with Squamish Nation on this matter, the Ministry is of the understanding that Squamish Nation has no outstanding concerns or comments with respect to the Plan.

Squamish Nation did not request revisions to the Draft Aboriginal Consultation Plan. The Consultation Plan was revised, based on input received from other Aboriginal Groups, and approved by EAO on April 6, 2016. In consideration of the confidential nature of comments provided on the draft Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to each group regarding their respective comments on the Plan.

Capacity Funding

In a December 2015 letter to the Ministry, the Squamish Nation identified the need for capacity funding to support Squamish Nation's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Squamish Nation subsequently identified the need for funding for a Squamish Nation report. The Ministry and Squamish Nation worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement

and Project/EA-related documents for Squamish Nation's review and comment. The funding agreement was executed in the pre-Application Phase and Squamish submitted a report on April 26, 2016.

Involvement in Archaeological Component of the Project

From the outset of discussions, Squamish Nation identified the importance of the archaeological component of the Project and of Squamish Nation's involvement in review of draft archaeological documents. All draft archaeological documents were shared with Squamish Nation for review and comment. Squamish Nation representatives were invited to participate in all archaeological fieldwork for the Project.

Pre-Application Consultation Phase

The following section outlines consultation activities that the Ministry has undertaken with Squamish Nation during the pre-Application Phase. The approach informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Squamish Nation, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Squamish Nation's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Squamish Nation to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Squamish Nation;
- Continued to work with Squamish Nation to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Squamish Nation with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity

support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to support Squamish Nation in presenting information regarding their respective Aboriginal Interests and to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Squamish Nation in an effort to finalize a funding agreement for the Application Review.

Consultation on EA-related documents

During this phase, the Ministry consulted Squamish Nation on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements
- Content of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Draft Consultation Report 2 was also provided to Squamish Nation for review and comment. Where appropriate, Report 2 will be revised based on input received from Squamish Nation and other Aboriginal Groups.

Squamish submit a letter to the Ministry (December 17, 2015) in response to the November 13, 2014 letter requesting Squamish Nation's review of the draft Project Description and Key Areas of Study document. Squamish indicated a concern that the Project could impact their fishing rights on the Fraser River and requested funding for participation in the Project review process. On February 2, 2016, the Ministry responded to the letter indicating that the Ministry would follow up with Squamish upon issuance, by EAO, of the final Section 11 Order. The Section 11 Order assigned Squamish to Schedule B and the Ministry formally began consulting with Squamish accordingly.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Squamish Nation for review and comment prior to finalization and submission to EAO indicating that feedback provided by May 2, 2106 will be incorporated into the final version as appropriate. Squamish Nation reviewed the draft document and had no comments.

Participation in fieldwork

In April 2016, Squamish Nation was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the

Regional Assessment Area, document and describe use of riparian areas; identify high use areas, and potential areas and options for mitigation. Squamish Nation did not participate in the fieldwork.

Materials shared with Squamish Nation during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013) |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussions of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Squamish Nation

During the pre-Application Phase, the Ministry met twice with Squamish Nation in relation to the Project.

Squamish has had communications directly with EAO with respect to the EA process.

Squamish was not invited to the first EAO-led Working Group as it was not yet classified

as a Schedule B Aboriginal group. Squamish was invited to the second EAO-led Working Group meeting, but did not participate. Squamish was provided with materials from both meetings.

The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Squamish Nation representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Squamish Nation
- Confirmation of information and follow up to previous communications
- Updates and sharing of information

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Squamish Nation include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Squamish reviewed and provided comment on draft Part C content, in particular the map of Squamish Nation's asserted traditional territory. Changes were made to the draft content based on input received from Squamish Nation.

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Squamish for review and comment. Squamish Nation also reviewed Aboriginal Consultation Report 2 and had no comments on the document. Squamish confirmed the presentation of Squamish Nation's concerns documented in the accompanying issues table, which has been updated to reflect input provided in a June 14, 2016 meeting.

Squamish will be provided with a final copy of the Consultation Report.

On June 28, 2016, Squamish provided the following comments on Consultation Report 2. Schedule A: Key Issues and Concerns has been modified to reflect this input.

- The Project area is heavily used by migratory birds and eagles. It is important to ensure migratory birds and eagles are protected and that any mitigation is considers a First Nations perspective. (use existing response and that to ensure an Aboriginal perspective is understood, the Ministry will continue to consult Aboriginal groups regarding mitigation).
- Concern with further alienation of Aboriginal fishers from fishing locations and impacts to the exercise of the right to fish. (use response in tables)
- Interest in training and employment opportunities for youth, including archaeological and environmental monitoring. (use response in tables)
- Concern with impacts to marshes and shorelines from tunnel decommissioning. (response exists)
- Importance of proper sampling of dredgeate and testing of materials from tunnel decommissioning prior to disposal or reuse. (response exists)
- Importance of knowing which properties will be acquired and the process for disposition of surplus properties early in the EA process. (use existing response – CNA table and note where information on property acquisition is found and commitment to discuss further with Squamish during ongoing consultation)

Concerns, Issues and Interests Raised by Squamish Nation

Consultation efforts to date, have sought to identify and address concerns and issues raised by Squamish during the Initial Consultation and pre-Application Phases. The Ministry requested Squamish's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix J2

2.13 Summary of Consultation Activities with Stz'uminus First Nation

The following section summarizes consultation undertaken with Stz'uminus First Nation during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Stz'uminus First Nation and issues, concerns and interests raised to date. The Ministry considered Stz'uminus First Nation's input on the draft of this Consultation Report, and revised content where appropriate, and will share a final version of the Consultation Report with Stz'uminus First Nation.

Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation advised the Ministry that they would participate in the environmental assessment process as part of Cowichan Nation Alliance. As noted below, the Ministry provided information and funding directly to Stz'uminus First Nation. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribes represented Cowichan Nation Alliance in correspondence, meetings and fieldwork.

Initial Consultation Phase

The Ministry initiated consultation with Stz'uminus First Nation in early 2014.

In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with Stz'uminus First Nation:

- Meetings with Stz'uminus First Nation Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of studies.

During initial discussions with Stz'uminus First Nation, and as demonstrated in the

Consultation Plan and participation funding agreements with Stzùminus First Nation, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Stzùminus First Nation.

Stzùminus First Nation was represented by Cowichan Nation Alliance in meetings and fieldwork. Stzùminus First Nation participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Stzùminus First Nation's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Stzùminus First Nation during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Stzùminus First Nation's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the draft Aboriginal Consultation Plan, the Ministry met with Stzùminus First Nation, represented by Cowichan Nation Alliance, and walked through these draft documents. Focused discussions on these documents were intended to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Stzùminus First Nation

Between early 2014 and May 2016, the Ministry and Stzùminus First Nation or Cowichan

Nation Alliance discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. Meetings and related activities undertaken with Stzùminus First Nation or Cowichan Nation Alliance in relation to the Project are outlined below.

At meetings with Cowichan Nation Alliance during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Stzùminus First Nation's past, current and future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to potential impacts on Stzùminus First Nation's Aboriginal Interests. The Ministry also sought to determine C Stzùminus First Nation's preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed. Stzùminus First Nation confirmed that they would like to receive notifications directly; however, they would be represented by Cowichan Nation Alliance in correspondence, meetings and fieldwork.

In coordinating and conducting meetings with Cowichan Nation Alliance, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Cowichan Nation Alliance.
- Meetings were scheduled at a date and time convenient for Cowichan Nation Alliance and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Cowichan Nation Alliance include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|---|---|
| 2014-06-02 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • Hwlitsum | Travelodge Silver Bridge Inn | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-08-28 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • Hwlitsum • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-06 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan Tribes and Stz'uminus for Cowichan Nation Alliance • GMT • BC EAO | Stz'uminus Band Office Ladysmith, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2014-09-18 | Initial Consultation | <ul style="list-style-type: none"> • Halalt First Nation • GMT | Halalt First Nation 7973 Chemainus Road, RR 5 Chemainus, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-25 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stz'uminus • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2015-03-24 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT • Golder • BC Hydro | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary Presentation • Draft Application Information Requirements • Draft Application Information Requirements Presentation • Utilities Presentation |
| 2015-05-08 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT • Northwest Hydraulics | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Fish and Fish Habitat Presentation • Green Slough Conceptual Plan • Green Slough Stone Columns, concept • River Hydraulics and Morphology Presentation |
| 2015-07-27 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt | Cowichan Tribes Boardroom | <ul style="list-style-type: none"> • Agenda • BCH Bridge Rendering with Hydro |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| | | | | |
|------------|----------------------|---|---|---|
| | | <ul style="list-style-type: none"> • Penelakut • Stzuminus • GMT • BC Hydro | Duncan, BC | <p>Towers</p> <ul style="list-style-type: none"> • BCH Transmission Relocation Presentation) • Green Slough Concept • Marine Use Presentation • Traffic Update Presentation |
| 2015-08-26 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • Lyackson | Project Tour | <ul style="list-style-type: none"> • Discussed: Project components: decommissioning of Tunnel; Green Slough, Deas Slough, Indigenous plants, fish and fish habitat, enhancement opportunities. |
| 2015-11-10 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan, Penelakut and Halalt for Cowichan Nation Alliance • GMT | Cowichan Boardroom Duncan, BC | <ul style="list-style-type: none"> • Agenda • Human Health Presentation • Roll-out Map • Draft Application Information Requirements • Draft Project Description |
| 2016-02-05 | pre-Application | <ul style="list-style-type: none"> • Cowichan • Halalt • Penelakut • Stzuminus • GMT • BC EAO | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • GMT 2016-01-21 TWG1 EA Process Presentation • GMT 2016-01-21 TWG1 Project Overview • GMT 2016-01-21 TWG1 Key Areas of Study Presentation • GMT 2016-01-21 TWG1 dAIR Presentation • GMT 2015-01-21 TWG1 Figures to draft AIR • GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation • List of Project-related documents on the Project website |
| 2016-03-10 | pre-Application | <ul style="list-style-type: none"> • Cowichan for Cowichan Nation Alliance • Halalt First Nation | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> • TWG2 Agenda • TWG2 EA Process Presentation • TWG2 Review of Comments Working Group Presentation • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List |
| 2016-03-30 | pre-Application | <ul style="list-style-type: none"> • Cowichan Tribes for Cowichan Nation Alliance • GMT • BC EAO | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • TWG2 Agenda • TWG2 EA Process Presentation • TWG2 Review of Comments Working Group Presentation • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List • Business Case <p>Update on EA process</p> |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| | | | | |
|------------|-----------------|---|-----------------|---|
| | | | | CNA strength of claim & EAO analysis CNA review of draft documents Review of Working Group 2 discussion/presentations Procurement process |
| 2016-04-27 | pre-Application | <ul style="list-style-type: none"> • Cowichan Tribes for Cowichan Nation Alliance • GMT | Conference call | <ul style="list-style-type: none"> • Draft Part C content • Draft Aboriginal Consultation Report 1 Procurement Review of draft documents Input on mapping |

As outlined in the Project’s Consultation Plan, the Ministry has been committed to sharing Project-related information with Cowichan Nation Alliance members as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Cowichan Nation Alliance members as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Cowichan Nation Alliance members’ review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Cowichan Nation Alliance members in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Cowichan Nation Alliance members through letters, email and phone calls.

Letters sent to Stzùminus First Nation during this consultation Phase include:

- Introductory letters notifying Stzùminus First Nation of the Project and offering to meet regarding the proposed Project;
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letters to Stzùminus First Nation requesting review and comment on the draft Archaeological Overview Assessment.
- Project Description letters to Stzùminus First Nation accompanying a draft copy of the Project Description and Key Areas of Study document requesting review

and comment; and

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Stzùminus First Nation;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Stzùminus First Nation; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Stzùminus First Nation;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Aboriginal Consultation Plan – Stzùminus First Nation review and comment

From the beginning of consultation, the Ministry worked with Stzùminus First Nation to develop a mutually acceptable consultation approach, including the manner in which Stzùminus First Nation was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Stzùminus First Nation, and specific input received during initial GMT consultation meetings with Cowichan Nation Alliance representatives. The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Stzùminus First Nation's capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Aboriginal Consultation Plan provided as an attachment.

- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Aboriginal Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Cowichan Nation Alliance representatives to the Ministry.
- Revision of Draft Aboriginal Consultation Plan
- Sharing of Revised Aboriginal Consultation Plan and a summary of responses to Cowichan Nation Alliance's comments/input.
 - Revised Aboriginal Consultation Plan and, for ease of reference, original Draft Aboriginal Plan provided via email.
 - Summary of comments/input provided by Cowichan Nation Alliance and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request).

In consideration of the confidential nature of comments provided on the draft Aboriginal Consultation Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to both Stzùminus First Nation and Cowichan Nation Alliance regarding their respective comments on the Aboriginal Consultation Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Stzùminus First Nation and Cowichan Nation Alliance on this matter, the Ministry is of the understanding that Stzùminus First Nation have no outstanding concerns or comments with respect to the Plan.

Comments were received from Cowichan Nation Alliance on the Draft Aboriginal Consultation Plan via letter, October 30 2015. The Consultation Plan was revised, based on input received from Cowichan Nation Alliance and other Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Stzùminus First Nation identified the need for capacity funding to support Stzùminus First Nation's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Stzùminus First Nation also identified the need for funding for a Stzùminus First Nation Study. The Ministry and Stzùminus First Nation worked together to finalize a funding agreement. This agreement specifies the activities covered under the agreement and Project/EA-related documents for Stzùminus First Nation's review and comment.

Involvement in Archaeological Component of the Project

From the outset of discussions, Stzùminus First Nation identified the importance of the archaeological component of the Project and of Stzùminus First Nation's involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Stzùminus First Nation for review and comment. The Ministry and its archaeologist met with Stzùminus First Nation to present on this aspect of the Project. Cowichan Nation Alliance representatives from Cowichan Tribes, Penelakut Tribe and Stzùminus First Nation participated in all archaeological fieldwork for the Project.

Cowichan Nation Alliance commented on the Draft Heritage Resources Overview Assessment via letter June 25, 2015.

During Initial Consultation Phase, Stzùminus First Nation and Cowichan Nation Alliance provided input on the Project and commented on EA-related documents in meetings, via email, phone and letter.

Documents and formal comments shared with Stzùminus First Nation during this phase include:

- FLNRO Map of Cowichan Nation Alliance Use and Occupancy of the Project Area (Email Feb 11, 2015)
- Comment on Draft Project Description and Key Areas of Study (Letter March 09, 2015)
- Comments on Heritage Resources Overview Assessment (Letter June 25, 2015)
- Comments on Draft Application Information Requirements (Letter August 05, 2015)
- Comments on Draft Aboriginal Consultation Plan (Letter October 30, 2015)
- Salish Sea Vessel Traffic Projections (Email November 19, 2015)

The Ministry provided Stzùminus First Nation with funding for the submission of a Traditional Use Study. The following three studies were submitted to the Ministry:

- Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015
- George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 25, 2015

- Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010

Pre-Application Consultation Phase

The following section outlines consultation activities that the Ministry has undertaken with Stzùminus First Nation during the pre-Application Phase. The approach was developed with input from Stzùminus First Nation and Cowichan Nation Alliance during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Stzùminus First Nation, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Stzùminus First Nation's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Stzùminus First Nation and Cowichan Nation Alliance to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Stzùminus First Nation and Cowichan Nation Alliance;
- Continued to work with Stzùminus First Nation to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Stzùminus First Nation with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to support Stzùminus First Nation in presenting information regarding their Aboriginal Interests and to ensure the consultation requirements pursuant to the

Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Stzùminus First Nation in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Stzùminus First Nation on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application; and
- Draft Consultation Report 1

The Ministry provided draft Part C content and mapping to Stzùminus First Nation for review and comment by letters/emails (April 18, 2016). Cowichan Nation Alliance provided comments on this draft via a letter/email (May 05, 2016) along with the Cowichan Nation Alliance Declaration (signed Jan 2016) and Schedule A and B maps.

In letters/emails of April 22, 2016, the Ministry provided draft Consultation Report 1 to Stzùminus First Nation for review and comment prior to finalization and submission to EAO. Stzùminus First Nation and Cowichan Nation Alliance reviewed the draft and Cowichan Nation Alliance advised that they had no comments or requested changes (email May 05, 2015).

During the pre-Application Phase, documents/information shared by Stzùminus First Nation includes:

- Environment Canada's Streambank Lupine information (Email March 31, 2016)
- Steveston Diking Referral Part1 & 2 (Email March 16, 2016)
- Cowichan Nation Alliance Strength of Claim Assessment – Aboriginal Right to Fish for Food in the South Arm of the Fraser River (Email April 15 2016)
- List of Place Name (Working Group, March 10, 2016)

Cowichan Nation Alliance participated in the Working Group and commented on the Draft Application Information Requirements. The Ministry responded to the Working Group on comments received in relation to the dAIR.

Participation in Fieldwork

In April 2016, Stzùminus First Nation and Cowichan Nation Alliance were invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and

describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. A Cowichan Nation Alliance representative from Stzùminus First Nation participated in this work.

Materials shared with Stzùminus First Nation during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussions of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| List of Project-related documents on the GMT Project website | A list of Project-related documents available in the Project document library on the Project website. |
| Health Impact Assessment (HIA) scoping document | Document outlining scope of the HIA and input being sought from Aboriginal groups/Working Group members. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Stz'uminus First Nation – pre-Application Phase

During the pre-Application Phase, the Ministry met three times with Cowichan Nation Alliance (see list of meetings for details) and conducted a conference call in relation to Cowichan Nation Alliance' interest in the procurement process and Project-related benefits and to discuss comments on the draft Part C content and Aboriginal Consultation Report 1.

Cowichan Nation Alliance attended two EAO-led Working Group meetings and communicated directly with EAO with respect to the EA process. Halalt represented Cowichan Nation Alliance at the first Working Group meeting. Halalt First Nations and Cowichan Tribes represented Cowichan Nation Alliance at the second Working Group meeting. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Cowichan Nation Alliance was offered and provided with two separate Working Group meetings which took place following EAO-led Working Group meetings. These were attended by Cowichan Tribes, Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation.

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Stz'uminus First Nation and Cowichan Nation Alliance

- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Stzùminus First Nation and Cowichan Nation Alliance
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Stzùminus First Nation and Cowichan Nation Alliance
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Stzùminus First Nation during this Phase include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Stzùminus First Nation for review and comment.

Stzùminus First Nation provided feedback on Aboriginal Consultation Report 2 via a Cowichan Nation Alliance letter of June 22, 2016, noting an error on page 159 that needed to be addressed in the revised document and requesting the table of meetings (pages 151-154) be modified to provide greater clarity with respect to meeting attendees. Aboriginal Consultation Report 2 has been revised to reflect this input.

Stzùminus First Nation will be provided with a final copy of Aboriginal Consultation Report 2 along with an explanation of how their input has been considered and reflected in the final Aboriginal Consultation Report 2.

Concerns, Issues and Interests Raised by Cowichan Nation Alliance

Consultation efforts to date, have sought to identify and address concerns and issues raised by Stzùminus First Nation and Cowichan Nation Alliance during the Initial

Consultation and pre-Application Phases. The Ministry requested Stzùminus First Nation`s input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2`s Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix M2.

2.14 Summary of Consultation Activities with Tsawwassen First Nation

The following section summarizes consultation undertaken with the Tsawwassen First Nation during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with TSAWWASSEN and of the issues, concerns and interests raised to date. The Ministry considered TSAWWASSEN`s input on the draft of this Consultation Report, and revised content where appropriate, and will share a final version of the Consultation Report with TSAWWASSEN.

Initial Consultation Phase

The Ministry initiated consultation with Tsawwassen First Nation in late 2012. In support of consultation during the Initial Consultation Phase the following Ministry-led activities have been undertaken with TSAWWASSEN:

- Meetings with Tsawwassen First Nation Chief and Council, staff and consultants;
- Community meeting
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of a Tsawwassen First Nation Project Impact Study.

During initial discussions with Tsawwassen First Nation, and as demonstrated in the Consultation Plan and Tsawwassen First Nation/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to TSAWWASSEN.

In addition to meetings with TSAWWASSEN representatives during the Initial Consultation Phase, TSAWWASSEN participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

In December 2014, the Ministry conducted a TSAWWASSEN community meeting. The Ministry presented on various aspects of the Project including the scope and key components, schedule and proposed studies. The presentation was followed by a question and answer period where attendees could ask questions, identify concerns and obtain additional information on various aspects of the Project. EAO was in attendance and responded to questions related to EAO's regulatory process.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on TSAWWASSEN's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to TSAWWASSEN during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Tsawwassen's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the Draft Aboriginal Consultation Plan, the Ministry met with Tsawwassen and walked through the above- listed draft documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input.

While documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were also provided to TSAWWASSEN again in their revised format for further review in the pre-Application Phase.

Meetings with Tsawwassen

Between late 2012 and May 2016, the Ministry and the Tsawwassen First Nation discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. Meetings and related activities undertaken with Tsawwassen First Nation in relation to the Project are outlined below.

At meetings with Tsawwassen First Nation during Initial Consultation, the Ministry

provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Tsawwassen’s use of the Project area for the exercise of treaty rights, Tsawwassen’s future desired use, and any concerns related to potential impacts on Tsawwassen’s Treaty Rights. The Ministry also sought to determine Tsawwassen’s preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Tsawwassen, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Tsawwassen.
- Meetings were scheduled at a date and time convenient for Tsawwassen and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Tsawwassen include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--|--|
| 2012-12-07 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Phase 1 Discussion Guide |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--|---|
| 2013-05-03 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Phase 2 Discussion Guide |
| 2014-01-21 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • News Release 2013-09-20 Bridge Announcement FINAL |
| 2014-05-12 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Bridge Rendering FINAL • Corridor Map FINAL • Project Definition Phase Presentation |
| 2014-07-10 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map FINAL • Project Definition Phase Presentation |
| 2014-07-11 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map FINAL • Project Definition Phase Presentation |
| 2014-08-29 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-11-03 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--|--|
| 2014-12-01 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT • BC EAO | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map • Environmental Overview Presentation • Project Description and Key Areas of Study |
| 2015-04-09 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT • BC EAO • BC Hydro • Golder | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Heritage Resources Assessment Summary • Draft Application Information Requirements • Draft Application Information Requirements Presentation • Utilities Presentation |
| 2015-05-04 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT • Northwest Hydraulics | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Agenda • Fish and Fish Habitat Presentation • Green Slough Conceptual Plan • Green Slough Stone Columns, concept • River Hydraulics and Morphology Presentation |
| 2015-07-13 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT • BC Hydro | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Agenda • BCH Bridge Rendering with Hydro Towers • BCH Transmission Relocation Presentation • Green Slough Concept • Marine Use Presentation • Traffic Update Presentation |
| 2015-12-14 | Initial Consultation | <ul style="list-style-type: none"> • Tsawwassen • GMT • | Tsawwassen Main Offices 1926 Tsawwassen Drive Tsawwassen, BC | <ul style="list-style-type: none"> • Draft Application Information Requirements (dAIR) • Project Definition Report • Project Description |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|---|---|---|---|
| 2016-01-21 | pre-Application GMT Technical Working Group 1 | <ul style="list-style-type: none"> • Tsawwassen • GMT | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> • GMT 2016-01-21 TWG1 EA Process Presentation • GMT 2016-01-21 TWG1 Project Overview • GMT 2016-01-21 TWG1 Key Areas of Study Presentation • GMT 2016-01-21 TWG1 dAIR Presentation • GMT 2015-01-21 TWG1 Figures to draft AIR • GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation • GMT 2016-01-21 TWG1 Agenda |
| 2016-03-29 | pre-Application | <ul style="list-style-type: none"> • Tsawwassen • GMT • BC EAO | Tsawwassen First Nation Administration Building | <ul style="list-style-type: none"> • GMT 2016-01-21 TWG1 EA Process Presentation • GMT 2016-01-21 TWG1 Project Overview • GMT 2016-01-21 TWG1 Key Areas of Study Presentation • GMT 2016-01-21 TWG1 dAIR Presentation • GMT 2015-01-21 TWG1 Figures to draft AIR • GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation • Business Case • Discussion regarding EA Process, Summary of Working Group 2, Discussion regarding decommissioning, changes to dAIR, business case |
| 2016-04-29 | pre-Application | <ul style="list-style-type: none"> • Tsawwassen • GMT | Tsawwassen First Nation Administration Building | <ul style="list-style-type: none"> • Business Case • Project Concept • PDR • Drawings of Steveston Interchange and 17A interchange <p>Discussion:</p> <ul style="list-style-type: none"> • Procurement • Project update • EA-related documents and TSAWWASSEN review • Traffic and ensuring access to TSAWWASSEN |

As outlined in the Consultation Plan, the Ministry has been committed to sharing Project-related information with Tsawwassen First Nation as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Tsawwassen as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Tsawwassen First Nation's' review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Tsawwassen in advance of the pre-Application Phase.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Tsawwassen First Nation through letters, email and phone calls.

Letters sent to Tsawwassen during the Initial Consultation Phase include:

- Introductory letter notifying Tsawwassen First Nation of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Tsawwassen First Nation representatives;
- Follow up to meetings or earlier communications;

- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Tsawwassen; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Tsawwassen First Nation;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Tsawwassen Review and Comment

From the beginning of consultation, the Ministry worked with Tsawwassen to develop a mutually acceptable consultation approach, including the manner in which Tsawwassen was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Tsawwassen First Nation, an established working relationship with Tsawwassen, and specific input received during initial consultation meetings with Tsawwassen. The Consultation Plan lists consultation activities, agreed to by both parties, and specified under the Tsawwassen/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Consultation Plan:

- Email request for review and comment on a draft of the Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Aboriginal Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Tsawwassen to the Ministry.

- Revision of draft Consultation Plan
- Sharing of Consultation Plan and a summary of responses to Tsawwassen’s comments/input.
 - Revised Consultation Plan and, for ease of reference, the original draft of the Consultation Plan provided via email
 - Summary of comments/input provided by Tsawwassen and corresponding action taken by the Ministry (i.e. revision to plan, comment “noted”, request for further discussion regarding request)

In consideration of the confidential nature of comments provided on the draft Aboriginal Consultation Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to each group regarding their respective comments on the Aboriginal Consultation Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Tsawwassen requested one change to the Plan and the Ministry made the requested revision. Based on feedback received to date, the Ministry is of the understanding that Tsawwassen First Nation has no outstanding concerns or comments with respect to the Plan.

Capacity Funding

During Initial Consultation meetings, Tsawwassen N identified the need for capacity funding to support Tsawwassen’s involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Tsawwassen First Nation also identified the need for funding for a Tsawwassen First Nation Project Impact Study. The Ministry and Tsawwassen worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Tsawwassen’s review and comment.

Involvement in the Archaeological Component of the Project

From the outset of discussions, Tsawwassen First Nation identified the importance of the archaeological component of the Project and of Tsawwassen’s involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Tsawwassen First Nation for review and comment, and the Ministry, and its archaeologist met with Tsawwassen First Nation to present on this aspect of the Project. Tsawwassen First Nation has participated in all archaeological fieldwork for the Project.

Pre-Application Phase Consultation

The following section outlines consultation activities that the Ministry has undertaken with Tsawwassen First Nation during the pre-Application Phase. The approach was developed

with input from Tsawwassen during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

As it pertains to consultation with Tsawwassen, during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Tsawwassen First Nation's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Tsawwassen to participate in fieldwork (River otter study);
- Identified and documented questions, issues and interests raised by Tsawwassen First Nation;
- Continued to work with Tsawwassen with respect to the potential for the Project to affect Tsawwassen treaty rights;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Tsawwassen First Nation with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to support Tsawwassen in presenting information regarding their respective Aboriginal Interests and to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Tsawwassen First Nation in an effort to finalize a funding agreement for the Application Review phase.

Consultation on EA-related documents:

During this phase, the Ministry consulted Tsawwassen on the following Project-related documents:

- Draft Project Description and Key Areas of Study document);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Draft Consultation Report 2 was also provided to Tsawwassen for review and comment. Where appropriate, revisions to draft Report 2 will be made based on input received from Tsawwassen and other Aboriginal Groups.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Tsawwassen for review and comment prior to finalization and submission to EAO, indicating that feedback received by May 2, 2106 would be incorporated into the final version as appropriate. Tsawwassen reviewed and had no comments on the Consultation Report.

Participation in Fieldwork

In April 2016, Tsawwassen First Nation was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas; identify high use areas, and potential areas and options for mitigation. Tsawwassen did not participate in the fieldwork.

Materials shared with Tsawwassen First Nation during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |

| Document | Description |
|---|---|
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft summary with more detailed information of consultation undertaken to date on the Project. For review and comment. |

Meetings with Tsawwassen

During the pre-Application Phase, the Ministry met three times with Tsawwassen First Nation. One of these meetings included a review of information shared at Working Group 2, a Project update, and a discussion regarding GMT procurement. Other meetings focused on procurement and Project design, and on a review of Aboriginal Consultation Report 1 and Draft Part C Content. The Ministry also presented to Tsawwassen’s Natural Resources Committee on the Project’s Fish and Fish Habitat Assessment (see list of meetings for details).

Tsawwassen First Nation attended one EAO-led Working Group meeting and engaged directly with EAO with respect to the EA process. The Ministry and EAO met with Tsawwassen to review key aspects of the 2nd Working Group meeting that Tsawwassen could not attend. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website

- Review of comments received on dAIR and resulting changes to the dAIR
- Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Tsawwassen First Nation representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Tsawwassen First Nation
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Tsawwassen First Nation
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Tsawwassen during this Phase include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Tsawwassen reviewed Draft Part C content and indicated that they had no concerns with the draft document and made no requests for changes.

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of this report was shared with Tsawwassen for review and comment. Tsawwassen reviewed Report 2 and indicated that they had no concerns or comments with respect to the document.

Tsawwassen will be provided with a final copy of Consultation Report 2.

Concerns, Issues and Interests Raised by Tsawwassen First Nation

Consultation efforts to date, have sought to identify and address concerns and issues raised by Tsawwassen during the Initial Consultation and pre-Application Phases. The Ministry has requested Tsawwassen's input on a table accompanying both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Tsawwassen's concerns, issues and interests are outlined in Appendix A and Part C Appendix N2 and reflect any input received to date.

2.15 Summary of Consultation Activities with Tsleil-Waututh First Nation

The following section summarizes consultation undertaken with the Tsleil-Waututh Nation (Tsleil-Waututh) during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Tsleil-Waututh and of the issues, concerns and interests raised to date. The Ministry will consider Tsleil-Waututh Nation's input on this draft, will revise content where appropriate, and will share a final version of the Consultation Report with Tsleil-Waututh.

Initial Consultation Phase

The Ministry initiated consultation with Tsleil-Waututh Nation in early 2014. To date, two phases of consultation have been completed: Initial Consultation Phase and the pre-Application Phase. In support of consultation, the following Ministry-led activities have been undertaken with Tsleil-Waututh Nation during these phases:

- Meetings with Tsleil-Waututh Nation staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment;
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of a Tsleil-Waututh Nation Knowledge Study.

During initial discussions with Tsleil-Waututh Nation, and as demonstrated in the Consultation Plan and Tsleil-Waututh Nation/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Tsleil-Waututh.

In addition to meetings with Tsleil-Waututh representatives during the Initial Consultation Phase, Tsleil-Waututh participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas

Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Tsleil-Waututh's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Tsleil-Waututh during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

During the Initial Consultation Phase, the Ministry sought Tsleil-Waututh's input on the following EA-related documents:

- Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

The Ministry met with Tsleil-Waututh and walked through the Project Description and Key Areas of Study and Draft Application Information Requirements documents, in an effort to explain the scope and content, to respond to any initial questions and to elicit input Tsleil-Waututh comments on draft EA documents shared during this Phase.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Tsleil-Waututh

Between early 2014 and May 2016, the Ministry and the Tsleil-Waututh Nation discussed and exchanged Project-related information through emails, phone calls, and meetings. Meetings and related activities undertaken with Tsleil-Waututh Nation in relation to the Project are outlined below.

At meetings with Tsleil-Waututh Nation during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Tsleil-Waututh's past, current and future use of the Project area for the exercise of identified Aboriginal Interests, and any concerns related to

potential impacts on Tsleil-Waututh’s Aboriginal Interests. The Ministry also sought to determine Tsleil-Waututh’s preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Tsleil-Waututh, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Tsleil-Waututh.
- Meetings were scheduled at a date and time convenient for Tsleil-Waututh and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Tsleil-Waututh include: Archaeology/Heritage Resources, Wildlife, Marine Use, Fish and Fish Habitat, Traffic, Human Health (air and noise), River Hydraulics and Morphology, Utilities, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|---|--|--|
| 2014-01-31 | Initial Consultation | <ul style="list-style-type: none"> • Tsleil-Waututh • GMT | Tsleil-Waututh Band Office Treaty, Lands and Resources Boardroom | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • News Release • 2013-09-20 Bridge Announcement |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|---|---|--|--|
| 2014-11-20 | Initial Consultation | <ul style="list-style-type: none"> Tsleil-Waututh GMT BC EAO | Tsleil-Waututh Band Office Treaty, Lands and Resources Boardroom | <ul style="list-style-type: none"> Agenda Bridge Rendering Corridor Map Environmental Overview Presentation Project Description and Key Areas of Study |
| 2015-04-15 | Initial Consultation | <ul style="list-style-type: none"> Tsleil-Waututh GMT | Tsleil-Waututh Band Office Treaty, Lands and Resources Boardroom | <ul style="list-style-type: none"> Heritage Resources Assessment Summary Presentation Draft Application Information Requirements Draft Application Information Requirements Presentation Utilities Presentation |
| 2015-05-14 | Initial Consultation | <ul style="list-style-type: none"> Tsleil-Waututh GMT Northwest Hydraulics | Tsleil-Waututh Band Office Treaty, Lands and Resources Boardroom | <ul style="list-style-type: none"> Agenda Fish and Fish Habitat Presentation Green Slough Stone Columns, concept Green Slough Conceptual Plan River Hydraulics and Morphology Presentation |
| 2015-08-25 | Initial Consultation | <ul style="list-style-type: none"> Tsleil-Waututh GMT | Tsleil-Waututh Band Office Treaty, Lands and Resources Boardroom | <ul style="list-style-type: none"> BCH Bridge Rendering with Hydro Towers BCH Transmission Relocation Presentation) Green Slough Concept Marine Use Presentation Traffic Update Presentation Heath presentation |
| 2015-10-27 | Initial Consultation | <ul style="list-style-type: none"> Tsleil-Waututh GMT | Site visit | |
| 2016-01-21 | pre-Application GMT Technical Working Group 1 | <ul style="list-style-type: none"> Tsleil-Waututh | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> 01 GMT 2016-01-21 TWG1 EA Process Presentation 02 GMT 2016-01-21 TWG1 Project Overview 03 GMT 2016-01-21 TWG1 Key Areas of Study Presentation 04 GMT 2016-01-21 TWG1 dAIR Presentation 05 GMT 2015-01-21 TWG1 Figures to draft AIR 06 GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation 07 GMT 2016-01-21 TWG1 Agenda |

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|--|---|---|---|
| 2016-01-27 | pre-Application | <ul style="list-style-type: none"> Tsleil-Waututh GMT | Conference call | <ul style="list-style-type: none"> Project Update Outstanding comments and concerns (dAIR and Project Description) Cultural Health Assessment Project options outside of the EA Tsleil-Waututh provided a paper on cultural assessment methodology |
| 2016-02-21 | pre-Application | <ul style="list-style-type: none"> Tsleil-Waututh GMT | Conference Call | <ul style="list-style-type: none"> draft Application Information Requirements |
| 2016-03-08 | pre-Application | <ul style="list-style-type: none"> Tsleil-Waututh GMT | Tsleil-Waututh Economic Development office | <ul style="list-style-type: none"> Presentation – GMT Project procurement Discussions regarding procurement process for GMT and Tsleil-Waututh businesses, capacity and interest in contracting opportunities. |
| 2016-03-10 | pre-Application GMT Technical Working Group 2 | <ul style="list-style-type: none"> Tsleil-Waututh | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> TWG2 Agenda TWG2 EA Process Presentation TWG2 Review of Comments Working Group Presentation TWG2 Spatial Boundaries of Proposed Areas of Study TWG2 Website Materials List |

As outlined in the Project’s Consultation Plan, the Ministry has been committed to sharing Project-related information with Tsleil-Waututh Nation as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Tsleil-Waututh as an opportunity to:

- Acknowledge and respond, in part, to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Tsleil-Waututh Nation’s’ review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to
- Allow time for meetings to be coordinated and conducted regarding particular documents or aspect of the Project of interest to Tsleil-Waututh in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Tsleil-Waututh Nation through letters, email and phone calls.

Letters sent to Tsleil-Waututh during this consultation Phase include:

- Introductory letter notifying Tsleil-Waututh Nation of the Project and offering to meet regarding the proposed Project;
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Tsleil-Waututh Nation representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Tsleil-Waututh; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Tsleil-Waututh Nation;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Tsleil-Waututh review and comment

From the beginning of consultation, the Ministry worked with Tsleil-Waututh to develop a mutually acceptable consultation approach, including the manner in which Tsleil-Waututh was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used

to avoid or minimize those effects) were to be communicated and addressed by the Ministry. Tsleil-Waututh provided the Ministry with the Tsleil-Waututh Stewardship Policy (2009) which outlines Tsleil-Waututh's expectations and requirements with respect to consultation.

The Ministry's Draft Aboriginal Consultation Plan was informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Tsleil-Waututh Nation, consideration of the Tsleil-Waututh Stewardship Policy, an established working relationship with Tsleil-Waututh, and specific input received during initial GMT consultation meetings with Tsleil-Waututh.

The Draft Consultation Plan listed consultation activities, agreed to by both parties, and specified under the Tsleil-Waututh/GMT participation funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Draft Aboriginal Consultation Plan:

- Email request for review and comment with the Draft Aboriginal Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the Draft Aboriginal Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Tsleil-Waututh to the Ministry.
- Revision of Draft Aboriginal Consultation Plan
- Sharing of Revised Aboriginal Consultation Plan and a summary of responses to Tsleil-Waututh's comments/input.
 - Revised Aboriginal Consultation Plan and, for ease of reference, original Draft Aboriginal Plan provided via email
 - Summary of comments/input provided by Tsleil-Waututh and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request)

Comments were received from Tsleil-Waututh on the draft Consultation Plan on November 16, 2015 via letter/email. The Ministry responded to Tsleil-Waututh's comments, explaining how input had been considered and discussed any outstanding concerns or questions. Based on feedback received to date and discussions with Tsleil-Waututh on this matter, the Ministry is of the understanding that Tsleil-Waututh Nation has no outstanding concerns or comments with respect to the Plan. In consideration of the confidential nature of comments provided on the draft Aboriginal Consultation Plan and that specific consultation activities were planned for each Aboriginal group, the Ministry responded directly to each group regarding their respective comments on the

Aboriginal Consultation Plan.

The Consultation Plan was revised, based on input received from Tsleil-Waututh Nation and other Aboriginal Groups, and approved by EAO on April 6, 2016.

Capacity Funding

During Initial Consultation meetings, Tsleil-Waututh identified the need for capacity funding to support Tsleil-Waututh's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Tsleil-Waututh Nation also identified the need for funding for a Tsleil-Waututh Nation Knowledge Study. The Ministry and Tsleil-Waututh worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Tsleil-Waututh's review and comment.

Involvement in Archaeological Component of the Project

From the outset of discussions, Tsleil-Waututh Nation identified the importance of the archaeological component of the Project and of Tsleil-Waututh's involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Tsleil-Waututh Nation for review and comment. The Ministry, and its archaeologist offered to meet with Tsleil-Waututh Nation to present on this aspect of the Project. Tsleil-Waututh Nation has participated in archaeological fieldwork for the Project.

Tsleil-Waututh Nation provided comments on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (Letter/email October 27, 2014).

Documents/information shared by Tsleil-Waututh

During the Initial Consultation Phase Tsleil-Waututh submitted the following documents to the Ministry:

- Letter/email (October 27, 2014) Comments on the Draft Archaeological Overview Assessment
- Email (December 04, 2014) Tsleil-Waututh Stewardship Policy
- Letter/email (2014-12-05) Comments on Draft Project Description and Key Areas of Study
- Letter/email (November 16, 2015) comments on draft Aboriginal Consultation Plan

The Ministry provided Tsleil-Waututh with funding for the submission of a Project-related study and received the Tsleil-Waututh Knowledge Study for the George Massey Tunnel Project during the Initial Consultation Phase.

Pre-Application Phase Consultation

The following section outlines consultation activities that the Ministry has undertaken with Tseil-Waututh Nation during the pre-Application Phase. The approach was developed with input from Tseil-Waututh during the Initial Consultation Phase described above and EAO, and is outlined in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines consultation requirements for the Ministry.

With respect to consultation with TSLEIL-WAUTUTH during the pre-Application phase, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Tseil-Waututh Nation's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Tseil-Waututh to participate in fieldwork (i.e. River otter study);
- Identified and documented questions, issues and interests raised by Tseil-Waututh Nation;
- Continued to work with TSLEIL-WAUTUTH to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate;
- Supported participation in EAO-led Technical Working Group; and
- Committed to continued discussion with respect to non-economic Project-related benefits, including environmental and social benefits.

Funding for Application Review

The Ministry will work with Tseil-Waututh Nation with respect to the provision of capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for involvement in ongoing consultation activities (as specified in the Consultation Plan), to support Tseil-Waututh in presenting information regarding their respective Aboriginal Interests and to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended. The Ministry will work with Tseil-Waututh Nation in an effort to finalize a funding agreement for the Application

Review phase.

Consultation on EA-related documents

During this phase, the Ministry consulted Tsleil-Waututh on the following Project-related documents:

- Draft Project Description and Key Areas of Study (Project Description);
- Draft Application Information Requirements;
- Content of draft Part C of the Environmental Assessment Application; and
- Draft Consultation Report 1.

Draft Consultation Report 2 was also provided to TSLEIL-WAUTUTH for review and comment.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Aboriginal Consultation Report 1 to Tsleil-Waututh for review and comment prior to finalization and submission to EAO. Tsleil-Waututh provided comments on the draft Aboriginal Consultation Report 1 (letter/email May 06, 2016). Tsleil-Waututh requested that non-economic benefits categories (environmental and social) be included in the revised report and that the Ministry acknowledge ongoing discussions with Tsleil-Waututh in this regard. The requested change was made to draft Aboriginal Consultation Report 1 and carried over to Aboriginal Consultation Report 2 and Part C of the Application.

Tsleil-Waututh also commented that it is burdensome to review two Aboriginal Consultation Reports within a two month period.. Tsleil-Waututh indicated a preference to receive both Aboriginal Consultation Report 1 which provided a general overview of consultation activities and Aboriginal Consultation Report 2 which outlined specifics for each Aboriginal Group together for review and comment to ensure that the paraphrasing of Tsleil-Waututh's concerns had not allowed for any misunderstandings and to provide greater confidence with generalized statements.

Tsleil-Waututh also identified concerns or comments that were not captured in Appendix A: Key Issues and Concerns. The Ministry revised Appendix A to reflect these concerns.

Participation in fieldwork

In April 2016, Tsleil-Waututh Nation was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. Tsleil-Waututh

was unable to coordinate a qualified representative to participate in this fieldwork within the timeframe provided.

Materials shared with Tsleil-Waututh Nation during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

During the pre-Application Phase, documents/information shared by Tsleil-Waututh include:

- STIC Community Health Indicators (Email January 27, 2016)

- Smart Roadways Feasibility Study outlined (Email February 22, 2016)
- Comments on Draft Part C (Letter/email April 27, 2016)
- Comments on Aboriginal Consultation Plan 1 (Letter/email May 6, 2015)
- Information related to suicide prevention concept (Email January 27, 2016)

Meetings with Tsleil-Waututh

During the pre-Application Phase, the Ministry met twice with Tsleil-Waututh Nation (see list of meetings for details) and conducted two conference calls in relation to Tsleil-Waututh's comments on the dAIR.

Tsleil-Waututh Nation has attended two EAO-led Working Group meetings and has engaged directly with EAO with respect to the EA process. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Tsleil-Waututh Nation representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project

- Clarification of information and feedback shared by Tsleil-Waututh Nation
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Tsleil-Waututh Nation
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier. Letters sent to Tsleil-Waututh include:

- Letter requesting review of Draft Part C content
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Consultation on Aboriginal Consultation Report 2

On June 17, 2016, Tsleil-Waututh Nation provided comments on draft Aboriginal Consultation Report 2.

Tsleil-Waututh requested that the summary of Tsleil-Waututh's input on Aboriginal Consultation Report 1 (p.144) be updated to reflect two other comments: general comments on the organization of ACR1 (general and Tsleil-Waututh documents provided separately vs together) and; concerns expressed that were not captured in Table 7 of ACR1. The Ministry revised the summary of Tsleil-Waututh's comments on Aboriginal Consultation Report 1 per Tsleil-Waututh's request.

Tsleil-Waututh also requested edits to page 143 to ensure a bullet point that was added to accommodate feedback on Aboriginal Consultation Report 1 was properly encapsulated into the points. The requested edits were made per Tsleil-Waututh's request.

In addition to this feedback, Tsleil-Waututh requested that the Tsleil-Waututh issues table be directly and formally captured in Aboriginal Consultation Report 2, that it be embedded in the document. Tsleil-Waututh also noted that, per their comment on Aboriginal Consultation Report 1, concerns expressed in the March 1, 2016 tracking table had not been captured. The Ministry has revised the Tsleil-Waututh issues table to ensure all concerns are captured and has embedded the table within Aboriginal Consultation Report 2.

Tsleil-Waututh also noted that while Aboriginal Consultation Report 2 accurately reported that Tsleil-Waututh declined to participate in the river otter-related fieldwork, Tsleil-Waututh was unable to coordinate a qualified representative within the timeframe provided. The Ministry revised the text related to the river otter fieldwork to include this additional information.

Concerns, Issues and Interests Raised by Tsleil-Waututh Nation

Consultation efforts to date, have sought to identify and address concerns and issues raised by Tsleil-Waututh Nation during the Initial Consultation and pre-Application Phases.

The Ministry has requested Tsleil-Waututh's input on a table accompanying both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. The Ministry requested Tsleil-Waututh's input on Appendix A: Key Issues and Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix O2.

2.16 Summary of Consultation Activities with Hwlitsum

The following section summarizes consultation undertaken with the Hwlitsum during the Initial Consultation and the pre-Application Phases of the Project. This content reflects efforts taken to consult with Hwlitsum and of the issues, concerns and interests raised to date. The Ministry has considered Hwlitsum's input on the draft of this Consultation Report and revised content where appropriate, and will share a final version of the Consultation Report with Hwlitsum.

Initial Consultation

The Ministry initiated consultation with Hwlitsum in early 2014. At that time, Hwlitsum was affiliated with the Cowichan Nation Alliance and participated in Project consultation as a member of the Cowichan Nation Alliance. In fall 2014, Hwlitsum indicated that they would engage with the Ministry directly. In support of consultation undertaken during the Initial Consultation Phase, the following Ministry-led activities have been undertaken with Hwlitsum:

- Meetings with Hwlitsum Chief and Council, staff and consultants;
- Site visit;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities,

review of documents, and submission of an Hwlitsum Project-related Study.

During initial discussions with Hwlitsum, and as demonstrated in the Consultation Plan and Hwlitsum/George Massey Tunnel Replacement Project Funding Agreement, the Ministry sought input in the development of a consultation approach, and later a Consultation Plan, specific to Hwlitsum.

Consultation activities during this period were focused on, among other things, the Project scope and schedule, proposed Studies/Valued Components, and identification of potential impacts on Hwlitsum's Aboriginal Interests and mitigation measures that may be used to avoid or minimize any effects on Aboriginal Interests.

These discussions were supported by presentations and where possible, involved the Project's subject matter experts. The Ministry offered to present on any topic of interest to Hwlitsum during this phase including any of the presentations from the May 2015 Environmental Update package (contents detailed in list of materials).

In addition to meetings with Hwlitsum representatives during the Initial Consultation Phase, Hwlitsum participated in a site visit which focused on key Project components, mutual sharing of information, plans for Tunnel decommissioning, the Deas Slough Bridge, and Deas Island, as well as anticipated works and enhancement opportunities for Green Slough.

During the Initial Consultation Phase, the Ministry sought Hwlitsum's input on the following EA-related documents:

- Draft Project Description and Key Areas of Study
- Draft Archaeological Overview Assessment
- Draft Archaeological Heritage Resources Assessment
- Draft Aboriginal Consultation Plan
- Draft Application Information Requirements

With the exception of the draft Consultation Plan, the Ministry met with Hwlitsum and walked through these draft documents. Focused discussions on these documents were intended to explain the scope and content, to respond to any initial questions and to elicit input.

While early drafts of these documents such as the Project Description and Key Areas of Study and the draft Application Information Requirements were shared during the Initial Consultation Phase, they were provided again in their revised format for further review in the pre-Application Phase.

Meetings with Hwlitsum

Between early 2014 and May 2016, the Ministry and Hwlitsum discussed and exchanged Project-related information through emails, phone calls, a community meeting and in-person meetings. Meetings and related activities undertaken with Hwlitsum in relation to the Project are outlined below.

At meetings with Hwlitsum during Initial Consultation, the Ministry provided introductory information regarding the proposed Project scope and Project schedule, and sought input with respect to Hwlitsum’s past, current and future use of the Project area for the exercise of identified Aboriginal Interests, concerns related to potential impacts on Hwlitsum’s Aboriginal Interests and opportunities related to mitigation of any potential effects. The Ministry also sought to determine Hwlitsum’s preferences with respect to participation in Project consultation, EA review, and related activities. During the initial meetings, communications protocols were established and key contacts were identified and/or confirmed.

In coordinating and conducting meetings with Hwlitsum, wherever possible, the Ministry has ensured the following:

- Meetings were held at the preferred location and in the preferred format for Hwlitsum.
- Meetings were scheduled at a date and time convenient for Hwlitsum and that facilitated the attendance of key representatives.
- Input into the agenda was considered in the planning of the meeting and, where input had not been provided beforehand, the agenda made provisions for additional topics to be discussed.
- Technical and knowledgeable Ministry representatives have been present.
- Materials have been shared beforehand and are provided in a preferred format.
- Meetings have been respectful, productive and consistent with the principles and objectives of the Consultation Plan.

During this period, key topics and presentations covered during meetings with Hwlitsum include: Archaeology/Heritage Resources, Marine Use, Fish and Fish Habitat, River Hydraulics and Morphology, Green Slough concept, Project Description and Key Areas of Study document, Project Definition Report and the Draft Application Information Requirements.

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------|--------------------|-----------|------------------|---------------------|
|------|--------------------|-----------|------------------|---------------------|

ABORIGINAL CONSULTATION REPORT
George Massey Tunnel Replacement Project

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|----------------------|--|---|---|
| 2014-06-02 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan Nation Alliance • Penelakut Tribe • Halalt First Nation • Stz'uminus First Nation • Hwlitsum • GMT | Travelodge Silver Bridge Inn | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2014-08-28 | Initial Consultation | <ul style="list-style-type: none"> • Cowichan Tribes • Halalt First Nation • Penelakut Tribe • Stz'uminus First Nation • Hwlitsum • GMT | Cowichan Tribes Boardroom Duncan, BC | <ul style="list-style-type: none"> • Bridge Rendering • Corridor Map • Project Definition Phase Presentation |
| 2015-02-23 | Initial Consultation | <ul style="list-style-type: none"> • Hwlitsum • GMT • BC EAO | GMT Richmond Project Office 2030 – 11662 Steveston Highway Richmond, BC | <ul style="list-style-type: none"> • Agenda • Bridge Rendering • Corridor Map (revised) • Environment Overview Presentation • Project Description and Key Areas of Study |
| 2015-05-12 | Initial Consultation | <ul style="list-style-type: none"> • Hwlitsum • GMT • Northwest Hydraulics | GMT Richmond Project Office 2030 – 11662 Steveston Highway Richmond, BC | <ul style="list-style-type: none"> • Agenda • Fish and Fish Habitat Presentation • Green Slough Conceptual Plan • Green Slough Stone Columns, concept • River Hydraulics and Morphology Presentation |
| 2015-10-29 | Initial Consultation | <ul style="list-style-type: none"> • Hwlitsum • GMT | GMT Richmond Project Office 2030 – 11662 Steveston Highway Richmond, BC | <ul style="list-style-type: none"> • No presentation materials used |
| 2015-11-19 | Initial Consultation | <ul style="list-style-type: none"> • Hwlitsum • GMT | Project Tour | <ul style="list-style-type: none"> • No materials used |
| 2015-12-18 | pre-Application | <ul style="list-style-type: none"> • Hwlitsum • GMT • BC Hydro | GMT Richmond Project Office 2030 – 11662 Steveston Highway Richmond, BC | <ul style="list-style-type: none"> • Draft Application Information Requirements (AIR) Presentation • Draft Application Information Requirements (AIR) |
| 2016-01-21 | pre- | <ul style="list-style-type: none"> • Hwlitsum | BCIT | <ul style="list-style-type: none"> • GMT 2016-01-21 TWG1 EA |

| Date | Consultation Phase | Attendees | Meeting Location | Materials Presented |
|------------|--------------------|---|---|---|
| | Application | <ul style="list-style-type: none"> • GMT | 555 Seymour Street Vancouver, BC | Process Presentation <ul style="list-style-type: none"> • GMT 2016-01-21 TWG1 Project Overview • GMT 2016-01-21 TWG1 Key Areas of Study Presentation • GMT 2016-01-21 TWG1 dAIR Presentation • GMT 2016-01-21 TWG1 Figures to draft AIR • GMT 2016-01-21 TWG1 Preliminary Conclusions Presentation • GMT 2016-01-21 TWG1 Agenda |
| 2016-01-31 | pre-Application | <ul style="list-style-type: none"> • Hwlitsum • GMT | Fisherman's Hall Ladner | <ul style="list-style-type: none"> • Fish and Fish Habitat Presentation • GMT Open House boards • Project Definition Report • Description and Key Studies |
| 2016-03-10 | pre-Application | <ul style="list-style-type: none"> • Hwlitsum • GMT | BCIT 555 Seymour Street Vancouver, BC | <ul style="list-style-type: none"> • TWG2 Agenda • TWG2 EA Process Presentation • TWG2 Review of Comments Working Group Presentation • TWG2 Spatial Boundaries of Proposed Areas of Study • TWG2 Website Materials List |

As outlined in the Aboriginal Consultation Plan, the Ministry has been committed to sharing Project-related information with Hwlitsum as it becomes available. The Ministry considered the provision of early drafts of key EA documents to Hwlitsum as an opportunity to:

- Acknowledge and respond to known concerns regarding the high volume of project referrals, challenging timelines for review and limited resources to allocate to EA review processes;
- Meet the objective of sharing Project-related documents in a timely manner with the intent to facilitate Hwlitsum's' review and comment;
- Consider and incorporate input, address concerns and identify gaps in relation to key aspects of the Project (e.g. Valued Components, studies and study area boundaries) prior to the pre-Application Phase; and to

- Allow time for meetings to be coordinated and conducted regarding particular documents or aspects of the Project of interest to Hwlitsum in advance of the pre-Application Phase.

During the Initial Consultation Phase, the Ministry communicated with Hwlitsum through letters, email and phone calls.

Letters sent to Hwlitsum during this consultation Phase include:

- Introductory letter notifying Hwlitsum of the Project and offering to meet regarding the proposed Project;
- Project Description letter accompanying a draft copy of the Project Description and Areas of Study document requesting review and comment; and
- Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment letter requesting review and comment on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment (document also provided).

Email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Hwlitsum representatives;
- Follow up to meetings or earlier communications;
- Provision of Project-related documents, updates and sharing of information;
- Response to concerns or questions in relation to the Project;
- Clarification of information and feedback shared by Hwlitsum; and
- To address and resolve Project-related concerns.

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Hwlitsum;
- Confirmation of information and follow up to previous communications;
- Updates and sharing of information; and
- To address and resolve Project-related concerns.

Project-related documents and materials used during consultation are listed in Aboriginal Consultation Report 1.

Aboriginal Consultation Plan – Hwlitsum Review and Comment

From the beginning of consultation, the Ministry worked with Hwlitsum to develop a mutually acceptable consultation approach, including the manner in which Hwlitsum was to be kept informed about the Project, and the means by which comments (e.g., on the Project, its potential effects and the mitigation measures that may be used to avoid or minimize those effects) were to be communicated and addressed by the Ministry.

The Consultation Plan is informed by regulatory and legal requirements, the importance of enhancing or maintaining a positive, respectful and productive working relationship with Hwlitsum, and specific input received during initial GMT consultation meetings with Hwlitsum. The Consultation Plan lists consultation activities, agreed to by both parties, and specified under the Hwlitsum/GMT capacity funding agreement.

The Ministry undertook the activities below in order to obtain and, where appropriate, incorporate, input on the Aboriginal Consultation Plan:

- Email request for review and comment on a draft of the Consultation Plan provided as an attachment.
- Follow up communications (email and phone calls) to schedule a meeting to discuss the draft Consultation Plan.
 - Discuss or obtain clarification on any comments provided by Hwlitsum to the Ministry.
- Revision of draft Consultation Plan
- Sharing of Consultation Plan and a summary of responses to Hwlitsum's comments/input.
 - Revised Consultation Plan and, for ease of reference, original Draft Consultation Plan provided via email
 - Summary of comments/input provided by Hwlitsum and corresponding action taken by the Ministry (i.e. revision to plan, comment "noted", request for further discussion regarding request)

The Consultation Plan was revised, based on input received from Hwlitsum and other Aboriginal Groups, and approved by EAO on April 6, 2016. In consideration of the confidential nature of comments provided on the draft Plan and that specific consultation activities were planned for each Aboriginal Group, the Ministry responded directly to each group regarding their respective comments on the Plan. Where Aboriginal Groups comments or requests did not result in changes to the Plan, a response was provided, along with an offer to meet to discuss any outstanding concerns or questions. Based on feedback received to date and discussions with Hwlitsum on this matter, the Ministry is of the understanding that Hwlitsum has no outstanding concerns or comments with

respect to the Plan.

Capacity Funding

During Initial Consultation meetings, Hwlitsum identified the need for capacity funding to support Hwlitsum's involvement in Project consultation activities, review of EA-related documents and participation in the pre-Application phase of the EA process. Hwlitsum also identified the need for funding for a Project-related Study. The Ministry and Hwlitsum worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Hwlitsum's review and comment. Hwlitsum submitted a study entitled "Hwlitsum Traditional Use and Occupancy Study 2015".

Involvement in Archaeological Component of the Project

From the outset of discussions, Hwlitsum identified the importance of the archaeological component of the Project and of Hwlitsum's involvement in fieldwork and review of draft archaeological documents. All draft archaeological documents were shared with Hwlitsum for review and comment. The Ministry and its archaeologist offered to meet with Hwlitsum to present on this aspect of the Project. Hwlitsum representatives were invited to participate in archaeological fieldwork for the Project.

Hwlitsum submitted comments on the Draft Heritage Resources Overview Assessment/Archaeological Overview Assessment for the Project via letter/email dated December 12, 2014. Where appropriate, revisions to the draft Overview assessment were made based on input received from Aboriginal Groups during their review.

Pre-Application Consultation

The following section outlines consultation activities that the Ministry has undertaken with Hwlitsum during the pre-Application Phase. The approach was developed with input from Hwlitsum during the Initial Consultation Phase described above and as detailed in the Consultation Plan. It is also informed by EAO's Section 11 Order, specifically Part G section 13 and 14, which outlines Aboriginal consultation requirements for the Ministry.

During pre-Application phase consultation with Hwlitsum, the Ministry has:

- Provided capacity funding to support continued involvement in Project consultation activities and the regulatory process;
- Provided all relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Hwlitsum's Aboriginal Interests;
- Identified and provided, where possible, opportunities for Hwlitsum to participate

in fieldwork (River otter study);

- Identified and documented questions, issues and interests raised by Hwlitsum;
- Continued to work with Hwlitsum to identify potentially affected Aboriginal Interests;
- Identified measures to avoid, mitigate, or where required accommodate, potential adverse effects on Aboriginal Interests as appropriate; and
- Supported EAO-led Technical Working Group.

Funding for Application Review

The Ministry will work with Hwlitsum to provide capacity funding for the Application Review Phase, with the aim of providing reasonable capacity support for participation in the review of the EA and any related permitting processes. Funding is intended to facilitate participation in technical reviews and analyses, for ongoing consultation activities (as specified in the Consultation Plan), and to support Hwlitsum in presenting information regarding their respective Aboriginal Interests. Funding is also being provided to ensure the consultation requirements pursuant to the Section 11 Order are met and the Consultation Plan is implemented as intended.

Consultation on EA-related documents

During this phase, the Ministry consulted Hwlitsum on the following Project-related documents:

- Draft Project Description and Key Areas of Study document
- Draft Application Information Requirements;
- Content of draft Application Part C of the Environmental Assessment Application
- Draft Consultation Report 1

Draft Consultation Report 2 was provided to Hwlitsum for review and comment. Where appropriate, input received from Hwlitsum on Report 2 has been incorporated into the revised document.

Consultation on Aboriginal Consultation Report 1

The Ministry provided draft Consultation Report 1 to Hwlitsum for review and comment prior to finalization and submission to EAO indicating that feedback received by May 2, 2016, would be incorporated into the final version as appropriate. Draft Part C content was also provided for review. Hwlitsum provided comments on Aboriginal Consultation Report 1 and Draft Part C content on May 10, 2016. Where appropriate, revisions were made to these drafts based on the input received.

Hwlitsum attended two EAO-led Working Group meetings and engaged directly with EAO with respect to the EA process.

Participation in Fieldwork

In April 2016, Hwlitsum was invited to participate in river otter-related fieldwork. The objectives of this work were to document river otter relative abundance within the Regional Assessment Area, document and describe use of riparian areas, identify high use areas, and potential areas and options for mitigation. Hwlitsum was unable to participate in the fieldwork due to a scheduling conflict.

Materials shared with Hwlitsum during the pre-Application Phase are outlined below:

| Document | Description |
|---|---|
| Project Description and Key Areas of Study (Project Description) | Document prepared according to guidance provided in EAO's <i>Guidelines for Preparing a Project Description for an Environmental Assessment in British Columbia</i> (EAO 2013). |
| Draft Application Information Requirements | The Working Group review of the draft Application Information Requirements (dAIR) commenced on January 6, 2016 . The dAIR outlines the studies, methods and information required for the Application for an Environmental Assessment Certificate. |
| Draft Application Information Requirements Presentation (December 2015) | Discussion of how comments received on first draft Application Information Requirements document were integrated into the next revised version. |
| Application Information Requirements | Final version of the document was issued on May 24, 2016. |
| Aboriginal Consultation Plan (April 2016) | Final version of Aboriginal Consultation Plan that incorporated input received from Aboriginal Groups and EAO. |
| Draft Part C content | Draft components of Part C for review and comment by Schedule B Aboriginal groups: baseline summaries and mapping. |
| Aboriginal Consultation Report 1 | Draft summary of general consultation undertaken to date on the Project. For review and comment. |
| Aboriginal Consultation Report 2 | Draft report with Aboriginal Group-specific information on consultation undertaken to date on the Project. For review and comment. |

Meetings with Hwlitsum

During the pre-Application Phase, the Ministry held a community meeting with Hwlitsum. At the request of Hwlitsum, the Project team provided an overview of the Project (scope, components, schedule, EA process) and a focused presentation on fish and fish habitat (see list of meetings for details).

Hwlitsum has attended two EAO-led Working Group meetings and has communicated directly with EAO with respect to the EA process. The EAO-led Working Group meetings focused on the following:

- Working Group Meeting (January 21, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - Project overview and update
 - Key Areas of Study
 - dAIR Overview
 - Preliminary conclusions from study results to date
- Working Group Meeting (March 10, 2016): *A one-day workshop with all members of working group. Discussions and presentations focused on:*
 - EA Process
 - List of materials available on Project website
 - Review of comments received on dAIR and resulting changes to the dAIR
 - Description and rationale of assessment areas

Communications Methods

During the pre-Application Phase, email communication was used for the following purposes:

- Coordination of meetings and other consultation activities with Hwlitsum representatives
- Follow up to meetings or earlier communications
- Provision of Project-related documents, updates and sharing of information
- Response to concerns or questions in relation to the Project
- Clarification of information and feedback shared by Hwlitsum
- To address and resolve Project-related concerns

The Ministry used phone communications for the following purposes:

- Coordination of meetings and other consultation activities with Hwlitsum
- Confirmation of information and follow up to previous communications
- Updates and sharing of information
- To address and resolve Project-related concerns

Documents for review were shared via email, in letter format and via mail/courier and include the following:

- Letter requesting review of Draft Part C content of the Application
- Letter requesting review of Draft Aboriginal Consultation Report 1
- Letter requesting review of Draft Aboriginal Consultation Report 2

Consultation on Aboriginal Consultation Report 2

Pursuant to the Section 11 Order, a draft version of Aboriginal Consultation Report 2 was shared with Hwlitsum for review and comment. Hwlitsum provided comments on June 20, 2016.

Among the comments provided by Hwlitsum was a request to refer to Hwlitsum as a First Nation. Hwlitsum has previously made this request. The Ministry has shared this concern with EAO and will continue its reference to “Hwlitsum” in accordance with the Section 11 Order.

Hwlitsum will be provided with a final copy of Aboriginal Consultation Report 2 along with an explanation of how their input has been considered and any changes to the final Aboriginal Consultation Report 2 as a result of their feedback.

On June 28, 2016, Hwlitsum provided the following comments on Consultation Report 2. These have been addressed in Schedule A: Key Issues and Concerns.

- Request to be referenced as a First Nation
- Hwlitsum participation

Concerns, Issues and Interests Raised by Hwlitsum

Consultation efforts to date have sought to identify and address concerns and issues raised by Hwlitsum during the Initial Consultation and pre-Application Phases.

Supported EAO-led Technical Working Group. George Massey Tunnel Replacement Project Funding Agreement Cowichan Tribes Cowichan Tribes Supported EAO-led Technical Working Group. The Ministry requested Hwlitsum’s input on Appendix A: Key Issues and

Concerns to both Aboriginal Consultation Reports to ensure that issues and concerns have been accurately and appropriately captured. Aboriginal Consultation Report 2's Appendix A has been revised to reflect input received to date and to include status and next steps. This table is also included in Part C as Appendix P2.

3. ONGOING CONSULTATION AND ENGAGEMENT

3.1 Application Review Consultation:

The Ministry will continue to implement consultation and engagement methods in accordance with the Consultation Plan and Section 11 Order. Input received from Aboriginal Groups on the planned consultation for the Application Review Phase as well as the Post Environmental Certificate Consultation will be considered and, subject to EAO approval, any necessary refinements to the Consultation Plan will be made.

During the Application Review Phase, the Ministry will continue to work with Aboriginal Groups to further refine community-specific consultation activities (Appendix A of Consultation Plan) and to coordinate the provision of Application Review Stage participation funding.

Ongoing consultation through this Phase will be focused on supporting Aboriginal Groups in their review of the Application; continuing to responding to questions, concerns and issues; and working with Aboriginal Groups with respect to the development of strategies to avoid, mitigate or otherwise address any adverse Project-related effects. The Ministry will also continue to explore, with Schedule B Aboriginal Groups, opportunities to provide economic and non-economic benefits to Aboriginal Groups that are directly affected by the Project. Opportunities include training, employment and contracting, as well as environmental enhancement works and other components of the Project.

The Ministry proposes to undertake the following consultation activities with Schedule B Aboriginal Groups during the Application Review Stage:

- Notify Aboriginal Groups of the submission of the Application.
- Provide copies of the Application to Aboriginal Groups (in preferred format) in advance of Application Review
- Conduct meetings with Chief and Council and/or staff in support of their review of the Application (with participation of appropriate technical experts); to continue to resolve issues and concerns, to refine mitigation measures; to discuss Project-related benefits and opportunities (economic and non-economic), to identify and plan follow up strategies, and additional consultation and engagement requirements or commitments in relation to the Project's approval and construction.

- Correspondence/communications related to, among other things, coordination of consultation activities, Project updates, resolution of concerns/issues, and identification of measures to avoid, mitigate or otherwise accommodate potential adverse effects on Aboriginal Interests.
- Presentations to Chief and Council, or in the case of the TSAWWASSEN, to Advisory Council and Executive Council.
- Open houses or other special meetings (per request of Aboriginal Groups).
- Provide responses to Aboriginal Groups' comments and maintain an issue/response tracking table that will be provided to EAO.
- Requirements as specified under the Section 11 Order.

Working Group Meetings/Open Houses:

At the direction of EAO, the Ministry will participate in and attend EAO-led Working Group meetings and Open Houses.

Aboriginal Consultation Report 3

During the Application Review Phase, the Ministry will prepare Aboriginal Consultation Report 3 which will include how potential adverse effects of the Project will be avoided, mitigated, addressed or otherwise accommodated, including any changes to the proposed Project design or other mitigation measures; as appropriate. Aboriginal Consultation Report 3 will also summarize the efforts undertaken by the Ministry to consult with Aboriginal Groups and comply with the Consultation Plan; identify the feedback and information received during consultation; identify the potential effects of the proposed Project on Aboriginal Groups' Aboriginal Interests; and provide next steps/future consultation activities, other than those outlined in the approved Consultation Plan.

As specifically outlined in the Section 11 Order, the Ministry must submit Aboriginal Consultation Report 3 to the Aboriginal Groups listed on Schedule B of this Order for review and comment prior to submitting the report to the Project Assessment Lead and must advise the Project Assessment Lead how Schedule B Aboriginal Groups were consulted and what feedback was provided when submitting Aboriginal Consultation Report 3 to the Project Assessment Lead.

The Project Assessment Lead will assess Aboriginal Consultation Report 3a. The Project Assessment Lead may order additional consultation activities within prescribed time limits.

Per the requirements of the Section 11 Order, the Ministry will undertake the following activities with Schedule C Aboriginal groups:

- Provide a response to comments received from Aboriginal groups, to the satisfaction and within the timeframe specified by the Project Assessment Lead; and
- Implement additional measures for consultation and accommodation of Aboriginal groups, where required by the Project Assessment Lead.

3.2 Post-Environmental Assessment Certificate Consultation

The Ministry will continue to consult with Aboriginal groups after issuance of the Environmental Assessment Certification. If issues arise during the Post-EAC Consultation Phase, the Ministry will:

- Notify Schedule B Aboriginal Groups of the outcome of the Application Review, including requirements of the EAC and related commitments and assurances.
- Continue to consult with Schedule B Aboriginal Groups to fulfill obligations outlined in the environmental certificate, including but not limited to, review of construction-related plans and designs, and involvement in Project components of interest such as environmental enhancement and mitigation.
- Continue to engage Schedule B Aboriginal Groups with respect to Project-related training, employment, contracting and other opportunities.
- Maintain ongoing communication and engagement with Schedule B Aboriginal Groups, including providing regular updates in relation to construction and Project milestones.

4. NEXT STEPS

This report summarizes the Ministry's consultation with Aboriginal Groups during the Initial Consultation Phase through to the submission of the Application for completeness review. Aboriginal Groups were provided with this draft report for the purposes of review and comment. The Ministry requested input by June 17, 2016, in order to be able to consider and incorporate feedback, where appropriate, in advance of submission to EAO. Feedback was incorporated into the Report up to June 29, 2016. The revised Consultation Report will be provided to all Aboriginal Groups for their reference.

The Ministry acknowledges the importance of appropriately and effectively engaging with Aboriginal Groups with Aboriginal Interests within the Project alignment. The Ministry is committed to building and maintaining positive working relationships with these Aboriginal groups. The Ministry has approached consultation and engagement in a manner consistent with this commitment and will continue to work with Aboriginal Groups in this way throughout this Project.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|-------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Cowichan Tribes' queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Cowichan Tribes to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Cowichan Tribes is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--------------------------------------|
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Cowichan Tribes title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
 - Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Cowichan Tribes as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Potential impacts to Cowichan Tribes title, Rights and culture. Identification of future developments should include potential Cowichan Tribes title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Cowichan Tribes title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Cowichan Tribes to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Cowichan Tribes and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on λəqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Cowichan Tribes access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Cowichan Tribes' access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Cowichan Tribes' knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Cowichan Tribes ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| | <p>predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application.</p> | | |
| <p>Protection of Cowichan Tribes' rights to harvest within the Project area.</p> | <p>Cowichan Tribes' rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Cowichan Tribes as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities.</p> | <p>The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Cowichan Tribes is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Cowichan Tribes received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Cowichan Tribes as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Cowichan Tribes may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Cowichan Tribes requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Cowichan Tribes which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Cowichan Tribes received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Cowichan Tribes as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Cowichan Tribes may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Cowichan Tribes requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Cowichan Tribes which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Opportunities for cultural recognition and naming</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will to work with Cowichan Tribes on this matter.</p> | <p>Ongoing</p> | <p>Further engagement with Cowichan Tribes is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Cowichan Tribes and importance of initiating related discussions with Cowichan Tribes during Pre-Application Stage. Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Cowichan Tribes to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Cowichan Tribes wants to prepare its membership for employment opportunities and will work with Cowichan Tribes to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Cowichan Tribes on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------|--|
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Cowichan Tribes to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Cowichan Tribes to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Change in flow rates after Tunnel removal | The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| | <p>anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | | |
| <p>Factoring in extreme weather events in River Hydraulics model</p> | <p>Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |
| <p>Effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>The Ministry is following up with Cowichan Tribes to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>Ongoing</p> | <p>Clarification regarding concern</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |
| Improved ditches will result in less filtering of deleterious materials | Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River. | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed in Application | None |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Cowichan Tribes. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Cowichan Tribes has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects
 No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation
 Minimize effects through Project design.
 Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.
 Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Cowichan Tribes fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Cowichan Tribes has not voiced any specific issues or concerns with respect to Land Use | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the Łæqtinəs/Tl'uqtinus site and potential archaeological values at interchanges</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Cowichan Tribes. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports | Cowichan Tribes participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Cowichan Tribes will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Ethnographical content in reports does not accurately reflect Cowichan Tribes historical presence within the Project area | The Ministry noted Cowichan Tribes concern that ethnographical content in Project reports does not accurately reflect Cowichan Tribes historical presence within the Project area. The Ministry continues to work with Cowichan Tribes to address this concern. | Ongoing | Ongoing consultation |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| | <p>construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | | |
| <p>New Bridge could “unleash pent-up demand” and create even more congestion</p> | <p>The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing.</p> | <p>Addressed</p> | <p>None</p> |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--------------------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Halat First Nations's queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Halalt First Nation to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Halalt First Nation is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Halalt First Nation title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Halalt First Nation as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential impacts to Halalt First Nation title, Rights and culture. Identification of future developments should include potential Halalt First Nation title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Halalt First Nation title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Halalt First Nation to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Halalt First Nation and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on Łæqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Halalt First Nation access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Halalt First Nation’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Halalt First Nation knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Halalt First Nation’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| | available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application. | | |
| Protection of Halalt First Nation's rights to harvest within the Project area. | Halalt First Nation's rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Halalt First Nation as a result of the Project are not expected. | Addressed in Application | Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4 |
| Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. | The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Halalt First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Halalt First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Halalt First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Halalt First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Halalt First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Halalt First Nation which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Halalt First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Halalt First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Halalt First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Halalt First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed funding agreements with Halalt First Nation which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Opportunities for cultural recognition and naming</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Halalt First Nation on this matter.</p> | <p>Ongoing</p> | <p>Further engagement with Halalt First Nation is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Halalt First Nation and importance of initiating related discussions with Halalt First Nation during Pre-Application Stage. Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Halalt First Nation to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Halalt First Nation wants to prepare its membership for employment opportunities and will work with Halalt First Nation to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Halalt First Nation on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------|--|
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Halalt First Nation to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Halalt First Nation to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Factoring in extreme weather events in River Hydraulics model</p> | <p>Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Effect of the Tunnel on dissolved oxygen content within the river. | <p>The Ministry is following up with Halalt First Nation to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river.</p> | Ongoing | Clarification regarding concern |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |
| Improved ditches will result in less filtering of deleterious materials | Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River. | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed in Application | None |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Halalt First Nation. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Halalt First Nation has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Halalt First Nation is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Halalt First Nation is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Halalt First Nation fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Halalt First Nation has not voiced any specific issues or concerns with respect to Land Use | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the ǻǻqtinǻs/TI'uqtinus site and potential archaeological values at interchanges</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Halalt First Nation.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports</p> | <p>Halalt First Nation was invited to participate in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed</p> | <p>Halalt First Nation will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |
| <p>Ethnographical content in reports does not accurately reflect Halalt First Nation historical presence within the Project area</p> | <p>The Ministry noted Halalt First Nation concern that ethnographical content in Project reports does not accurately reflect Halalt First Nation historical presence within the Project area. The Ministry continues to work with Halalt First Nation to address this concern.</p> | <p>Ongoing</p> | <p>Ongoing consultation</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|-------------------------|
| | Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects. | | |
| New Bridge could “unleash pent-up demand” and create even more congestion | The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing. | Addressed | None |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------------|-------------------------|
| <p>Social and cultural effects and the adequacy of Environmental Assessment (EA) methodology.</p> | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO). Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | <p>Referred to EAO</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|--------------------------------------|
| Inclusion in Environmental Assessment Office (EAO) process ensures that Katzie First Nation concerns are addressed. | Noted. | Noted | None |
| Project's EA Process and its associated timelines. Effectiveness and nature of the EA process as well as current volume of EAs underway, | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Katzie's queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Katzie title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- Fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

- Quality of experience while engaged in or tied to traditional use
- Changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
 - Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Katzie as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|---|
| <p>Potential impacts to Katzie First Nation title, Rights and culture</p> | <p>Potential Project related impacts to Katzie title, Rights and culture, the level of effect predicted, and mitigation measures are outlined in the Application. The Ministry will continue to meet with Katzie to ensure any effects are minimized.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures</p> |
| <p>Cumulative effects: Consideration of cumulative effects on Aboriginal rights. Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. Absence of a comprehensive study of cumulative effects on the Fraser River</p> | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual)</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------|-------------------------|
| | <p>cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. While the Ministry acknowledges that Katzie First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |
| <p>“Any work approval within the Katzie First Nation traditional territory is without prejudice to any positions that may be taken by the Katzie First Nation in any litigation or negotiation (including treaty negotiations) and is not intended to define, create, recognize, deny or amend any aboriginal or treaty right within the meaning of sections 25 and 35 of the Constitution Act, 1982.”</p> | <p>Noted</p> | <p>Noted</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Katzie First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Katzie’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Construction and demolition of structures within the Katzie First Nation traditional territory must not impact the ability of community members to participate in traditional activities on the land and water, specifically fishing in and around the Project area.</p> | <p>Katzie’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.X, residual effects on the exercise of Aboriginal Interests by Katzie as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Katzie First Nation requires the joint development of construction and demolition operations and mitigation plans to address this specific issue during the summer and fall fishing season.</p> | <p>The Ministry will consult with Aboriginal Groups in the development of Construction Environmental Management, Construction Traffic Management, Marine Access Management, Health and Safety, and Operation Environmental Management plans.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Adequacy of standard social and cultural impact assessment demonstrating Katzie’s use, occupancy, ties and attachment, and changes to cultural landscapes.</p> | <p>Social effects of the Project on Katzie’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Protection of Katzie First Nation’s rights to harvest within the Project area.</p> | <p>Katzie’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Katzie as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process. | Katzie received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Katzie First Nation as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Katzie may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Katzie requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed funding agreements with Katzie which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------|--|
| Opportunities for cultural recognition and naming. | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Katzie on this matter. | Ongoing | Discussion with Katzie to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Project-related employment, training, contracting, and economic development opportunities.</p> <p>Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage.</p> | <p>The Ministry is committed to working with Katzie to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Katzie to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |
| <p>The Ministry's approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups.</p> | <p>The Ministry is confident that the process will effectively allow for benefits to be provided to Aboriginal Groups.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Interest in revenue sharing opportunities from tolling</p> | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. In accordance with the provincial tolling strategy, revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways.</p> | <p>Addressed</p> | <p>None</p> |

4.1 RIVER HYDRALICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Change in flow rates after Tunnel removal. | The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 |

SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such a turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential effects of run off and drainage. | The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity in anticipated. No | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|-------------------------|
| | <p>appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | | |
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Potential effects to fish and fish habitat and spawning grounds, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, and salmon to Katzie and is committed to avoiding or mitigation any potential effects. Fish and Fish Habitat are discussed in Section 4.4. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures) of the Application |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Inclusion of mud sharks in baseline studies. | Fish species included in baseline studies were selected based on presence (or potential presence) in the study area and their potential for interaction with the Project. Mud sharks (spiny dogfish) are not known to frequent the Project area. | Addressed | None |
| Fish mortality from pile driving and blasting. | The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Fish mortality should not be a significant issue during pile driving. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Effects of pile driving on salmon migration. | The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Pile driving should not impact salmon migration. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 (Underwater Noise) and 4.4 (Fish and Fish Habitat).</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|--|
| Invasive plant species and proposed plans to manage presence during construction. | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------|---|
| Inclusion of culturally significant plants in planting plans and opportunity for Katzie in the identification of plants, and planting work. Katzie has the capacity to undertake this type of work. | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|---|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Katzie Alliance is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 (Terrestrial Wildlife) of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Katzie is concerned with the potential effects of the new bridge on species such as waterfowl and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highway will mitigate potential Project-related increase in traffic collision risk. Nesting opportunity provided by the new bridge will offset the loss of nesting habitat due to removal of the Deas Slough Bridge. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 (Terrestrial Wildlife) of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Impact of laydown areas on terrestrial wildlife.</p> | <p>The Application has been developed with the assumption that all temporary and permanent works will be included within the Project alignment. Potential staging areas that will be made available to the contractor encompass areas within the highway right-of-way that have been previously developed and disturbed.</p> <p>Any temporary or permanent works that are to take place will be subject to applicable permitting requirements, including Water Sustainability Act permitting. Applications for these permits will include detailed descriptions and locations of works to take place.</p> <p>If the contractor chooses to develop staging areas on sites other than those identified, site specific environmental permitting and approvals will be obtained by the contractor.</p> | <p>Addressed</p> | <p>Obtain site specific environmental permits and approvals</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|---|
| Potential impacts of noise from pile driving and blasting. | Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application. | Addressed | Implementation of mitigation measures as outlined in Section 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential effects of construction during fishing season on fishing activities.</p> | <p>Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction. Mitigation of these effects will include the development and implementation of a specific Katzie marine use protocol through direct consultation with Katzie. Further mitigation can be achieved through the development and implementation of a Marine Access Management Plan for inclusion of the CEMP, establishment of communications protocols, appropriate lighting and marking for safe navigation, and establishment of navigation protection zones during construction.</p> <p>The Ministry understands the importance of working closely with Katzie to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in 5.2.4 (Marine Use Mitigation Measures)</p> |
| <p>Effects of construction and decommissioning-related barging activities on Katzie First Nation fishing activities and on the test fishery.</p> | <p>Potential interference with Katzie fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|-----------------------------|
| <p>Katzie First Nation requires the joint development of construction and demolition operations and mitigation plans to address this specific concern during the summer and fall fishing seasons.</p> | <p>The Ministry understands the significance of fish and fish habitat to Katzie. The Ministry is committed to further discussions with Katzie regarding the Development of a Construction Environmental Management and a Marine Access Management Plan. Fish and Fish Habitat are discussed in Section 4.4.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Facilitation of barges and larger vessels in the South Arm channel.</p> | <p>The Project will not appreciably increase the size of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the river. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Land Use. | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Visual Quality | | | |

HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Katzie. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Katzie participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Katzie will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Concern that the Ministry's archaeological consultant will not work effectively with Aboriginal Groups based on experience on past projects | The Ministry worked with Katzie to resolve this concern. | Addressed | None |

HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible adverse effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible direct effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

| HUMAN HEALTH | | | |
|---|--|---------------------------------|---|
| <p>During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>During operation, a negligible effect on access to instream locations for traditional use has been determined.</p> <p>During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.</p> <p>Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Katzie First Nation has experience with the Golden Ears Bridge being in proximity to the community and with the issue of suicide. Concern that there will be appropriate safety/suicide fencing on the new structure and importance of considering how the new bridge could facilitate suicide.</p> | <p>The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Katzie First Nation.</p> <p>Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application.</p> | <p>Addressed in Application</p> | <p>Development of safety barrier policy for new bridges in the Lower Mainland.</p> <p>Implementation of mitigation measures outlined in Section 7.1</p> |

| ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|--|---|--------------------------|--|
| Consultation with Katzie First Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Length of time tolls are in place | The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |
| Potential for falling snow and ice | The design of the new bridge is similar to the Alex Fraser Bridge, with cable stays on the outside of the span. There are no cables crossing the deck. The Project design will include snow and ice control measures. | Addressed | Snow and ice control measures in Project design. |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic | Addressed in Application | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| | <p>driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application.</p> | | |
| <p>Potential for contaminants in the Tunnel and how this may affect Tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Social and cultural effects and the adequacy of Environmental Assessment (EA) methodology. | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Addressed | None |

ABORIGINAL INTERESTS

There are potential Project related impacts to Kwantlen title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Instream locations (during construction)

Quality of experience while engaged in or tied to traditional use

- cultural landscape
- Instream locations (during construction)

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations (during construction)
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Kwantlen as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Kwantlen First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Kwantlen’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Kwantlen First Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Kwantlen’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| | <p>Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | | |
| <p>Protection of Kwantlen First Nation’s rights to harvest within the Project area.</p> | <p>Kwantlen’s rights to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Kwantlen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process. | Kwantlen received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Kwantlen First Nation as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Kwantlen may be considered confidential. The Ministry is subject to the provisions of the <i>Freedom of Information and Protection of Privacy Act</i> . However, subject to the requirements of applicable laws, the Ministry will respect Kwantlen requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|-----------------------------------|---|---------------|--------------------------------|
| Funding for Traditional Use Study | The Ministry signed funding agreements with the members of the Kwantlen which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project. Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------|--|
| Opportunities for cultural recognition and naming. | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Kwantlen on this matter. | Ongoing | Discussion with Kwantlen to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|---|
| <p>Project-related employment, training, contracting, and economic development opportunities.</p> <p>Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage.</p> | <p>The Ministry is committed to working with Kwantlen to identify potential opportunities to benefit from the Project and is confident that the Project’s procurement process will effectively allow this commitment to be met. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Kwantlen to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |
| <p>The Ministry’s approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups.</p> | <p>The Ministry is confident that the Project’s procurement process will effectively allow for benefits to be provided to Aboriginal Groups.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Cumulative effects: Consideration of cumulative effects on Aboriginal rights. Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. Absence of a comprehensive study of cumulative effects on the Fraser River</p> | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---|--------|-------------------------|
| | <p>operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. While the Ministry acknowledges that Kwantlen First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Change in flow rates after Tunnel removal.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics and Morphology Mitigation Measures)</p> |

| 4.8 TERRESTRIAL WILDLIFE | | | |
|---|---|--------------------------|--|
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential light and noise effects on wildlife and fish. | The Ministry understands that Kwantlen is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) |
| Potential effects of the bridge structure on species such as waterfowl and migratory birds. | The Ministry understands that Kwantlen is concerned with the potential effects of the new bridge on species such as waterfowl and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highway will mitigate potential Project-related increase in traffic collision risk. Nesting opportunity provided by the new bridge will offset the loss of nesting habitat due to removal of the Deas Slough Bridge. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of run off and drainage.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, has been determined. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|-------------------------|
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Potential effects to fish and fish habitat and spawning grounds, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Kwantlen. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Importance of habitat restoration and Kwantlen’s interest in participating in all aspects of these works</p> | <p>The Ministry notes Kwantlen’s interest in participating in habitat restoration work.</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Invasive plant species and proposed plans to manage presence during construction.</p> | <p>Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |
| <p>Inclusion of culturally significant plants in planting plans and opportunity for Kwantlen in the identification of plants, and planting work.</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>The Ministry will develop planting plans with consultation from Aboriginal Groups</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

- A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

- Minimize potential effects through Project design.
- Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.
- There is a low, long-term probability of barn owl mortality.
- No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Terrestrial Wildlife. | | | |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|--|
| <p>Potential effects of construction during fishing season on fishing activities.</p> | <p>Potential interference with Kwantlen fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |
| <p>Effects of construction and decommissioning-related barging activities on Kwantlen First Nation fishing activities and on the test fishery.</p> | <p>Potential interference with Kwantlen fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a MarineAccess Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Visual Quality | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|--|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Kwantlen. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports</p> | <p>Kwantlen participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed</p> | <p>Kwantlen will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

| 7.0 HUMAN HEALTH | | | |
|---|----------------------------------|---------------|--------------------------------|
| <p>During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>During operation, a negligible effect on access to instream locations for traditional use has been determined.</p> <p>During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.</p> <p>Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Kwantlen has not voiced any specific issues or concerns with respect to Human Health. | | | |

8.0 ACCIDENTS AND MALFUNCTIONS

Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.

In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|----------------------------------|---------------|--------------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Accidents and Malfunctions. | | | |

| OTHER ISSUES | | | |
|--|---|---------------|--------------------------------|
| Consultation with Kwantlen First Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application. | Addressed | None |

| ENVIRONMENTAL ASSESSMENT PROCESS | | | |
|--|--|---------------|--------------------------------------|
| <p>An environmental assessment of the Project is required under the B.C. <i>Environmental Assessment Act</i> (B.C. <i>EAA</i>), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. <i>EAA</i> sets out the criteria for reviewable projects.</p> <p>On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. <i>EAA</i>, and that it requires an EAC.</p> <p>The Project as proposed is not subject to review under the <i>Canadian Environmental Assessment Act, 2012</i>, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| In addition to the funding provided by the Proponent, Lake Cowichan requires funding for participation in EAO's own process. | The Ministry provided funding to Lake Cowichan for the Pre-Application Phase. Funding for the Application Review Phase will be provided. Funding provided by the proponent is inclusive of EAO-led activities. | Addressed | Funding for Application Review Phase |

| ABORIGINAL INTERESTS | | | |
|--|--|---------------|--------------------------------|
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Consideration of cumulative effects on aboriginal rights | The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|-----------------------------|
| <p>Importance of maintaining and protecting traditional historical access to the Project area. Future aspirations of Ts'uubaasatx to learn about and exercise their rights in the Project area as the community grows.</p> <p>"Ts'uubaasatx members not only want to maintain and assert their aboriginal right to camp, hunt, fish and otherwise move about in the area of the George Massey Tunnel, they hope someday, the area will be restored as a healthy habitat that they can utilize for food gathering purposes, once again."</p> | <p>The Ministry will work closely with Aboriginal Groups to ensure the protection of Aboriginal rights within the project area.</p> <p>The Ministry will work with Aboriginal Groups on Project components, such as environmental enhancement, in an effort to support healthy habitat for current and future use by Ts'uubaasatx and other Aboriginal Groups.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Importance of Project area for trade both in terms of historic and current/future significance (ł̓aq̓tinəs/Tl'uqtinus was a "little New York")</p> | <p>Noted</p> | <p>Noted</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Protection of Lake Cowichan’s rights to harvest within the Project area. “Our people used to go over to the Fraser river delta area to fish and hunt, every year, but we haven’t done that for years. Still, our right to access the area needs to be maintained. In the future it might be that area will be restored to a healthy state and we could practice our rights to camp and fish there”. “Even though the tunnel area is full of people now, and we can’t hunt or fish there, we still need to protect our rights to be there and gather food.”</p> | <p>Lake Cowichan’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Lake Cowichan as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |
| <p>Revenue sharing opportunities from tolling</p> | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | <p>Addressed</p> | <p>None</p> |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Lake Cowichan received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Lake Cowichan First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Lake Cowichan may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Lake Cowichan requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Funding for Traditional Use Study | The Ministry signed funding agreements with the members of the Lake Cowichan which provided funding for a Traditional Use Study. | Addressed | None |
| Importance of continued engagement with Aboriginal Groups on matters of importance and on success of mitigation and enhancements. “There is a need for reporting out on post-construction monitoring. This should be provided to us in the form of meetings and in writing” | Mitigation and environmental protection programs are addressed in the Application. Reporting requirements will be determined. The Ministry will undertake further discussions with Aboriginal Groups regarding post-construction monitoring and reporting. | Addressed | Ongoing consultation |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components
- Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will work with Lake Cowichan on this matter. | Ongoing | Discussion with Lake Cowichan to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage. | The Ministry is committed to working with Lake Cowichan to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Lake Cowichan to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |
| Adequate training time to take full advantage of potential future Project work activities. Opportunities for training related to traditional activities. | The Ministry is committed to working with Lake Cowichan First Nation to identify potential opportunities to benefit from the Project. The Ministry has initiated discussions with Lake Cowichan First Nation regarding Project-related benefits and opportunities. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics and River Morphology Mitigation Measures)</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures) |
| Impacts of the River from potential pollutants and contaminants on the Tunnel walls if left in place | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|-------------------------|
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Lake Cowichan. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Fish mortality from pile driving and blasting | The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Fish mortality should not be a significant issue during pile driving. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |
| Effects of pile driving on salmon migration | Pile driving should not have an impact on salmon migration. | Addressed in Application | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |
| Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon | Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conservation interest, including southern resident killer whales, do not occur in the Fraser River.

Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.

Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Impact on marine mammals such as the Stellar Sea Lion</p> | <p>Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 mms. Standard industry and best management practices will be applied to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to. Marine Mammals are addressed in Section 4.6 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.6.4</p> |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Inclusion of culturally significant plants in planting plans and opportunity for Lake Cowichan in the identification of plants, and planting work. Lake Cowichan has the capacity to undertake this type of work.</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>Develop planting plans with consultation from Aboriginal Groups</p> |
| <p>Ministry’s hydro-seeding spray contains invasive grasses that will damage new plants and add to the problem of invasive plants.</p> | <p>The Ministry will review its hydro seed mixes.</p> | <p>Addressed</p> | <p>Review hydro-seed mixes</p> |
| <p>Potential effect of removing the Tunnel on marshes along the river</p> | <p>Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. Creating comparable habitat within the Project alignment will offset unavoidable potential Project-related effect, which is limited to a small reduction in area of the cattail marsh that overlaps with Project components. Vegetation is addressed in Section 4.7 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Lake Cowichan is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Lake Cowichan is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|-------------------------|
| <p>Congestion and air quality issues – support for improved transit and anything that reduces idling.</p> | <p>Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Potential impacts of noise from pile driving and blasting | The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.10.4 |

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic, and consequent increase in associated noise and vibration due to the increases capacity of the new bridge</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

, a negligible effect on access to instream locations for traditional use has been determined.

, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Lake Cowichan fishing.</p> | <p>Potential interference with Lake Cowichan fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Lake Cowichan has not voiced any specific issues or concerns with respect to Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Lake Cowichan has not voiced any specific issues or concerns with respect to Visual Quality. | | | |

6.1 HERITAGE RESOURCESE

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites.</p> <p>Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area. No more tolerance for further disturbance of archaeological sites in the overdeveloped Lower Mainland. This includes disturbed and intact sites.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Lake Cowichan.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports. Importance of having a cultural person, known to LCFN and LFN, participate in archaeological work. | Lake Cowichan participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Lake Cowichan will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.

Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| New bridge will result in increased suicide attempts | <p>The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Lake Cowichan.</p> <p>Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application.</p> | Addressed | <p>Development of safety barrier policy for new bridges in the Lower Mainland.</p> <p>Implementation of mitigation measures outlined in Section 7.1</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>Creation of areas of increased criminal activity, particularly attraction of the shadow population/marginalized groups</p> <p>“Elders have expressed concern that bridge footings and covered areas will create places used by drug users and prostitutes”.</p> <p>“The tunnel is a bottleneck and removing it will bring in more drug trafficking into Delta. I am shocked that the municipalities haven’t stood up on this one”.</p> | <p>While not assessed as a Value Component in the Application, the potential for “at-risk populations” to use/congregate in areas near the bridge will be considered in Section 7.1 of the Application.</p> | <p>Addressed</p> | <p>None</p> |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|--|---|---------------|--------------------------------|
| Consultation with Kwantlen First Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|-----------------------------------|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Adequacy of Environmental Assessment (EA) methodology to address social and cultural effects | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Concern with the inclusion of certain Aboriginal Groups in Project consultation per Schedule B of the Section 11 Order | Consultation is being undertaken in accordance with the requirements of the Section 11 Order and as outlined in the Aboriginal Consultation Plan. Further discussion regarding the assignment of Aboriginal Groups to Schedule B of the Section 11 Order should be undertaken directly with EAO. | Referred to EAO | None |
| EA Process for the Project and its associated timelines | Concerns relating to the EA process and its associated timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Musqueam’s queries regarding the EA Process and associated timelines. | Referred to EAO | None |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|--|-----------------|-------------------------|
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Musqueam to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Musqueam is working on. Support to date has included Pre-Application capacity funding and the development of a Musqueam-specific Consultation Plan outlining agreed to consultation activities. The Ministry is working with Musqueam on a Memorandum of Understanding that is intended to further support Musqueam's involvement in the EA Process and associated consultation. | Referred to EAO | None |
| Use of MARR database for assessing Strength of Claim | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO | None |
| Standard EA methodology's use of the term "baseline" – to Musqueam this means more that current levels | The Ministry acknowledges that Musqueam's interpretation/use of the term "baseline" differs from the standard definition/use of this terminology for the purposes of this EA. | Addressed | None |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------------|--|
| Request for a Musqueam Specific Project-related study to be undertaken in advance of the start of the Application Review Phase | The Ministry funded a Musqueam Project-related study during the Initial Consultation Phase and will work with Musqueam during the Application Review Phase to support Musqueam in sharing information, knowledge and input in relation to the Project and its review process. The Ministry anticipates further discussion regarding the request for an additional study during Memorandum of Understanding (MOU)-related discussions. | Ongoing | MOU-related discussions, including the request for an additional study |
| EA guidelines including Application Information Requirements (AIR) template were developed without First Nations' consultation | This concern is beyond the scope of the Project's EA process and pertains to EAO process. Concerns related to First Nations consultation during the development of the AIR template have been referred to EAO. | Referred to EAO | None |
| Lack of resources and funding for participation in the EA Process | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. The Ministry is working with Musqueam on a MOU that is intended to support Musqueam's involvement in the EA Process and associated consultation. The Ministry understands that Musqueam wishes to address Application Review Phase funding-related needs and concerns in the context of the MOU. | Ongoing | MOU-related discussions, including Application Review Phase funding |

ABORIGINAL INTERESTS

There are potential Project related impacts to Musqueam title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Instream locations (during construction)

Quality of experience while engaged in or tied to traditional use

- cultural landscape
- Instream locations (during construction)

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations (during construction)
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Musqueam as a result of the Project are not expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Potential impacts to Musqueam title, Rights and culture | Potential Project related impacts to Musqueam title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Musqueam to ensure any effects are minimized. | Addressed in Application | Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application |
| Social effects of the Project on Musqueam’s ability to transfer knowledge, language and participate in socio-cultural practices | Social effects of the Project on Musqueam’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application. | Addressed in Application | Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Consideration of cumulative effects on Aboriginal rights | The Application includes historical context relating to changes in use over time by Musqueam and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Musqueam or was otherwise available from publicly available sources. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Musqueam is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. The Ministry understands that Musqueam is discussing this request with other provincial and federal ministries and agencies. | Addressed | None |

ABORIGINAL CONSULTATION

Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.

Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.

In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs related to the exercise of Aboriginal Interests.

Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|--|----------------|--|
| <p>Consultation with Musqueam is required for any land disposition, including surplus lands potentially sold to adjacent farmers</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Ongoing</p> | <p>Appropriate consultation will be undertaken on any disposition</p> |
| <p>Capacity funding to facilitate participation in the Project review process</p> | <p>The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. The Ministry is working with Musqueam on a Memorandum of Understanding that is intended to support Musqueam’s involvement in the EA Process and associated consultation. It is the Ministry’s understanding that Musqueam wishes to address Application Review Phase funding-related needs and concerns in the context of the MoU.</p> | <p>Ongoing</p> | <p>MOU-related discussions, including Application Review Phase funding</p> |
| <p>Appropriate use of information shared by Musqueam as it relates to confidentiality and dissemination</p> | <p>The Ministry understands and respects that certain information shared by Musqueam may be considered confidential. The Ministry is subject to the provisions of the <i>Freedom of Information and Protection of Privacy Act</i>. Subject to the requirements of applicable laws, the Ministry will respect Musqueam requests to keep information confidential.</p> | <p>Ongoing</p> | <p>MOU-related discussions, including provisions related to the use of information</p> |

| | | | |
|--|--|-----------|---|
| Musqueam requests a Musqueam-only site visit | Per this request, the Ministry undertook a site visit with Musqueam. No other Aboriginal Groups were present. | Addressed | None |
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Musqueam which provided funding for a Traditional Use Study. Musqueam submitted a Project related study to the Ministry, but did not submit a Traditional Use Study. The Ministry is working with Musqueam with respect to the sharing of Traditional Use information and expects that related discussions will occur in the context of an MOU. | Ongoing | MOU-related discussions, including the sharing of Traditional Use information and study |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components
- Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Opportunities for cultural recognition and naming, art and interpretive signage. Funding for cultural interpretation and signage</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Musqueam on these opportunities and determine any related funding requirements.</p> | <p>Ongoing</p> | <p>Further engagement with Musqueam is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage.</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Adequate training time to take full advantage of potential future Project work activities</p> | <p>The Ministry is committed to working with Musqueam to identify potential employment, training, contracting and economic development. The Ministry acknowledges that Musqueam wants to prepare its membership for employment opportunities and will work with Musqueam to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>MOU-related discussions, including identification of potential employment, training, contracting and economic development opportunities and timelines.</p> |
| <p>Interest in revenue sharing opportunities from tolling</p> | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. In accordance with the provincial tolling strategy, revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways.</p> | <p>Addressed</p> | <p>None</p> |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects on salt wedge from decommissioning of the Tunnel</p> | <p>Potential Project-related effects of Tunnel removal on salt wedge from decommissioning the Tunnel are addressed in Sections 4.1 (River Hydraulics) and 4.4 (Fish and Fish Habitat) of the Application. The timing window during which the salinity of the water exceeds the threshold for irrigation is almost identical with and without the Tunnel. The Tunnel does not substantially protrude above the riverbed and removal will not affect the behaviour of the salt wedge in any significant way with respect to the availability of water that is suitable for irrigation or to fish and fish habitat.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Potential effects on flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures)</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Potential effects on sedimentation after Tunnel removal | No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures) |
| Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge | The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. The bridge will collect and direct runoff to specifically designed biofiltration marshes at the bases of the main towers. The purpose of these biofiltration marshes is to naturally clean the water prior to re-entry into the ecosystem. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciate change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures) |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|--|---------------------------------|-------------------------|
| <p>Effect of shipping on carbon dioxide levels in the water, concern with effluent acidity levels and carbon outputs from ships affecting water and air quality</p> | <p>This is outside the scope of the Project. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed in Application</p> | <p>None</p> |
| <p>Use and disposal of dredged and other material in the river</p> | <p>The minimal amount of dredged sediment will be placed on a barge as will sections of the concrete mattress and brought to shore for applicable testing prior to disposal/recycling. The shot rock removed will be stored on shore and potentially reused as further protection to the Metro Vancouver watermain just downstream of the project.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|--|---|---|
| Protection of Musqueam 's rights to harvest under the Sparrow decision | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam's established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigating any potential effects on fish and fish habitat. | Acknowledged and addressed in Application | Ongoing consultation and implementation of mitigation measures in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Musqueam and is committed to avoiding or mitigation any potential effects | Addressed in Application | Implementation of mitigation measures outlined in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Importance of Musqueam Fisheries Department reviewing Green Slough concept | The Ministry will continue to meet with Musqueam's Fisheries Department on the Green Slough concept and any other component of the Project. The Green Slough concept has been shared with Musqueam, including representatives of Musqueam Fisheries Department, for input. | Ongoing | Ministry will continue to meet with Musqueam's Fisheries Department |
| Importance of sloughs, tributaries (Serpentine River), riparian work for fish stocks | Fish and fish habitat is discussed in Section 4.4 (Fish and Fish Habitat). The Ministry acknowledges the importance of sloughs, tributaries and riparian areas for fish stocks and is undertaking enhancement and riparian works. The Ministry will continue to seek Musqueam's input in the development of related plans. | Addressed in Application | Ministry will continue to seek Musqueam's input in the development of plans |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities.</p> | <p>There will be no direct pile driving in the river. Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shallow water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Sections 4.3.4 (Underwater Noise Mitigation Measures 4.4.4 (Fish and Fish Habitat Mitigation Measures))</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|--|
| Protection of Musqueam 's Aboriginal Interests – availability, quality, experience tied to traditional use of marine mammal resources for traditional purposes.. | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam's established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigation any potential effects on marine mammals. | Acknowledged and addressed in Application | Ongoing consultation and implementation of mitigation measures in Section 4.6.4 (Marine Mammals Mitigation Measures) |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--|--|
| <p>Protection of Musqueam 's Aboriginal Interests – availability, quality, experience tied to traditional use of vegetation resources for traditional purposes.</p> | <p>The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam's established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigation any potential effects on vegetation.</p> | <p>Acknowledged and addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures in Section 4.7.4 (Vegetation Mitigation Measures)</p> |
| <p>Invasive plant species and proposed plans to manage presence during construction</p> | <p>Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures) of the Application</p> |
| <p>Culturally significant plants should be used in planting plans</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Musqueam on the development of these plans.</p> | <p>Addressed</p> | <p>The Ministry will develop planting plans with consultation from Musqueam</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---|---|
| Protection of Musqueam’s Aboriginal Interests – availability, quality, and experience tied to traditional use of terrestrial wildlife resources for traditional purposes. | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam’s established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigation any potential effects on terrestrial wildlife. | Acknowledged and addressed in Application | Ongoing consultation and implementation of mitigation measures in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) of the Application |

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential light effects on wildlife | The Ministry understands that Musqueam is concerned with the potential effects of light on wildlife. Lighting design will address safety requirements while still adhering to best management practices to minimize sensory disturbance to terrestrial wildlife. | Addressed in Application | Implementation of mitigation measures outlined in Sections 4.8.4 (Terrestrial Wildlife Mitigation Measures) and 4.10 (Atmospheric Noise) of the Application |
| Potential noise effects on wildlife | The Ministry understands that Musqueam is concerned with the potential effects of noise on wildlife. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. | Addressed in Application | Implementation of mitigation measures outlined in Sections 4.8.4 (Terrestrial Wildlife Mitigation Measures) and 4.10 (Atmospheric Noise) of the Application |
| Potential effects of the bridge structure on species such as mammals, waterfowl and migratory birds, particular concern for the importance of protecting eagles. | The Ministry understands that Musqueam is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) of the Application |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Consideration of the airport in air quality assessment | Vancouver International Airport and Boundary Bay Airport were taken into consideration in the assessment of baseline studies for Air Quality. | Addressed | None |
| RAA is too large to properly measure cumulative effects of “intensified” industrial development on the South Arm of the Fraser River. MIB should be consulted directly regarding necessary boundaries. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Musqueam has not voiced specific concerns regarding Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Musqueam’s access to the Fraser River and the potential to displace fishing vessels.</p> <p>Potential interference with Musqueam fisheries during bridge construction and decommissioning of the Tunnel and the importance of working closely with Musqueam to ensure negative effects are avoided.</p> <p>Potential effects of construction during fishing season on fishing activities and access to the River.</p> <p>Impacts of Tunnel decommissioning on Musqueam fisheries, specifically as it relates to timing.</p> | <p>Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction. Mitigation of these effects will include the development and implementation of a specific MIB marine use protocol through direct consultation with MIB. Further mitigation can be achieved through the development and implementation of a Marine Access Management Plan for inclusion of the CEMP, establishment of communications protocols, appropriate lighting and marking for safe navigation, and establishment of navigation protection zones during construction.</p> <p>The Ministry understands the importance of working closely with Musqueam to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in 5.2.4 (Marine Use Mitigation Measures)</p> |
| <p>Inappropriateness/ inadequacy of marine users group for consultation with Musqueam</p> <p>Marine users group is not an appropriate format to address Musqueam concerns</p> | <p>The Ministry is continuing to work with Musqueam to better understand how they would like to participate in the development and implementation of mitigation measures in particular, in relation to alternatives to a marine users group. The Ministry has requested Musqueam input to ensure Musqueam’s concerns are discussed and addressed in an appropriate manner and looks forward to obtaining Musqueam’s feedback in this regard.</p> | <p>Ongoing</p> | <p>Ongoing consultation. The Ministry anticipates that plans related to Application Review consultation with Musqueam will be defined in the MoU.</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Project will facilitate increased development around the new Bridge and expansion of marina at Deas Slough</p> | <p>The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect overall regional growth trends of current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Impacts of staging/laydown areas. Request that the Ministry provide construction parameters to avoid impacting areas around Project footprint.</p> | <p>The Application has been developed with the assumption that all temporary and permanent works will be included within the Project alignment. Potential staging areas that will be made available to the contractor encompass areas within the highway right-of-way that have been previously developed and disturbed.</p> <p>Any temporary or permanent works that are to take place will be subject to applicable permitting requirements, including <i>Water Sustainability Act</i> permitting and archaeological investigation if required. Applications for these permits will include detailed descriptions and locations of works to take place.</p> <p>If the contractor chooses to develop staging areas on sites other than those identified, site-specific environmental permitting and approvals will be obtained by the contractor.</p> | <p>Addressed</p> | <p>Contractor will obtain permits and approvals as required</p> |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Musqueam has not voiced specific concerns regarding Visual Quality. | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area</p> | <p>The Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Musqueam. Musqueam has been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4 (Heritage Resources Mitigation Measures)</p> |

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Musqueam participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Ongoing | Musqueam will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Ministry's archaeological consultant will not work effectively with Aboriginal Groups based on experience on past projects | The Ministry worked with Musqueam to resolve this concern. | Addressed | None |
| Concern with the involvement of certain Aboriginal groups in archaeological fieldwork for the Project. | Schedule B Aboriginal groups were invited to participate in the archaeological component of the Project. | Addressed | None |

7.0 UMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

7.0 UMAN HEALTH

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.

Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on human health are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Consideration of municipal and regional health plans related to human health | Municipal and regional health plans were considered in the assessment of potential Project-related effects on human health, including community and social factors. | Addressed | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|---|---|---------------|--------------------------------|
| Consultation with Cowichan Nation Alliance identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
| Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommission | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River today. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed | None |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--------------------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Penelakut Tribe's queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Penelakut Tribe to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Penelakut Tribe is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Penelakut Tribe's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Penelakut Tribes as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential impacts to Penelakut Tribe’s title, Rights and culture. Identification of future developments should include potential Penelakut Tribe’s title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Penelakut Tribe’s title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Penelakut Tribe to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Penelakut Tribe and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on λəqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Penelakut Tribe’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Penelakut Tribe’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Penelakut Tribe’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Penelakut Tribe’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| | <p>predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application.</p> | | |
| <p>Protection of Penelakut Tribe’s rights to harvest within the Project area.</p> | <p>Penelakut Tribe’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Penelakut Tribe as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities.</p> | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Penelakut Tribe is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Penelakut Tribe received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Penelakut Tribe as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Penelakut Tribe may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Penelakut Tribe requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed funding agreements with Penelakut Tribe which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Penelakut Tribe received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Penelakut Tribe as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Penelakut Tribe may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Penelakut Tribe requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed funding agreements with Penelakut Tribe which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components
- Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Penelakut Tribe on this matter. | Ongoing | Further engagement with Penelakut Tribe is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Project-related employment, training, contracting, and economic development opportunities.</p> <p>Equity and revenue sharing for Penelakut Tribe and importance of initiating related discussions with Penelakut Tribe during Pre-Application Stage.</p> <p>Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Penelakut Tribe to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Penelakut Tribe wants to prepare its membership for employment opportunities and will work with Penelakut Tribe to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Penelakut Tribe on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |
| <p>Interest in surplus Agricultural Land Reserve (ALR) lands being provided to Penelakut Tribe for creation of a gas station or other businesses</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |
| <p>Penelakut Tribe, must be consulted for any land disposition - specific concern regarding surplus lands being sold to adjacent farmers</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|--|
| Importance of Fraser Richmond Lands/Cowichan Village site to Cowichan Nation Alliance, particularly Penelakut Tribe, and the importance of considering future land recovery in land use and Project planning | Noted | Noted | None |
| City of Richmond’s land use planning process does not consider the Cowichan Nation Alliance’s potential future reclamation of the Fraser Richmond Lands - City of Richmond is working with the Ministry, but not with the Penelakut Tribe with respect to land use planning | Noted. Penelakut Tribe concerns have been referred to the City of Richmond | Addressed | None |
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Penelakut Tribe to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Penelakut Tribe to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Factoring in extreme weather events in River Hydraulics model</p> | <p>Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |
| <p>Effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>The Ministry is following up with Penelakut Tribe to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>Ongoing</p> | <p>Clarification regarding concern</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |
| Improved ditches will result in less filtering of deleterious materials | Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River. | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed in Application | None |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Penelakut Tribe. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

| 4.6 MARINE MAMMALS | | | |
|--|---------------------------|--------|-------------------------|
| <p>Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River.</p> <p>Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.</p> <p><u>Effects</u></p> <p>A negligible effect on the availability of marine mammal resources for traditional use has been determined.</p> <p>A negligible effect on quality of marine mammal resources for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.</p> <p><u>Mitigation</u></p> <p>Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.</p> <p>Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan</p> <p>Monitor underwater noise.</p> <p><u>Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on marine mammals are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Penelakut Tribe has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will be included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Invasive plant species and proposed plans to manage presence during construction</p> | <p>Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4</p> |
| <p>Culturally significant plants should be used in planting plans</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>The Ministry will develop planting plans with consultation from Aboriginal Groups</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Penelakut Tribe is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Penelakut Tribe is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects
 No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation
 Minimize effects through Project design.
 Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.
 Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Penelakut Tribe fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|---|
| Interest in surplus Agricultural Land Reserve (ALR) lands being provided to Penelakut Tribe for creation of a gas station or other businesses | As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation. | Addressed | Determination of surplus lands and consultation |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the ǻǻqtinǻs/TI'uqtinus site and potential archaeological values at interchanges</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Penelakut Tribe.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports</p> | <p>Penelakut Tribe participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed</p> | <p>Penelakut Tribe will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |
| <p>Ethnographical content in reports does not accurately reflect Penelakut Tribe's historical presence within the Project area</p> | <p>The Ministry noted Penelakut Tribe's concern that ethnographical content in Project reports does not accurately reflect Penelakut Tribe's historical presence within the Project area. The Ministry continues to work with Penelakut Tribe to address this concern.</p> | <p>Ongoing</p> | <p>Ongoing consultation</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|-------------------------|
| | Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects. | | |
| New Bridge could “unleash pent-up demand” and create even more congestion | The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing. | Addressed | None |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|-------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project’s EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Stz’uminus First Nation’s queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA’s underway, the Ministry has and will continue to work with Stz’uminus First Nation to support their participation in this particular Project’s review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Stz’uminus First Nation is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--------------------------------------|
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Stz’uminus First Nation’s title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Stz’uminus First Nation as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential impacts to Stz’uminus First Nation’s title, Rights and culture. Identification of future developments should include potential Stz’uminus First Nation’s title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Stz’uminus First Nation’s title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Stz’uminus First Nation’s to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Stz’uminus First Nation and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on Łæqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Stz’uminus First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Stz’uminus First Nation’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Stz’uminus First Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Stz’uminus First Nation’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| | <p>predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application.</p> | | |
| <p>Protection of Stz’uminus First Nation’s rights to harvest within the Project area.</p> | <p>Stz’uminus First Nation’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Stz’uminus First Nation as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities.</p> | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Stz’uminus First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Stz’uminus First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Stz’uminus First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Stz’uminus First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Stz’uminus First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Stz’uminus First Nation which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Stz’uminus First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Stz’uminus First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Stz’uminus First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Stz’uminus First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Stz’uminus First Nation which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Opportunities for cultural recognition and naming</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Stz’uminus First Nation on this matter.</p> | <p>Ongoing</p> | <p>Further engagement with Stz’uminus First Nation is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Stz’uminus First Nation and importance of initiating related discussions with Stz’uminus First Nation during Pre-Application Stage. Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Stz’uminus First Nation to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Stz’uminus First Nation wants to prepare its membership for employment opportunities and will work with Stz’uminus First Nation to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Stz’uminus First Nation on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------|--|
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Stz’uminus First Nation to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Stz’uminus First Nation to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Factoring in extreme weather events in River Hydraulics model</p> | <p>Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers’ Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential effects of run off and drainage | The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Effect of the Tunnel on dissolved oxygen content within the river. | The Ministry is following up with Stz’uminus First Nation to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river. | Ongoing | Clarification regarding concern |
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Improved ditches will result in less filtering of deleterious materials</p> | <p>Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Stz’uminus First Nation. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Stz’uminus First Nation has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Stz’uminus First Nation is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Stz’uminus First Nation is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Stz’uminus First Nation fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Stz’uminus First Nation has not voiced any specific issues or concerns with respect to Land Use | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the Łæqtinəs/Tl’uqtinus site and potential archaeological values at interchanges | Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Stz’uminus First Nation. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1. | Addressed in Application | Implementation of mitigation measures as outlined in Section 6.1.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|---|
| <p>Participation in archaeological fieldwork and review of archaeological draft reports</p> | <p>Stz’uminus First Nation participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed</p> | <p>Stz’uminus First Nation will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |
| <p>Ethnographical content in reports does not accurately reflect Stz’uminus First Nation’s historical presence within the Project area</p> | <p>The Ministry noted Stz’uminus First Nation’s concern that ethnographical content in Project reports does not accurately reflect Stz’uminus First Nation’s historical presence within the Project area. The Ministry continues to work with Stz’uminus First Nation to address this concern.</p> | <p>Ongoing</p> | <p>Ongoing consultation</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

8.0 ACCIDENTS AND MALFUNCTIONS

Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.
 In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| | <p>construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | | |
| <p>New Bridge could “unleash pent-up demand” and create even more congestion</p> | <p>The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing.</p> | <p>Addressed</p> | <p>None</p> |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology. | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------------|--------------------------------|
| Effectiveness of the EAO-led process to address Tsleil-Waututh Nation's concerns. | Concerns related to the effectiveness of the EAO-led process to address Tsleil-Waututh's concerns are outside the scope of the Project and have been referred to EAO. | Referred to EAO | None |
| Inclusion of Economic Effects Assessment as part of EA. | Concerns related to the inclusion of economic effects assessment as part of the EA have been referred to EAO. | Referred to EAO | None |
| Consideration of cultural assessment methodology. | Concerns related to the consideration of cultural assessment methodology have been referred to EAO. | Referred to EAO | None |

ABORIGINAL INTERESTS

There are potential Project related impacts to Tseil-Waututh's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Quality of experience while engaged in or tied to traditional use
- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Tseil-Waututh as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Protection of Tsleil-Waututh Nation’s rights to harvest within the Project area.</p> | <p>Tsleil-Waututh’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Tsleil-Waututh as a result of the Project are not expected.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures</p> |
| <p>Tsleil-Waututh Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Tsleil-Waututh Nation’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Social effects of the Project such as Tsleil-Waututh Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Tsleil-Waututh’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights. • Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental</p> | | |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------|-------------------------|
| <ul style="list-style-type: none"> Absence of a comprehensive study of cumulative effects on the Fraser River | <p>cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> <p>While the Ministry acknowledges that Teleil- Waututh Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Tsleil-Waututh Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Tsleil-Waututh Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Tsleil-Waututh Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Tsleil-Waututh Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Funding for Knowledge Study | The Ministry signed a funding agreement with Tsleil-Waututh Nation which provided funding for a Knowledge Study. | Addressed | None |
| Input into areas for potential habitat enhancement | Request noted. The Ministry will consult with Tsleil-Waututh and other Aboriginal groups. | Noted | Ongoing consultation |
| Importance of working with Tsleil-Waututh in accordance with their stewardship policy | Noted and considered in planning for consultation with Tsleil-Waututh. | Noted | Ongoing consultation |
| Importance in distinction between consultation and information sharing | Importance in distinction between consultation and information sharing was addressed in the Aboriginal Consultation Plan. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will work with Tsleil-Waututh on this matter. | Ongoing | Discussion with Tsleil-Waututh to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities. | The Ministry is committed to working with Tsleil-Waututh to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Tsleil-Waututh to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |
| Revenue sharing opportunities from tolling | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Impact of Project on Deas and Tilbury Sloughs and Duck, Barber and Woodward Island complexes</p> | <p>Deas and Tilbury Sloughs and Duck, Barber and Woodward Island complexes are included in Section 4.1 of the Application.</p> <p>Removal of the Tunnel is not expected to have long term effects on Deas and Tilbury Sloughs and Duck, Barber and Woodward Island complexes.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential effects of run off and drainage - innovative stormwater solutions and bioengineering techniques</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>Water quality and sediment issues: comprehensive understanding of potential ecological impacts and core sampling</p> | <p>Changes in sediment riverbed characteristics that have the potential to affect receptor VCs include changes in sediment composition and organic carbon content, and changes in sediment quality in terms of contaminant concentrations. Similarly, changes in the water column that have the potential to affect receptor VCs include changes in total suspended solids (TSS) and turbidity levels, or changes in ambient water chemistry. Therefore, Project-related study of water and sediment quality was designed to focus on these aspects. A literature review, gap analysis, and field program, as outlined in Table 4.2-1, were undertaken to establish existing conditions, and sediment fate predictions described in Section 4.1 River Hydraulics and River Morphology were used to identify potential Project-related effects of water quality and sediment quality in the Fraser River South Arm, Deas Slough, and Green Slough.</p> | <p>Addressed</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|---|
| Species of salmon | The Ministry will work with the BC Environmental Assessment Office to ensure that the methodology used to support the assessment of environmental values is consistent with current best practice and guidance materials that support the assessment of projects under the BC Environmental Assessment Act. | | |
| Evaluation on impacts to ecological services for all ecosystems within the vicinity of the Project | Pacific salmon species selected for Project-related baseline studies include Chinook salmon, Chum salmon, Coho salmon, Pink salmon, and Sockeye salmon. Using existing scientific and literature, baseline conditions will be described for all life history stages of each salmon species, with emphasis on those life history stages that use aquatic habitats within the Project Area. Fish sampling focused on potential rearing values within drainage ditches in Richmond and Delta, for which limited existing inventory information exists, has been incorporated into the baseline studies. | Addressed | Implementation of mitigation measures outlined in 4.4.4 |
| Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon | Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project- | Addressed | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| | <p>related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | | |
| <p>Disturbance to benthic and aquatic invertebrates and their habitat</p> | <p>Aquatic habitats, which include habitat for fish and other aquatic species (including benthic and aquatic invertebrates), will be a primary area of focus for the environmental assessment of the Project.</p> <p>Potential disturbance to benthic and aquatic invertebrates is not, on its own, proposed as a key area of study given the nature of the project and the aquatic habitats it overlaps with. Aquatic habitats overlapping with the Project occur within a section of the Fraser River that is dynamic, influenced by large flow variations and downstream transport of sand and organic matter. Therefore, aquatic and benthic invertebrate communities in the Project Area are expected to be resilient to physical disturbance. Given the temporary and short-term changes in flow and water quality expected from Project activities, it is anticipated that the benthic and aquatic invertebrates will recover rapidly from disturbance.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.

Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Effects on southern resident killer whales within 10 km of Project area | The Project is not anticipated to affect southern resident killer whales (SRKW). Based on the results of underwater noise modelling completed to date, underwater noise generated by Project-related activities is not predicted to extend outside of the Fraser River, and therefore will not affect SRKW. In addition, studies completed to date also indicate that SRKW prey (i.e., chinook salmon) in the Fraser River is not likely to be affected by the Project at a level that could affect the survival or recovery of SRKW. | Addressed | None |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Tsleil-Waututh is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Tsleil-Waututh is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Wetland assessment (ecological services, productivity and biodiversity), particularly with respect to at-risk amphibians</p> | <p>At-risk amphibians were not detected within the Project alignment during field studies undertaken in 2014 and 2015. The potential for at-risk amphibians to occur within the Project alignment is low. Applying mitigation, including least-risk timing windows, and adherence to standard practices for undertaking in-stream works and highway maintenance activities, will ensure that Project-related effects on at-risk amphibians are addressed.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Table 4.5-6</p> |
| <p>Protection of large mammals including black-tail deer and clarification of WARS on Project area</p> | <p>The Wildlife Accident Reporting System (WARS) contains long-term wildlife-related accident records that provide wildlife data for a range of purposes, including highway planning (Sielecki 2003). Data collected through WARS helps improve understanding of where wildlife mortality is occurring such that measures can be taken to avoid or reduce such mortality. WARS data are primarily collected by highway maintenance crews.</p> <p>Due to previous development in areas directly adjacent to the existing right-of-way, habitat features for deer are absent. As such, large mammals have not been included as a valued component in the environmental assessment for the Project.</p> | <p>Addressed</p> | <p>None</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|----------------------------------|
| Interest in climate change resiliency and a request for review with the Ministry when forms are complete | The Ministry has committed to sharing this information when available | Addressed | Share information when available |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Tseil-Waututh has not voiced any specific issues or concerns with respect to Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential effects of construction during fishing season on fishing activities</p> | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |
| <p>Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing</p> | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewscales.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

Negligible effect on access to upland locations for traditional use

Negligible effect on quality of experience tied to access of upland areas for traditional use.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Impacts of staging/laydown areas. Request that the Ministry provide construction parameters to avoid impacting areas around Project footprint.</p> | <p>The Application has been developed with the assumption that all temporary and permanent works will be included within the Project alignment. Potential staging areas that will be made available to the contractor encompass areas within the highway right-of-way that have been previously developed and disturbed.</p> <p>Any temporary or permanent works that are to take place will be subject to applicable permitting requirements, including <i>Water Sustainability Act</i> permitting and archaeological investigation if required. Applications for these permits will include detailed descriptions and locations of works to take place.</p> <p>If the contractor chooses to develop staging areas on sites other than those identified, site-specific environmental permitting and approvals will be obtained by the contractor.</p> | <p>Addressed</p> | <p>Contractor will obtain permits and approvals as required</p> |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation: A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Tseil-Waututh Nation has not voiced any specific issues or concerns with respect to Visual Quality. | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

During construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation: A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Tseil-Waututh Nation.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports | Tsleil-Waututh Nation participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Tsleil-Waututh Nation will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Request that First Nations permits be obtained before the commencement of archaeological work | First Nations heritage permits were obtained by the archaeologist in advance of work commencing. | Addressed | Obtain permits as required |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improved connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

7.0 HUMAN HEALTH

A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|--|
| Interest in considering methods in addition to barriers, for suicide prevention | The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Tseil-Waututh. Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application. | Addressed in Application | Development of safety barrier policy for new bridges in the Lower Mainland. Implementation of mitigation measures outlined in Section 7.1 |
| Interest in social determinants of health being assessed in the EA Application and Human Health being a VC | Social determinants of health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|--|---|---------------|---|
| Consultation with Tsleil-Waututh Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Consideration of smart technologies in Project design | The Ministry is developing an Intelligent Transportation System Strategy for the Highway 99 corridor as part of the Project scope. Proposed infrastructure includes a fibre optic network connecting the highway to the Regional Transportation Management Centre, cameras providing coverage of the highway, vehicle detection sensors, changeable message signs and additional infrastructure to allow for expansion of the system as new technologies come into use. | Addressed | Development of Intelligent Transportation System Strategy |
| Length of time tolls are in place | The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|-------------------------|
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Consideration of traffic data from other proposed projects or regional studies</p> | <p>As outlined in Section 5.1.9, traffic data from a number of sources was considered.</p> | <p>Addressed</p> | <p>None</p> |

| ENVIRONMENTAL ASSESSMENT PROCESS | | | |
|---|----------------------------------|---------------|--------------------------------|
| <p>An environmental assessment of the Project is required under the B.C. <i>Environmental Assessment Act</i> (B.C. <i>EAA</i>), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. <i>EAA</i> sets out the criteria for reviewable projects.</p> <p>On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. <i>EAA</i>, and that it requires an EAC.</p> <p>The Project as proposed is not subject to review under the <i>Canadian Environmental Assessment Act, 2012</i>, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.</p> <p>EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the <i>Environmental Assessment Act</i>.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Squamish did not voice any issues or concerns regarding the Environmental Assessment Process. | | | |

ABORIGINAL INTERESTS

There are potential Project related impacts to Squamish's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Instream locations (during construction)

Quality of experience while engaged in or tied to traditional use

- cultural landscape
- Instream locations (during construction)

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations (during construction)
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- Fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Protection of Squamish Nation’s right to fish within the Project area.</p> | <p>Squamish’s rights to fish within the Project area is addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.4 (Fish and Fish Habitat), residual effects on the exercise of Aboriginal Interests by Squamish as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Access to the Fraser River and the potential to displace fishing vessels. Squamish gets their food fish from the Project area and is concerned with any impacts that would harm this.</p> | <p>Squamish’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Social effects of the Project such as Squamish Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Squamish’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |

| ABORIGINAL CONSULTATION | | | |
|---|--|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Squamish received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Funding for Project Report | The Ministry signed a funding agreement with Squamish Nation which provided funding for a GMT Project Report. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns.

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes.

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------|--|
| Opportunities for cultural recognition and naming, specifically interpretive signage by highway including road signs and kiosks | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Squamish on this matter. | Ongoing | Discussion with Squamish to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------|--|
| Project-related employment, training, contracting, and economic development opportunities. | The Ministry is committed to working with Squamish to identify potential opportunities to benefit from the. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Squamish to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Change in flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures) |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential effects of run off and drainage - innovative stormwater solutions and bioengineering techniques</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Water quality and sediment issues: comprehensive understanding of potential ecological impacts and core sampling</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. New studies have proven that hard surface runoff from roads will kill salmon within two hours of exposure.</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Squamish. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Evaluation on impacts to ecological services for all ecosystems within the vicinity of the Project</p> | <p>Pacific salmon species selected for Project-related baseline studies include Chinook salmon, Chum salmon, Coho salmon, Pink salmon, and Sockeye salmon. Using existing scientific and literature, baseline conditions will be described for all life history stages of each salmon species, with emphasis on those life history stages that use aquatic habitats within the Project Area. Fish sampling focused on potential rearing values within drainage ditches in Richmond and Delta, for which limited existing inventory information exists, has been incorporated into the baseline studies.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Disturbance to benthic and aquatic invertebrates and their habitat</p> | <p>Aquatic habitats, which include habitat for fish and other aquatic species (including benthic and aquatic invertebrates), will be a primary area of focus for the environmental assessment of the Project.</p> <p>Potential disturbance to benthic and aquatic invertebrates is not, on its own, proposed as a key area of study given the nature of the project and the aquatic habitats it overlaps with. Aquatic habitats overlapping with the Project occur within a section of the Fraser River that is dynamic, influenced by large flow variations and downstream transport of sand and organic matter. Therefore, aquatic and benthic invertebrate communities in the Project Area are expected to be resilient to physical disturbance. Given the temporary and short-term changes in flow and water quality expected from Project activities, it is anticipated that the benthic and aquatic invertebrates will recover rapidly from disturbance.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding Marine Mammals | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|---|
| Use of culturally significant plants in planting plans and importance of obtaining input from Squamish on plant selection | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed in Application | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

- A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

- Minimize potential effects through Project design.
- Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Squamish is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Potential effects of the bridge structure on species such as waterfowl and migratory birds. | The Ministry understands that Squamish is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding the Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on atmospheric noise are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding the Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> | <p>Potential interference with Squamish fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Fishing patterns and practices have adapted to the Tunnel in the riverbed. Removal of the Tunnel would impact these established patterns and practices</p> | <p>As discussed in Section 4.4 (Fish and Fish Habitat) of the Application, potential effects on habitat quality associated with decommissioning of the existing Tunnel are considered negligible. Sensitive life stages of salmonids migrating through or foraging in this section of the river tend to occupy the upper water column, and eulachon spawning habitat is absent near the Tunnel crossing, while sturgeon overwintering habitat will continue to be present after the trench has naturally infilled. As a result, potential Project-related effects associated with fish habitat alteration are not considered further in the assessment.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Squamish has not voiced specific concerns regarding Visual Quality. | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Squamish. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Squamish participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Squamish will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been

7.0 HUMAN HEALTH

determined.
 During operation, a negligible effect on access to instream locations for traditional use has been determined.
 During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.
Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.
Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|-------------------------|
| While many contaminants are expected to remain stable or drop, two specifically are a concern (DFO Canadian Scientific Advisory Report 2015-002, FVRD Highlights of Emission Trends 1990-2013): <ul style="list-style-type: none"> • Diesel particulate matter levels in the FRVD post a health risk for developing cancer at more than 20x the Health Canada acceptable threshold • Acrolein levels in the FVRD poses a risk for non-cancer outcomes more than 15x times the Health Canada threshold | Section 7.0 of the Application includes an assessment of potential Project-related effects on human health. The Human Health Risk Assessment (HHRA) conducted in support of the environmental assessment will include a consideration of air contaminants near Highway 99. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| <p>Scope of pollution testing was one km from work zone. However, increases in traffic from this route will have a long ranging, long term impact through the East to the Fraser Valley. The projection graphs do not predict what the maximum capacity of the route once completed. Is such a projection available to ascertain outcomes?</p> | <p>The future conditions for the Air Quality Assessment used the reference year 2031 to make effective use of the vehicle fleet emissions forecasts set out by Metro Vancouver, and the Regional Transportation Model. Metro Vancouver’s emission inventory was used. Metro Vancouver conducts an emission inventory, and forecasts emissions, and the latest emission forecasting by Metro Vancouver includes emission forecasts to 2031. Forecasting emissions, and resulting air quality, further into the future will have more uncertainty as projections of what future regulations may be implemented and available vehicle technologies for new vehicles built are unknown. Therefore, 2031 represents a conservative projection of what air quality is expected to be like in the future with and without the Project.</p> | <p>Addressed</p> | <p>None</p> |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|--|---|---------------|--------------------------------|
| Consultation with Squamish Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Increased shipping | The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. | Addressed | None |

Note: Concerns listed in this table include those outlined in the GMT Project Impact Study prepared and submitted by Tsawwassen First Nation.

| ENVIRONMENTAL ASSESSMENT PROCESS | | | |
|---|---|-----------------|--------------------------------|
| <p>An environmental assessment of the Project is required under the B.C. <i>Environmental Assessment Act</i> (B.C. <i>EAA</i>), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. <i>EAA</i> sets out the criteria for reviewable projects.</p> <p>On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. <i>EAA</i>, and that it requires an EAC.</p> <p>The Project as proposed is not subject to review under the <i>Canadian Environmental Assessment Act, 2012</i>, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.</p> <p>EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the <i>Environmental Assessment Act</i>.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Project's EA Process and its associated timelines | Concerns relating to the EA process and its associated timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Tsawwassen's queries regarding the EA Process and associated timelines. | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------------|-------------------------|
| <p>Social and cultural effects and the adequacy of EA methodology</p> | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO). Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | <p>Referred to EAO</p> | <p>None</p> |
| <p>Federal government participation in regulatory process. Participation of federal government in Working Group. Request for clarity and certainty with respect to DFO's participation in Project review</p> | <p>The Ministry reviewed the need for a federal review with the federal government. The Project did not meet the Canadian Environmental Assessment Agency (CEAA) requirements for a federal review. Federal agencies, including Environment and Climate Change Canada, are members of the Technical Working Group.</p> | <p>Addressed</p> | <p>None</p> |

| TSAWWASSEN TREATY AND OTHER INTERESTS | | | |
|--|--|---------------------------------|--|
| <p>The Tsawwassen First Nation Final Agreement (TFNFA) secures harvesting rights to the Tsawwassen First Nation in areas located within Tsawwassen Territory, which is defined as the area of land that Tsawwassen First Nation identified in its Statement of Intent to the British Columbia Treaty Commission, and included as a map in Appendix A to the agreement (TFN et al. 2009b). This territory extends from the southern Gulf Islands to the area around Pitt Lake. Rights under the TFNFA are limited by measures necessary for conservation, public health, or public safety (TFN et al. 2009a).</p> <p>The Project area lies within Tsawwassen Territory, and is situated in or near several harvesting areas defined in the TFNFA relating to fishing, wildlife and migratory bird harvesting, and plant gathering (TFN et al. 2009a,b).</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Obligations to Tsawwassen as a Treaty Nation must be recognized and consultation must be undertaken as set out in the Tsawwassen Final Agreement</p> | <p>The Ministry recognizes and respects the obligations to Tsawwassen as a Treaty Nation and will continue to undertake consultation according to the requirements outlined in the Tsawwassen Final Agreement. Potential effects to Tsawwassen treaty rights and other interests are discussed in Part C of the Application.</p> | <p>Ongoing</p> | <p>Ongoing consultation</p> |
| <p>Potential effects to Tsawwassen Fishing Right: Project activities may affect ability of Members to participate in commercial fisheries and/or as participants in the general commercial fishery Direct impacts on fish or fish habitat and impact on water quality could affect fisheries resources Impact on fishing locations Interference or displacement of fishing opportunities within the Project area</p> | <p>The Ministry will work closely with Tsawwassen to ensure negative effects are avoided. Potential interference with Tsawwassen fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Sections 4.4.4 (Fish and Fish Habitat Mitigation Measures) and 5.2.4 (Marine Use Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to Tsawwassen Right to Harvest Wildlife: Spills contaminating habitat, directly killing or poisoning animals. Human presence and activities can lead to safety concerns related to the use of firearms for hunting wildlife resulting in loss of opportunity for TFN Members to exercise treaty rights. Increased wildlife mortality as a result of vehicle collisions and collision with infrastructure. Loss or restriction of harvesting activities over the status quo. Disturbance or displacement of species. Loss or degradation of wildlife habitat.</p> | <p>Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |
| <p>Potential effects to Tsawwassen’s Right to Harvest Migratory Birds: Increased wildlife mortality as a result of vehicle collisions and collision with infrastructure. Loss or restriction of harvesting activities over the status quo. Disturbance or displacement of migratory birds Loss or degradation of bird habitat. Human presence and activities can lead to safety concerns related to the use of firearms for hunting migratory birds resulting in loss of opportunity for members to exercise treaty rights.</p> | <p>Tsawwassen’s rights to harvest terrestrial wildlife within the Project area are addressed in Section 4.8 (Terrestrial Wildlife) of the Application. With the implementation of mitigation measures, residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential effects to Tsawwassen’s Right to Harvest Plants: Changes in river hydrology affecting shorelines, tidal wetlands, mudflats, drainage channel and uplands of the south arm marshes wildlife management area and adjoining areas that may lead to changes impacting members’ ability to gather and use plants. Loss or degradation of plant harvesting areas, including damage by invasive plants. Human activities directly killing biota (collisions, pile driving and dredging). Spills contaminating habitat, directly killing or poisoning plants.</p> | <p>Tsawwassen’s rights to harvest vegetation within the Project area are addressed in Section 4.7 (Vegetation) of the Application. With the implementation of mitigation measures, residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |
| <p>Need for Proponent to understand that Tsawwassen’s Treaty rights are not limited to how the right is currently being exercised. Instead, impacts can include the potential loss of future opportunities for activities that were either not always practiced historically or that may or may not be currently being exercised.</p> | <p>Noted and reflected in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Aboriginal Groups' access to the Fraser River and the potential to displace Aboriginal fishing vessels</p> | <p>Tsawwassen's access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as knowledge transmission, language loss, dependency and social interaction</p> | <p>Social effects of the Project on Tsawwassen's ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| | <p>Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | | |
| <p>Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided</p> | <p>Potential interference with Tsawwassen fisheries during bridge construction and decommissioning of the Tunnel is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. The Ministry understands the importance of working closely with Tsawwassen to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Implementation measures outlined in Section 5.2.4</p> |
| <p>Significant contracting set aside for Aboriginal businesses to compete</p> | <p>The Ministry is committed to working with Tsawwassen to identify potential opportunities to benefit from the Project and is confident that the Project's procurement process will effectively allow this commitment to be met.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Stronger presence of Tsawwassen and Musqueam in the Project area should be reflected in the way the two Nations participate in the work</p> | <p>Noted.</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-----------------------------|
| <p>Importance of professional development and career planning in relation to career opportunities</p> | <p>The Ministry will continue discussions with Aboriginal Groups' regarding employment, training and contracting opportunities in relation to the Project.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Cumulative effects: Consideration of cumulative effects on Aboriginal rights. Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. Absence of a comprehensive study of cumulative effects on the Fraser River</p> | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|--|--------|-------------------------|
| | <p>outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> <p>While the Ministry acknowledges that Tsawwassen is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |

| ABORIGINAL CONSULTATION | | | |
|---|--|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process. | Tsawwassen received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Importance of ensuring appropriate use of information shared by Aboriginal Groups' as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Tsawwassen may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. Subject to the requirements of applicable laws, the Ministry will respect Tsawwassen requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Project Related Study | Tsawwassen received funding for a Project related Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will work with Tsawwassen on this matter. | Ongoing | Discussion with Tsawwassen to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Tsawwassen to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Tsawwassen want to prepare their membership for employment opportunities and will work with Tsawwassen to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |
| Interest in revenue sharing opportunities from tolling | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | | None |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures)</p> |
| <p>Potential effect of removing the Tunnel on marshes along the river</p> | <p>Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary march, that occur in the vicinity of the Project.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures)</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|--|
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity in anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (sediment and water quality mitigation measures</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|---|
| <p>Management of run off from the bridge</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciate change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (sediment and water quality mitigation measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>High volumes of sediment in Canoe Pass caused by project construction.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures)</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | <p>Tsawwassen's rights to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures in Section 4.4 (Fish and Fish Habitat), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | Addressed in Application | Implementation of mitigation measures in Section 4.4 (Fish and Fish Habitat) |
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. Effects of the Project on sturgeon, eulachon, and salmon spawning grounds | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Tsawwassen. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | Addressed | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Effects of lighting on fish | <p>Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | Addressed | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | | <p>Implementation of mitigation measures outlined in 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Accommodation of construction windows for fish cycle spikes (i.e. 4 year sockeye and 2 year pink)</p> | <p>To the extent that is technically feasible and viable, sediment removal will be undertaken between July 16th and February 28th, the least-risk timing window for the protection of juvenile salmon and eulachon.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Requirement for HAAD (Harmful Alteration, Disruption and Destruction) permit</p> | <p>All required permits will be obtained.</p> | <p>Addressed</p> | <p>Obtain required permits</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.6 (Marine Mammals), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected. | Addressed in Application | Implementation of mitigation measures in Section 4.6 (Marine Mammals) |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.
 A negligible effect on quality of vegetation resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.
 Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.
 Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.
 Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.7 (Vegetation), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected. | Addressed in Application | Implementation of mitigation measures in Section 4.7 (Vegetation) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|--|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed | Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures) |
| Use of culturally significant plants in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.
 A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.
 Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.
 Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.
 There is a low, long-term probability of barn owl mortality.
 No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected. | Addressed in Application | Implementation of mitigation measures in Section 4.8 (Terrestrial Wildlife) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------|-------------------------|
| <p>Potential light and noise effects on wildlife</p> | <p>The Ministry understands that Tsawwassen is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | | |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds and bats</p> | <p>The Ministry understands that Tsawwassen is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | | |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| <p>Effects of change in air quality resulting from increase in traffic volume due to the Project</p> | <p>Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience while engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|-------------------------------------|---|-----------|--|
| Potential noise effects on wildlife | The Ministry understands that Tsawwassen is concerned with the potential effects of noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Development and implementation of a specific Tsawwassen First Nation marine use protocol through direct consultation with Tsawwassen First Nation.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-------------|---|
| Potential effects of construction during fishing season on fishing activities | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | Addressed | Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures) |
| Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | Addressed | Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures) |
| Inappropriateness/inadequacy of Marine Users Group for consultation with Tsawwassen | <p>The Ministry is continuing to work with Tsawwassen to better understand how they would like to participate in the development and implementation of mitigation measures in particular, in relation to alternatives to a marine users group.</p> | In progress | Ongoing consultation |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Tsawwassen has not voiced any concerns or issues with Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|---|--|--|--|
| Tsawwassen has not voiced any concerns or issues with Visual Quality. | | | |
|---|--|--|--|

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|--|
| Protection of archaeological and heritage resources, including intangible heritage sites | Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Tsawwassen. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1. | Addressed | Implementation of mitigation measures as outlined in Section 6.1.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Tsawwassen participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Tsawwassen will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During operation, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.

Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Contamination from harvested species will be passed along to members | Assessments of potential Project-related effects on human health are presented in Section 7.1 of the Application. The Ministry is taking every precaution to ensure that vegetation, fish and fish habitat, and terrestrial wildlife are not contaminated. | Addressed in Application | Implementation of mitigation measures outlined in Sections 4.4.4 (Fish and Fish Habitat Mitigation Measures), 4.7.4 (Vegetation Mitigation Measures), 4.8.4 (Terrestrial Wildlife Mitigation Measures), and 7.1 (Human Health) |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|---|--------------------------|--|
| Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur. In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Potential for contamination from fuel and battery acid leaks in soils adjacent to the highway | Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97. Spill prevention and management during construction are described in Section 12 of the Application. | Addressed in Application | Adherence to the Construction Environmental Management Plan and applicable legislation |

| OTHER ISSUES | | | |
|---|---|---------------|--------------------------------|
| Consultation with Tsawwassen identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Maintaining access to points connecting to Tsawwassen, specifically access to Highway 17A | As indicated in the Section 16.1 (Draft Reference Concept), the Project will not impact Tsawwassen access. | Addressed | None |
| Length of time tolls are in place | The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |
| Potential increase in vessel traffic on the Fraser River as a result of the decommissioning of the Tunnel | The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|-------------------------|
| <p>Use and disposal of dredged and other material in the river as well as general concerns related to dredging of the Fraser River</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed</p> | <p>None</p> |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|--------------------------------------|
| In addition to the funding provided by the Proponent, Lyackson First Nation requires funding for participation in EAO's own process. | The Ministry provided funding to Lyackson First Nation for the Pre-Application Phase. Funding for the Application Review Phase will be provided. Funding provided by the proponent is inclusive of EAO-led activities. | Referred to EAO | Funding for Application Review Phase |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associated timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Lyackson's queries regarding the EA Process and associated timelines. | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--------------------------------------|
| Effectiveness and nature of the EA process as well as current volume of EAs underway. | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Lyackson to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Lyackson is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |
| Lack of resources and funding for First Nations communities. "It is like 100 referrals in one spread out over a number of years." | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |
| Strength of Claim assessment and related depth of consultation. Proper context of Village site is not considered nor is the Village site as a trade centre accurately characterized. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Lack of EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessment of VCs that are directly linked to the exercise of those Aboriginal Interests | Concerns relating to the lack of EAO requirement to assess incremental cumulative effects have been referred to EAO. | Referred to EAO | None |

| ABORIGINAL INTERESTS | | | |
|---|--|---------------------------------|---|
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Lyackson First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided. “It is clear that Lyackson First Nation values, particularly those related to subsistence fishing, are likely to be directly impacted by Project construction and operation.”</p> | <p>Lyackson’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Lyackson First Nation’s use of lands, waters, and resources in the area of the mouth and south arm of the Fraser River within 5 km of the Project, including the ancestral village site of the ʔəq̓t̓inəs/TI’uq̓tinus and camps, cabins, and other residences in the area of Steveston and Canoe Pass, are fundamental to past, present, and future Lyackson First Nation use and occupancy, and to the ongoing practice of Lyackson First Nation culture, identity, and rights.</p> | <p>Noted.</p> | <p>Noted.</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Protection of Lyackson First Nation’s rights to harvest within the Project area. | <p>Lyackson’s rights to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.5, residual effects on the exercise of Aboriginal Interests by Lyackson as a result of the Project are not expected.</p> | Addressed in Application | Implementation of measures outlined in Section 10.1.3.5 |
| Consideration of cumulative effects on aboriginal rights | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | Addressed in Application | None |
| Inappropriate toll burden to access Lyackson village site, especially considering the current BC Ferries toll burden. | Noted. | Noted | Ongoing consultation |

ABORIGINAL CONSULTATION

Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.

Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.

In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.

Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Capacity funding to facilitate participation in the Project review process | Lyackson received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Funding for Traditional Use Study | The Ministry signed funding agreements with the members of the Lyackson which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Revenue sharing opportunities from tolling | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|----------------|---|
| <p>Opportunities for cultural recognition and naming. Suggestion that a Canoe be commissioned which would have paddles for each Nation showing the relationship between the Ministry and the Nations.</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Lyackson and other Aboriginal groups on this matter. Lyackson’s suggestion is noted.</p> | <p>Ongoing</p> | <p>Discussion with Aboriginal groups to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage.</p> | <p>The Ministry is committed to working with Lyackson to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Lyackson to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |
| <p>Adequate training time to take full advantage of potential future Project work activities. Opportunities for training related to traditional activities.</p> | <p>The Ministry is committed to working with Lyackson First Nation to identify potential opportunities to benefit from the Project. The Ministry has initiated discussions with Lyackson First Nation regarding Project-related benefits and opportunities.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Potential effect of removing the Tunnel on marshes along the river. “Marshes should be allowed to naturally occur as they are critical habitat for fish for protection for predators, rest and clear water to breathe.”</p> | <p>Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. Creating comparable habitat within the Project alignment will offset unavoidable potential Project-related effect, which is limited to a small reduction in area of the cattail marsh that overlaps with Project components. Vegetation is addressed in Section 4.7 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|---|
| <p>Post decommissioning monitoring of potential effects of Tunnel removal and importance of sharing this information with Aboriginal Groups in writing and through meetings.</p> | <p>Environmental monitoring will be conducted during construction of the Project and will have the key objective of ensuring construction activities are undertaken in accordance with the mitigation described within the Application and EAC, CEMP, and associated permits, licenses, and approvals. The CEMP will describe the frequency and scope of environmental monitoring and reporting that will be implemented throughout construction of the Project. Implementation of the environmental monitoring program will be overseen by a qualified environmental professional and will be carried out during all construction activities that have the potential to result in adverse environmental effects. The environmental monitor will assess the implementation of the CEMP and any permits or approvals assigned to the Project, as well the effectiveness of the mitigation applied. The environmental monitor will be authorized to suspend any activity resulting in or potentially resulting in a breach of the CEMP or associated environmental permits, licenses and approvals.</p> <p>The Ministry will share this information with Lyackson.</p> | <p>Addressed</p> | <p>Environmental monitoring and ongoing information sharing</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | Addressed | Implementation of mitigation measures outlined in Section 4.2.4 |
| Impacts of the River from potential pollutants and contaminants on the Tunnel walls if left in place | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Lyackson. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|--|
| <p>Concern with increased water temperatures in the Fraser River and the importance of opportunities to provide additional shade along the river</p> | <p>The Project will not have any measureable effects on water temperatures within the Fraser River South Arm and there are limited opportunities to provide shade that could moderate water temperature within this wide mainstem channel. More specifically, the Project will extensively avoid any riparian clearing on the river and any shading provided by the new bridge will be negligible. Determined by factors functioning at a watershed-level (e.g., climate and weather), water temperatures within the lower reaches of the river are primarily determined by upstream factors and not notably influenced by riparian shading. Riparian vegetation does, however, also provide a wide range of other fish habitat functions on large river channels like the Fraser River. These fish habitat functions include, but are not limited to shoreline habitat complexity, biofiltration functions, insect drop for food, and detrital inputs which support the broader food web. Although there are limited opportunities to directly affect water temperatures within the mainstem river, the Project’s proposed restoration of Green Slough is anticipated to provide enhanced habitat for fish, including riparian vegetation that will provided shaded habitat for fish.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Fish mortality from pile driving and blasting | The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Fish mortality should not be a significant issue during pile driving. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |
| Effects of pile driving on salmon migration | Pile driving should not have an impact on salmon migration. | Addressed in Application | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |
| Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon | Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River.

Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.

Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Impact on marine mammals such as the Stellar Sea Lion</p> | <p>Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 kms. Standard industry and best management practices will be applied to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to. Marine Mammals are addressed in Section 4.6 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.6.4</p> |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|--|
| <p>Inclusion of culturally significant plants in planting plans and opportunity for Lyackson in the identification of plants, and planting work. Lyackson has the capacity to undertake this type of work.</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>Develop planting plans with consultation from Aboriginal Groups</p> |
| <p>Ministry’s hydro-seeding spray contains invasive grasses that will damage new plants and add to the problem of invasive plants.</p> | <p>The Ministry will review its hydroseed mixes.</p> | <p>Addressed</p> | <p>Review hydro-seed mixes</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Potential light and noise effects on wildlife and fish. | The Ministry understands that Lyackson is concerned with the potential effects of light and noise on species such as waterfowl, owls, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 |
| Potential effects of the bridge structure on species such as waterfowl and migratory birds. | The Ministry understands that Lyackson is concerned with the potential effects of the new bridge structure on species such as waterfowl and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 |
| Destruction of wildlife habitat, especially for bald eagles and blue herons, due to disturbance of green space on Deas Island and other riparian areas in the Project footprint during construction and operation of the Project. | Environmental protection measures that will be implemented during Project construction and operation to prevent of minimize potential effects on vegetation, and thereby potential effects on wildlife habitat, will be outlines in a Construction Environmental Management Plan as described in Section 12.0. The Plan will include a Terrestrial Vegetation and Wildlife Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|-------------------------|
| <p>Decreased quantity of birds, especially migratory waterfowl and eagles, in the Project area due to BC Hydro power lines and other above-ground structures.</p> | <p>As discussed in Section 4.7 (Terrestrial Wildlife), a collision risk study was conducted to understand seasonal use and behaviours by birds, and to estimate collision risk at the new bridge crossing location. The findings of the study indicate that collision effects to birds are considered unlikely and that most birds avoid collisions by flying above or below structures</p> | <p>Addressed in Application</p> | <p>None</p> |
| <p>Potential for impacts to wildlife , including nesting birds, due to increased air contamination from idling vehicles and the running of BC Hydro power lines above ground (as opposed to their current location within the George Massey Tunnel).</p> | <p>As discussed in Section 4.9 (Air Quality), ambient air quality in the vicinity of the Highway 99 corridor is expected to improve in the future, with or without the Project.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>Congestion and air quality issues – support for improved transit and anything that reduces idling.</p> | <p>Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| <p>Increased air contamination from idling vehicles, perceivable from the Fraser River banks, resulting in disturbance of LFN use and potential adverse effects on human and animal health</p> | <p>Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience while engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|--|
| Potential impacts of noise from pile driving and blasting | The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Mitigation in accordance with the Ministry’s 2014 <i>Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways</i> will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.10.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic, and consequent increase in associated noise and vibration due to the increases capacity of the new bridge</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Lyackson fishing.</p> | <p>Potential interference with Lyackson fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Lyackson has not voiced any specific issues or concerns with respect to Land Use. | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Running of BC Hydro power lines above ground (as opposed to their current location within the George Massey Tunnel). | If the BC Hydro's transmission line is built above ground, it is expected that it will visually blend with the bridge structure. | Addressed | None |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites.</p> <p>Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area. No more tolerance for further disturbance of archaeological sites in the overdeveloped Lower Mainland. This includes disturbed and intact sites.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Lyackson.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports.</p> <p>Importance of having a cultural person, known to LCFN and LFN, participate in archaeological work.</p> | <p>Lyackson participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed in Application</p> | <p>Lyackson will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |
| <p>Assessment of cultural significance of the site, if a run off pool is being created for the Project on Deas Island</p> | <p>The cultural significance of Deas Island is noted. The use of biofiltration ponds will provide a benefit by improving the level of treatment of surface runoff from highway 99.</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| New bridge will result in increased suicide attempts | The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Lyackson. Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application. | Addressed in Application | Development of safety barrier policy for new bridges in the Lower Mainland. Implementation of mitigation measures outlined in Section 7.1 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>The potential spread of social problems, including drug and sex trafficking, to more areas in the Lower Mainland due to economic change.</p> <p>Bottleneck at current Tunnel hampers illegal drug traffic - new Bridge will facilitate drug flow.</p> <p>New bridge will create proliferation of prostitution and drugs.</p> <p>Areas under Bridge will attract homeless population. Value added parks will not offset social impacts.</p> | <p>While not assessed as a Value Component in the Application, the potential for “at-risk populations” to use/congregate in areas near the bridge will be considered in Section 7.1 of the Application.</p> | <p>Addressed</p> | <p>None</p> |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Section appears to focus exclusively on the construction phase. Lyackson’s concerns are with the full life cycle - construction, operations, and deconstruction. | Section 8.0 (Accidents and Malfunction) addresses all aspects of the Project including construction, Tunnel decommissioning and operations. During construction and decommissioning, construction personnel will act in accordance with the Emergency Response and Spill Contingency Plan. During operations, accidents and other types of emergencies will be managed in accordance with the Ministry’s Highway Maintenance Specifications for Emergency Maintenance and related standards. | Addressed in Application | Adherence to appropriate plans, specifications and standards. |

| OTHER ISSUES | | | |
|---|---|---------------|--------------------------------|
| Consultation with Lyackson identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|-------------------------|
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed</p> | <p>None</p> |

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of Environment Assessment (EA) methodology. | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|-------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Federal government participation in regulatory process and participation of federal government in Working Group. | Ministry reviewed the need for a federal review with the federal government. The Project did not meet the Canadian Environmental Assessment Agency (CEAA) requirements for a federal review. Federal agencies, including Environment and Climate Change Canada, are members of the Technical Working Group. | Addressed | None |
| Hwlitsum's assignment on Schedule B as a sub-group of Penelakut | Concerns related to Hwlitsum's assignment on Schedule B have been referred to the Environmental Assessment Office (EAO). | Referred to EAO | None |
| Request to be referred to as Hwlitsum First Nation | Hwlitsum's request to be referred to as Hwlitsum First Nation is acknowledged; however, the name is reproduced verbatim from the Section 11 Order. Hwlitsum's point that they have been recognized as a First Nation by government entities, including the BC Treaty Commission, has been added to Aboriginal Consultation Report #2 and to this Issues Summary Table. | Addressed | None |

ABORIGINAL INTERESTS

There are potential Project related impacts to Hwlitsum's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Hwlitsum “is greatly concerned that the Project will negatively impact our ability to fish, hunt and gather as we have done since time immemorial. These practices are central and integral to our Hwlitsum and Coast Salish identity and without them, we are unable to continue to pass on the teachings of generations of our ancestors.”</p> | <p>Hwlitsum’s ability to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections 4.4.4 (Fish and Fish Habitat Mitigation Measures), 4.6.4 (Marine Mammals Mitigation Measures), 4.7.4 (Vegetation Mitigation Measures), and 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |
| <p>Hwlitsum’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Hwlitsum’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Social effects of the Project on knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Hwlitsum’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Protection of Hwlitsum’s rights to harvest within the Project area. Importance of ensuring fish and fish habitat is protected for future generations of Hwlitsum.</p> | <p>Hwlitsum’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline.</p> | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Absence of a comprehensive study of cumulative effects on the Fraser River.</p> | <p>While the Ministry acknowledges that Hwlitsum is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | <p>Addressed</p> | <p>None</p> |

ABORIGINAL CONSULTATION

Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.

Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.

In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.

Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised by Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------|---|
| Capacity funding to facilitate participation in the Project review process. | Hwlitsum received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Hwlitsum as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Hwlitsum may be considered confidential. The Ministry is subject to the provisions of the <i>Freedom of Information and Protection of Privacy Act</i> . However, subject to the requirements of applicable laws, the Ministry will respect Hwlitsum requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Importance of having opportunities for the community to learn about the Project. | The Ministry met with the Hwlitsum community and will continue to work with Hwlitsum in accordance with the Aboriginal Consultation Plan. | Ongoing | Ongoing consultation |
| Traditional Use Study: <ul style="list-style-type: none"> • Funding for Traditional Use Study (TUS). • Amount of funding provided for TUS. | The Ministry signed a funding agreement with Hwlitsum which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Opportunities for cultural recognition and naming. | The Ministry is exploring opportunities for cultural recognition and naming and will work with Hwlitsum on this matter. | Ongoing | Discussions with Hwlitsum to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities. | The Ministry is committed to working with Hwlitsum to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Hwlitsum to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Hwlitsum on the type of information that would be useful. |
| Revenue sharing opportunities from tolling. | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Lack of inclusion of Deas Slough and the stagnant waters east by the rowing club in the river hydraulics and morphology study.</p> | <p>Deas Slough and the stagnant waters east by the rowing club were included in the River Hydraulics and River Morphology study. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed</p> | <p>None</p> |

SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential effects of run off from bridge and tunnel decommissioning</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon.</p> <p>Hwlitsum consider the creation and preservation of habitat for fish and wildlife as a key concern and priority.</p> <p>Hwlitsum have a strong connection to the Project area and to the river and are concerned with any additional impacts on fish and fish habitat.</p> <p>Elders are concerned with habitat loss partly due to “the mismanagement of fisheries by DFO” and expressed concerns related to future generations and practice of traditional activities.</p> <p>“What I say about the loss of these fish, including eulachons, is it is death by a 1000 cuts”</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, and salmon to Hwlitsum and is committed to avoiding or mitigation any potential effects. Fish and Fish Habitat are discussed in Section 4.4</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River.

Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.

Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan

Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Invasive plant species and proposed plans to manage presence during construction.</p> | <p>Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |
| <p>Inclusion of culturally significant plants in planting plans and opportunity for Hwlitsum in the identification of plants, and planting work.</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>The Ministry will develop planting plans with consultation from Aboriginal Groups</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential light and noise effects on wildlife</p> | <p>The Ministry understands that Hwlitsum is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds. Concern with the effects of the Project on species hunted by Hwlitsum such as on ducks and geese</p> | <p>The Ministry understands that Hwlitsum is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds including ducks and geese. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities.</p> <p>Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> | <p>Potential interference with Hwlitsum fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river. “Our concern being a salmon culture is there would be a build-up of ships which makes it impossible for us to fish and puts us in hazardous situations”.</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed in Application</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operations, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Construction Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--------------------------------|
| Interest in the inclusion of a single multi-use pathway. | The Project will include multi-use pathways on both sides of the new bridge, which will provide new and enhanced opportunities for cycling and pedestrians, as well as enhanced connections to community trails and cycling routes for interchange and overpass reconstructions. | Addressed | None |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Visual Quality. | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the ǻǻqtinǻs/Tl'uqtinus site and potential archaeological values at interchanges.</p> | <p>The Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Hwlitsum.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports.</p> | <p>Hwlitsum will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports</p> | <p>Addressed</p> | <p>Hwlitsum will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

7.0 HUMAN HEALTH

A negligible effect on access to instream locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Human Health. | | | |

8.0 ACCIDENTS AND MALFUNCTIONS

Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.

In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|--|
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|---|--|---------------|--|
| Consultation with Hwlitsum identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential for falling snow and ice | The design of the new bridge is similar to the Alex Fraser Bridge, with cable stays on the outside of the span. There are no cables crossing the deck. Snow and ice control measures will be reflected in the bridge design. | Addressed | Inclusion of snow and ice control measures in bridge design. |

APPENDIX C

Cowichan Tribes

1.0 Introduction

Cowichan Tribes engaged directly with the Ministry on the Project and also collectively with *Halalt First Nation, Penelakut Tribe and Stz'uminus First Nation* as member nations of the Cowichan Nation Alliance. *The Ministry provided information and funding directly to Cowichan Tribe.* However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribe represented Cowichan Nation Alliance in correspondence, meetings and fieldwork. As such, Cowichan Nation Alliance is only noted when Cowichan Tribes was not the Cowichan Nation Alliance representative. This overview provides information on consultation with Cowichan Tribes specifically, and with Cowichan Nation Alliance as applicable to Cowichan Tribes.

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Cowichan Tribes.

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Cowichan Nation Alliance, refer to the following sections of Part C:

- Consultation with Cowichan Tribes (**Section 10.1.2.10**);
- Cowichan Tribes community profile (**Section 10.1.1.1**);
- Description of existing Cowichan Tribes Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Cowichan Tribes Aboriginal Interests (**Section 10.1.3.3**);

- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Cowichan Tribes Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of the Aboriginal Interests Assessment for Cowichan Tribes is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Cowichan Tribes Overview Table (**Appendix C2**), which provides detailed information regarding:

- Cowichan Tribes issues and concerns identified to date;
- Identification of effects on VCs and ICs that relate to the assessment of effects on Cowichan Tribes' Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Cowichan Tribes;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Cowichan Tribes and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, EAO held two Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations. Halalt First Nation represented Cowichan Nation Alliance at the first meeting. Halalt First Nation and Cowichan Tribes represented Cowichan Nation Alliance at the second meeting..

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Cowichan Nation Alliance in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence within the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Cowichan Tribes also participated in the completeness review for the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Cowichan Tribes will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Cowichan Tribes in early 2014 in order to identify the nature and scope of Cowichan Tribes' Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Cowichan Tribes. A more detailed discussion is provided under the Cowichan Tribes section in **Section 10.1.2.10 Overview of consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Cowichan Tribes. The Ministry has been working with Cowichan Tribes regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Cowichan Tribes for the preparation and submission of Traditional Use, Traditional Knowledge or other studies. Cowichan Tribes worked with other Cowichan Nation Alliance members and submitted the following traditional use studies:

- *Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015*
- *George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015*

Cowichan Nation Alliance also provided to the Ministry: *Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010.*

The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Cowichan Tribes during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16,

2015 with submission of the Project Description and Key Areas of Study document. The focus of the Initial Consultation Phase was a collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Cowichan Tribes included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Cowichan Tribes;
- Funding for Cowichan Tribes' participation in Project consultation activities and EA process;
- Cowichan Tribes participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, AIR, Heritage Resources Assessment and Aboriginal Consultation Plan;
- Meetings with Cowichan Tribes Chief and Council, staff, consultants, and elders; and
- Response and follow up with Cowichan Tribes regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study document on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Cowichan Tribes included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Cowichan Tribes;
- Funding for Cowichan Tribes' participation in Project consultation activities and EA process;
- Meetings with Cowichan Tribes leadership, staff, consultants, elders and membership and Cowichan Nation Alliance representatives;
- Cowichan Tribes participation in fieldwork;
- Cowichan Tribes participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Cowichan Tribes regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Cowichan Tribes’ concerns, identified through consultation undertaken to-date, are presented in **Appendix C2 Cowichan Tribes Overview Table**. The Ministry’s response to Cowichan Tribes’ key concerns regarding potential impacts on Cowichan Tribes’ Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|--|--|
| <p>Potential impacts to Cowichan Tribes title, Rights and culture.</p> | <p>Potential Project related impacts to Cowichan Tribes title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Cowichan Tribes to ensure any effects are minimized.</p> |
| <p>Aboriginal participation and Project-related opportunities</p> <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Revenue sharing opportunities from tolling • Re-establishment of a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes • Surplus land | <p>The Ministry is committed to working with Cowichan Tribes to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness.</p> <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Cowichan Tribes on these opportunities.</p> <p>The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways.</p> <p>The Ministry notes Cowichan Nation Alliance’s wish to re-establish a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes. The Ministry will continue to consult with Cowichan Nation Alliance on this matter.</p> <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation</p> |

| Concerns Identified to Date | Response |
|---|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Cowichan Tribes and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Process and associated timelines • Strength of Claim Assessment | <p>The Ministry acknowledges the importance of Cowichan Tribes' involvement in the environmental assessment process and is committed to funding Cowichan Tribes' participation in the Initiation Consultation and Application Review phases.</p> <p>Cowichan Tribes' concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects, process and associated timelines are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Concerns relating to the Strength of Claim Assessment have been referred to EAO and MARR.</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Social effects of the Project on Cowichan Tribes' ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Cowichan Tribes' ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Cowichan Tribes and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Cowichan Tribes or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>While the Ministry acknowledges that Cowichan Tribes is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> |

| Concerns Identified to Date | Response |
|--|--|
| <p>Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project, including the decommissioning of the Tunnel, will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> |
| <p>Potential effects on Fraser River flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> |
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile: Cowichan Tribes

Cowichan Tribes is governed by a chief and council with a two-year term under an *Indian Act* electoral system. Cowichan Tribes has a 13-member council, with the current term expiring in December 2017.

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round, Cowichan Tribe's main present-day community is located in Cowichan, on southeast Vancouver Island. The largest First Nation in British Columbia, Cowichan Tribes has 2,455 of its total membership of 4,755 living on reserve. The Project area does not overlap Cowichan Tribes' current or former reserve lands.

Cowichan Tribes is, or has been, affiliated with the Hul'qumi'num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the "Island" dialect of Halkomelem (*Hul'q'umi'num*), and have referred to themselves collectively as *Hul'qumi'num Mustimuhw*.

The Hul'qumi'num Treaty Group member bands collectively assert a core territory or "title lands" and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to "the south arm of the Fraser River, including Canoe Pass, up to and including Douglas Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the Fraser River along Canoe Pass up to Deas Island". This area is subsumed within the broader marine or fishing territory. The core territory of the Hul'qumi'num Treaty Group overlaps the Project area at the Tunnel crossing.

Cowichan Tribes, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia. The territorial maps attached to these agreements typically include areas on the western side of the Strait of Georgia only.

Locations along the South Arm of the Fraser River of importance to Cowichan Tribes, along with the other Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhits'um* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands, including Cowichan Tribes, as

ancestral village and resource sites. A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uqtinus* for residential and/or commercial purposes. Cowichan Nation Alliance's *Tl'uqtinus* claim area is shown in **Section 10.1.3.2 Existing Conditions** in Plate 1: Lands of Tl'uqtinus Claim Area.

3.1 Cowichan Tribes Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Cowichan Tribes' Aboriginal Interests. A more detailed discussion, including sources used, is provided under Cowichan Tribes in **Section 10.1.3.2 Existing Conditions**. In the following summary, specific information on Cowichan Tribe's traditional use has been supplemented with general information on traditional use by Cowichan Nation Alliance and Hul'qumi'num Treaty Group Nation Alliance member First Nations.

3.1.1 General

- Cowichan Tribes has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.
- Cowichan Tribes followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round. The seasonal round is described in Part C.
- Cowichan Tribes has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests.
- A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uqtinus* for residential and/or commercial purposes.

3.1.2 Fishing

- Cowichan Tribes harvested the following species historically on the South Arm of the Fraser River: sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while they were resident on the Fraser River.
- Cowichan Nation Alliance reports that *Tl'uqtinus* was used seasonally for harvesting purposes.

- Areas within the wider Fraser River estuary were also utilized by *Hul'qumi'num*'-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations.
- The Hul'qumi'num Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul'qumi'num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area. The Hul'qumi'num Treaty Group have also reported that government regulations introduced in the same era had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul'qumi'num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century.
- Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO). Access to sockeye for member First Nations is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008. In those years, the specific locations in the South Arm in which member First Nations of the Hul'qumi'num Treaty Group fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River.

3.1.3 Hunting/Trapping

- Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species.
- Along the Fraser River, including Canoe Pass, as well as elsewhere in their collective territory, brant goose, canvasback duck, common merganser, and mallard have been specifically identified as harvested species by Cowichan Tribes, and that this harvesting would have taken place in the fall. Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round.
- The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm. Cowichan Tribes may also have hunted for mountain goat in the mountains of the lower Fraser River. The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area.

- Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted.

3.1.4 Gathering

- Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested.
- Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed. With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees”.
- Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl'uqtinus*, which is currently surrounded by blueberry farms, Cowichan Nation Alliance has raised the potential for their former berry grounds to be re-established.
- Tree species available in the vicinity of the Fraser River and traditionally used by the Cowichan Tribes for manufacturing include crabapple, willow, alder, cottonwood, cedar, spruce, aspen, yew, hemlock, and vine maple.

3.1.5 Archaeology and Cultural Heritage Interests

- Locations along the South Arm of the Fraser River of importance to the Cowichan Nation Alliance in the vicinity of the Project include, but are not limited to, *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhits'um* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites.
- Cowichan Tribes has specifically noted the importance of archaeological site DgRs-17.

3.1.6 Other Related Interests

- Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl'uqtinus*, and given where *Tl'uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. Cowichan Nation Alliance has advised that it is also working to re-establish culturally integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl'uqtinus*.
- The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Cowichan Tribes' Aboriginal Interests, specifically. For a more detailed description, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**

- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.

- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Cowichan Tribes’ exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Cowichan Tribes' Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Cowichan Tribes' Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 8 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect |
|--|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

Species harvested historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Areas within the wider Fraser River estuary were also utilized by *Hul'q'umi'num'*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations. Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO).

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Cowichan Tribes, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Cowichan Tribes during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Cowichan Tribes from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance member First Nations, including Cowichan Tribes, has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Cowichan Tribes. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Cowichan Tribes; therefore, Potential Project-related effects on Cowichan Tribes fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in Section 4.10 Atmospheric Noise are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Cowichan Tribes.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Cowichan Tribes is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Cowichan Tribes' Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Cowichan Nation Alliance reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species. Along the Fraser River, including Canoe Pass, as well as elsewhere in their collective territory, brant goose, canvasback duck, common merganser, and mallard have been specifically identified as harvested species by Cowichan Tribes, and that this harvesting would have taken place in the fall. Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round. The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Cowichan Tribes as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Cowichan Tribes during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Cowichan Tribes from instream construction activities, are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Cowichan Tribes resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Cowichan Tribes. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Cowichan Tribes; therefore, Potential Project-related effects on Cowichan Tribes fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Cowichan Tribes.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Cowichan Tribes is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Cowichan Tribes' Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested. Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed. Tree species available in the vicinity of the Fraser River and traditionally used by the Cowichan Tribes for manufacturing include crabapple, willow, alder, cottonwood, cedar, spruce, aspen, yew, hemlock, and vine maple.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Cowichan Tribes as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Cowichan Tribes during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Cowichan Tribes from instream construction activities, are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance, on behalf of its member First Nations, has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Cowichan Tribes resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Cowichan Tribes; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Cowichan Tribes.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Cowichan Tribes is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Cowichan Tribes' Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Locations along the South Arm of the Fraser River of importance to the Cowichan Nation Alliance in the vicinity of the Project include, but are not limited to, *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhitsu'm* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites.

The proposed Project has the potential to affect Cowichan Tribes' Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Cowichan Tribes' archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Cowichan Tribes' interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Cowichan Tribes' archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Cowichan Tribes' archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Cowichan Tribes' archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Cowichan Tribes' archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-

sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Cowichan Tribes.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Cowichan Tribes (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Cowichan Tribes' Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Cowichan Tribes, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Cowichan Tribes. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.

- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Cowichan Tribes' Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Cowichan Tribes regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan. Residual Effects

With the implementation of mitigation measures identified in Section 10.1.3.4 and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

6.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Cowichan Tribes' Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Cowichan Tribes prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Cowichan Tribes during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Cowichan Tribes during consultations include:

- Potential impacts to Cowichan Tribes title, rights and culture;
- Consideration for future uses should include Cowichan Tribes' plans;
- Aboriginal participation and Project-related opportunities (e.g., potential employment, training, contracting and economic development opportunities);
- Potential effects to air quality, particularly in relation to terrestrial wildlife;

- Effects to fish and fish habitat, and importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon;
- Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities;
- Adequacy of EA methodology to address social and cultural effects;
- EA process and associated timelines;
- Strength of claim;
- Social effects of the Project on Cowichan Tribes' ability to transfer knowledge, language and participate in socio-cultural practices;
- Cumulative effects;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on Fraser River flow rates after Tunnel removal; and
- Potential effects of run off and drainage.

Based on information provided by Cowichan Tribes, Cowichan Nation Alliance and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Cowichan Tribes has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Cowichan Tribes' Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Cowichan Tribes, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Cowichan Tribes regarding proposed measures, management plans, and monitoring programs related to VC and IC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Cowichan Tribes, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--------------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associated timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Cowichan Tribes' queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Cowichan Tribes to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Cowichan Tribes is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--------------------------------------|
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Cowichan Tribes title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
 - Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Cowichan Tribes as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential impacts to Cowichan Tribes title, Rights and culture. Identification of future developments should include potential Cowichan Tribes title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Cowichan Tribes title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Cowichan Tribes to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Cowichan Tribes and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on λəqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Cowichan Tribes access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Cowichan Tribes' access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Cowichan Tribes' knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Cowichan Tribes ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| | <p>predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application.</p> | | |
| <p>Protection of Cowichan Tribes' rights to harvest within the Project area.</p> | <p>Cowichan Tribes' rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Cowichan Tribes as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities.</p> | <p>The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Cowichan Tribes is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Cowichan Tribes received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Cowichan Tribes as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Cowichan Tribes may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Cowichan Tribes requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Cowichan Tribes which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Cowichan Tribes received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Cowichan Tribes as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Cowichan Tribes may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Cowichan Tribes requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Cowichan Tribes which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Opportunities for cultural recognition and naming</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will to work with Cowichan Tribes on this matter.</p> | <p>Ongoing</p> | <p>Further engagement with Cowichan Tribes is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Cowichan Tribes and importance of initiating related discussions with Cowichan Tribes during Pre-Application Stage. Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Cowichan Tribes to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Cowichan Tribes wants to prepare its membership for employment opportunities and will work with Cowichan Tribes to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Cowichan Tribes on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------|--|
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Cowichan Tribes to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Cowichan Tribes to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Change in flow rates after Tunnel removal | The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| | <p>anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | | |
| <p>Factoring in extreme weather events in River Hydraulics model</p> | <p>Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |
| <p>Effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>The Ministry is following up with Cowichan Tribes to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>Ongoing</p> | <p>Clarification regarding concern</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |
| Improved ditches will result in less filtering of deleterious materials | Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River. | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed in Application | None |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Cowichan Tribes. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Cowichan Tribes has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Cowichan Tribes fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewscales.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Cowichan Tribes has not voiced any specific issues or concerns with respect to Land Use | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the ʔəqtinəs/Tl'uqtinus site and potential archaeological values at interchanges</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Cowichan Tribes. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports | Cowichan Tribes participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Cowichan Tribes will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Ethnographical content in reports does not accurately reflect Cowichan Tribes historical presence within the Project area | The Ministry noted Cowichan Tribes concern that ethnographical content in Project reports does not accurately reflect Cowichan Tribes historical presence within the Project area. The Ministry continues to work with Cowichan Tribes to address this concern. | Ongoing | Ongoing consultation |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

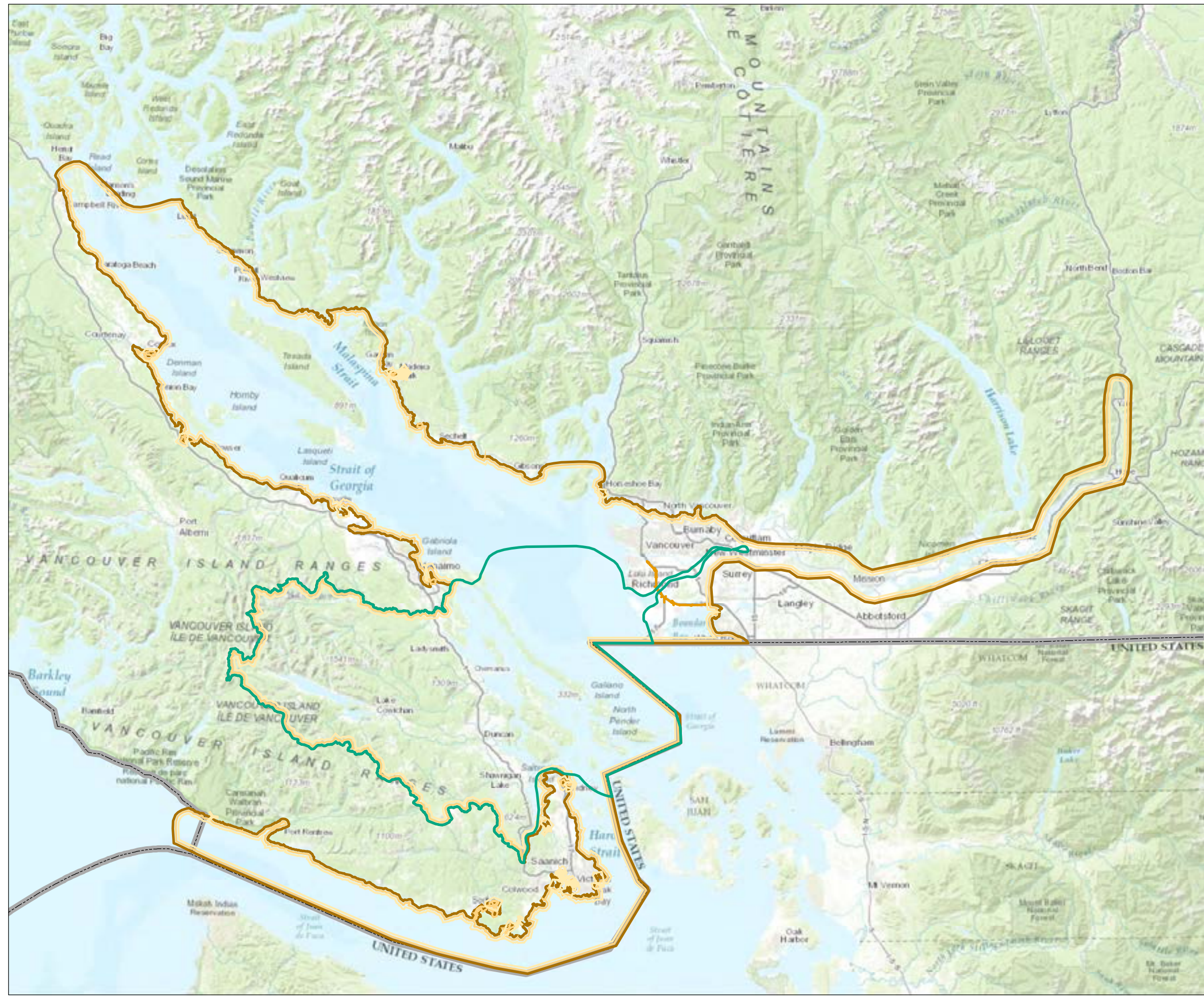
Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| | <p>construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | | |
| <p>New Bridge could “unleash pent-up demand” and create even more congestion</p> | <p>The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing.</p> | <p>Addressed</p> | <p>None</p> |

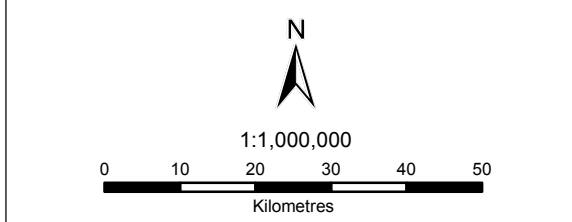
Path: C:\1217-299\285\077\03\mxd\FirstNations\EA\Fig10-2_285_077_03_FirstNations_HuIQ_160517_FINAL.mxd



Legend

-  Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory
-  Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**HUL'QUMI'NUM TREATY GROUP
ASSERTED TRADITIONAL TERRITORY**

| | |
|-------------|------------|
| Figure 10-2 | 26/05/2016 |
|-------------|------------|



APPENDIX D

Halalt First Nation

1.0 Introduction

Halalt First Nation engaged directly with the Ministry on the Project and also collectively with Cowichan Tribes, Penelakut Tribe and Stz'uminus First Nation as member nations of the Cowichan Nation Alliance. The Ministry provided information and funding directly to Halalt First Nation. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribe represented Cowichan Nation Alliance in correspondence, meetings and fieldwork. This overview provides information on consultation with Halalt First Nation specifically, and with Cowichan Nation Alliance as applicable to Halalt First Nation.

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Halalt.

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Halalt, refer to the following sections of Part C:

- Consultation with Halalt (**Section 10.1.2.10**);
- Halalt community profiles (**Section 10.1.1.2**);
- Description of existing Halalt Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Halalt Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Halalt Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of the Aboriginal Interests Assessment for Halalt is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Halalt Overview Table (**Appendix D2**), which provides detailed information regarding:

- Halalt issues and concerns identified to date;
- Identification of effects on VCs and ICs that relate to the assessment of effects on Halalt's Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Halalt;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act (BCEAA)*, that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Halalt and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, EAO held two Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations. Halalt First Nation represented Cowichan Nation Alliance at the first meeting. Halalt First Nation and Cowichan Tribes represented Cowichan Nation Alliance at the second meeting.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Cowichan Nation Alliance in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence within the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Cowichan Nation Alliance participated in the completeness review of the Application for an Environmental Assessment Certificate (Application) that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Halalt will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Halalt in early 2014 in order to identify the nature and scope of Halalt's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Halalt. A more detailed discussion is provided under the Halalt section in **Section 10.1.2.10 Overview of consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Halalt. The Ministry has been working with Halalt regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

- The Ministry provided additional funding to Halalt for the preparation and submission of Traditional Use, Traditional Knowledge or other studies. Halalt worked with other Cowichan Nation Alliance members and submitted the following traditional use studies: *Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015*
- *George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015*

Cowichan Nation Alliance also provided to the Ministry: *Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010.*

The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Halalt during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study document. The focus of

the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Halalt included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Halalt;
- Funding for Halalt's participation in Project consultation activities and EA process;
- Halalt participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, AIR, Heritage Resources Assessment and Aboriginal Consultation Plan;
- Meetings with Halalt Chief and Council, staff, consultants, and elders; and
- Response and follow up with Halalt regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study document on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Halalt included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Halalt;
- Funding for Halalt's participation in Project consultation activities and EA process;
- Meetings with Halalt Chief and Council, staff, consultants, elders and membership and Cowichan Nation Alliance;
- Halalt participation in fieldwork;
- Halalt participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Halalt regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Halalt’s concerns, identified through consultation undertaken to-date, are presented in **Appendix D2 Halalt First Nation Overview Table**. The Ministry’s response to Halalt’s key concerns regarding potential impacts on Halalt’s Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|--|--|
| <p>Potential impacts to Cowichan Nation Alliance title, Rights and culture.</p> | <p>Potential Project related impacts to Cowichan Nation Alliance title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Cowichan Nation Alliance to ensure any effects are minimized.</p> |
| <p>Aboriginal participation and Project-related opportunities</p> <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Revenue sharing opportunities from tolling • Re-establishment of a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes • Surplus land | <p>The Ministry is committed to working with Cowichan Nation Alliance to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness.</p> <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Cowichan Nation Alliance on these opportunities.</p> <p>The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways.</p> <p>The Ministry notes Cowichan Nation Alliance’s wish to re-establish a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes.</p> <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation</p> |

| Concerns Identified to Date | Response |
|---|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Halalt and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat..</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Process and associated timelines • Strength of Claim Assessment | <p>The Ministry acknowledges the importance of Halalt’s involvement in the environmental assessment process and is committed to funding Halalt’s participation in the Initiation Consultation and Application Review phases.</p> <p>Cowichan Nation Alliance’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects, process and associated timelines are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Concerns relating to the Strength of claim Assessment have been referred to EAO and MARR.</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Social effects of the Project on Cowichan Nation Alliance’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Cowichan Nation Alliance’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Cowichan Nation Alliance and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Cowichan Nation Alliance or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. While the Ministry acknowledges that Cowichan Nation Alliance is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> |

| Concerns Identified to Date | Response |
|--|--|
| <p>Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project, including the decommissioning of the Tunnel, will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> |
| <p>Potential effects on Fraser River flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> |
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile: Halalt First Nation

Halalt First Nation is governed by a chief and council with a two-year term under an *Indian Act* electoral system. Halalt has a three-member council, with the current term expiring in April 2017.

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round, Halalt's main present-day community is located in Chemainus on southeast Vancouver Island. Of 212 registered members, 84 live on reserve. The Project area does not overlap any of Halalt's current or former reserve lands.

Halalt is, or has been, affiliated with the Hul'qumi'num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the "Island" dialect of Halkomelem (*Hul'qumi'num*), and have referred to themselves collectively as *Hul'qumi'num Mustimuhw*.

The Hul'qumi'num Treaty Group member bands collectively assert a core territory or "title lands" and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to "the south arm of the Fraser River, including Canoe Pass, up to and including Douglas Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the Fraser River along Canoe Pass up to Deas Island". This area is subsumed within the broader marine or fishing territory. The core territory of the Hul'qumi'num Treaty Group overlaps the Project area at the Tunnel crossing.

Halalt, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia. The territorial maps attached to these agreements typically include areas on the western side of the Strait of Georgia only.

Locations along the South Arm of the Fraser River of importance to Halalt, along with the Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island (CNA 2016), and *Hwlhits'um* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites. A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uqtinus* for residential and/or commercial purposes. Cowichan Nation Alliance's *Tl'uqtinus* claim area is shown in **Section 10.1.3.2 Existing Conditions**.

3.1 Halalt First Nation: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Halalt's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Halalt in **Section 10.1.3.2 Existing Conditions**. In this summary, specific information on Halalt's traditional use has been supplemented with general information on traditional use by Cowichan Nation Alliance and Hul'qumi'num Treaty Group Nation Alliance member First Nations.

3.1.1 General

- Halalt has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.
- Halalt followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round. The seasonal round is described in Part C.
- Halalt has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests.
- A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uqtinus* for residential and/or commercial purposes.

3.1.2 Fishing

- Halalt harvested the following species harvested historically on the South Arm of the Fraser River: sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while they were resident on the Fraser River.
- Cowichan Nation Alliance reports that *Tl'uqtinus* was used seasonally for harvesting purposes, with Halalt reporting that they used the area specifically in July to fish for sockeye and pink salmon.
- Areas within the wider Fraser River estuary were also utilized by *Hul'qumi'num'*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations.

- The Hul'qumi'num Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul'qumi'num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area. The Hul'qumi'num Treaty Group have also reported that government regulations introduced in the same era had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul'qumi'num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century.
- Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO). Access to sockeye for member First Nations is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008. In those years, the specific locations in the South Arm in which member First Nations of the Hul'qumi'num Treaty Group fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River.
- The Hul'qumi'num Fisheries Limited Partnership (HFLP) is a commercial fishing business in which some of the Cowichan Nation Alliance member groups participate (Halalt, Penelakut, and Stz'uminus). Species harvested through this enterprise are crab, prawn, halibut, herring, rockfish, sablefish, and salmon.

3.1.3 Hunting/Trapping

- Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species.
- Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round.
- The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm. The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area.
- Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted.

3.1.4 Gathering

- Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested.
- Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed. With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees”.
- Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl'uqtinus*, which is currently surrounded by blueberry farms, Cowichan Nation Alliance has raised the potential for their former berry grounds to be re-established.

3.1.5 Archaeology and Cultural Heritage Interests

- Locations along the South Arm of the Fraser River of importance to the Halalt in the vicinity of the Project include, but are not limited to, *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island.
- Halalt has specifically noted the importance of archaeological site DgRs-17.

3.1.6 Other Related Interests

- Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl'uqtinus*, and given where *Tl'uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. Cowichan Nation Alliance has advised that it is also working to re-establish culturally integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl'uqtinus*.

- The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Halalt s Aboriginal Interests, specifically. For a more detailed description, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in sections 10.1.3.3 through 10.1.3.5, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|--|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |

| Indicator | Rationale for Selection |
|---|---|
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Halalt's exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Halalt’s Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Halalt’s Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect |
|--|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |

| Indicator | Potential Project-Related Effect |
|--|---|
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

Halalt harvested the following s historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while resident on the Fraser River. Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations. Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO).

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Halalt, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Halalt during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Halalt from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Halalt. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Halalt; therefore, Potential Project-related effects on Halalt fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in in Section 4.10 Atmospheric Noise are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Halalt.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Halalt is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Halalt's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Cowichan Nation Alliance reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species. Along the Fraser River, including Canoe Pass, as well as elsewhere in their collective territory, brant goose, canvasback

duck, common merganser, and mallard have been specifically identified as harvested species by Cowichan Tribes, and that this harvesting would have taken place in the fall. Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round. The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Halalt as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Halalt during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Halalt from instream construction activities, are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Halalt resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Halalt. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Halalt; therefore, Potential Project-related effects on Halalt fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Halalt.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Halalt is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Halalt's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested. Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed. Tree species available in the vicinity of the Fraser River and traditionally used by the Cowichan Tribes for manufacturing include crabapple, willow, alder, cottonwood, cedar, spruce, aspen, yew, hemlock, and vine maple.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Halalt as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Halalt during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Halalt from instream construction activities, are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Halalt resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Halalt; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Halalt.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Halalt is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Halalt's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Locations along the South Arm of the Fraser River of importance to the Halalt in the vicinity of the Project include, but are not limited to, *Ti'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhitsu'm* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites.

The proposed Project has the potential to affect Cowichan Nation Alliance's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Halalt's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Halalt's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Halalt's archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in

this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Halalt's archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Halalt's archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Halalt's archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Halalt.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Halalt (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Halalt's Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Halalt, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Halalt. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Potential effects to air quality, particularly in relation to terrestrial wildlife.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Halalt's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Halalt regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in Section 10.1.3.4 and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Halalt's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Halalt prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Halalt during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Halalt during consultations include:

- Potential impacts to Halalt title, rights and culture;
- Consideration for future uses should include Halalt's plans;
- Aboriginal participation and Project-related opportunities (e.g., potential employment, training, contracting and economic development opportunities);
- Effects to fish and fish habitat, and importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon;
- Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities;
- Adequacy of EA methodology to address social and cultural effects;
- EA process and associated timelines;
- Strength of claim;
- Social effects of the Project on Halalt's ability to transfer knowledge, language and participate in socio-cultural practices;
- Cumulative effects;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on Fraser River flow rates after Tunnel removal; and
- Potential effects of run off and drainage.

Based on information provided by Halalt and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Halalt has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Halalt's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Halalt, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Halalt regarding proposed measures, management plans, and monitoring programs related to VC and IC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Halalt, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--------------------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Halat First Nations's queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Halalt First Nation to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Halalt First Nation is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Halalt First Nation title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Halalt First Nation as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential impacts to Halalt First Nation title, Rights and culture. Identification of future developments should include potential Halalt First Nation title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Halalt First Nation title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Halalt First Nation to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Halalt First Nation and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on Łæqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Halalt First Nation access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Halalt First Nation’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Halalt First Nation knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Halalt First Nation’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| | available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application. | | |
| Protection of Halalt First Nation's rights to harvest within the Project area. | Halalt First Nation's rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Halalt First Nation as a result of the Project are not expected. | Addressed in Application | Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4 |
| Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. | The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Halalt First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Halalt First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Halalt First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Halalt First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Halalt First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Halalt First Nation which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Halalt First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Halalt First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Halalt First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Halalt First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed funding agreements with Halalt First Nation which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Opportunities for cultural recognition and naming</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will to work with Halalt First Nation on this matter.</p> | <p>Ongoing</p> | <p>Further engagement with Halalt First Nation is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Halalt First Nation and importance of initiating related discussions with Halalt First Nation during Pre-Application Stage. Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Halalt First Nation to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Halalt First Nation wants to prepare its membership for employment opportunities and will work with Halalt First Nation to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Halalt First Nation on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------|--|
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Halalt First Nation to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Halalt First Nation to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Change in flow rates after Tunnel removal | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 |
| Factoring in extreme weather events in River Hydraulics model | Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Effect of the Tunnel on dissolved oxygen content within the river. | <p>The Ministry is following up with Halalt First Nation to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river.</p> | Ongoing | Clarification regarding concern |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |
| Improved ditches will result in less filtering of deleterious materials | Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River. | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed in Application | None |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Halalt First Nation. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Halalt First Nation has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Halalt First Nation is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Halalt First Nation is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Halalt First Nation fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Halalt First Nation has not voiced any specific issues or concerns with respect to Land Use | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the ǻǻqtinǻs/TI'uqtinus site and potential archaeological values at interchanges</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Halalt First Nation.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports</p> | <p>Halalt First Nation was invited to participate in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed</p> | <p>Halalt First Nation will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |
| <p>Ethnographical content in reports does not accurately reflect Halalt First Nation historical presence within the Project area</p> | <p>The Ministry noted Halalt First Nation concern that ethnographical content in Project reports does not accurately reflect Halalt First Nation historical presence within the Project area. The Ministry continues to work with Halalt First Nation to address this concern.</p> | <p>Ongoing</p> | <p>Ongoing consultation</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

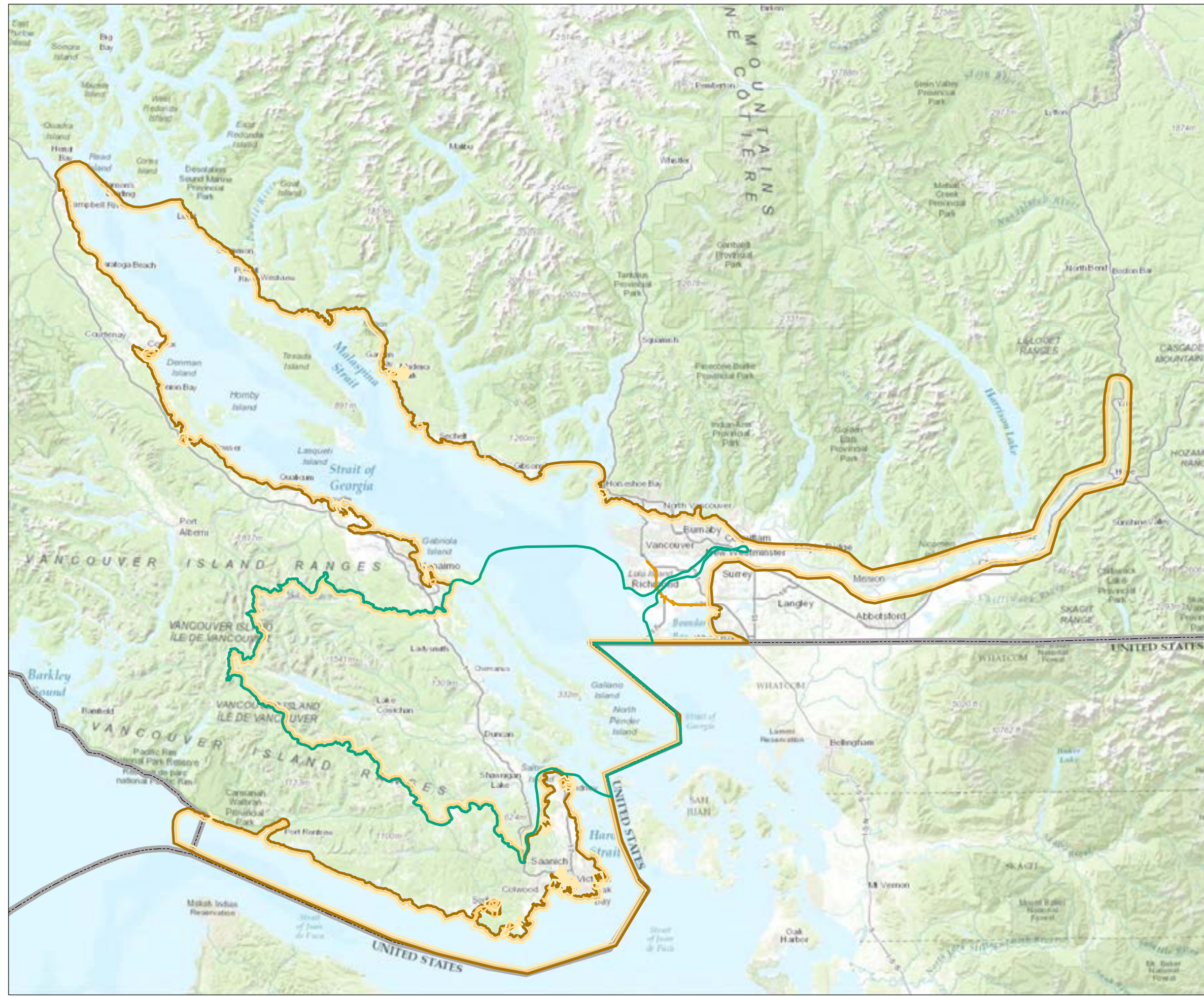
Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|-------------------------|
| | Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects. | | |
| New Bridge could “unleash pent-up demand” and create even more congestion | The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing. | Addressed | None |

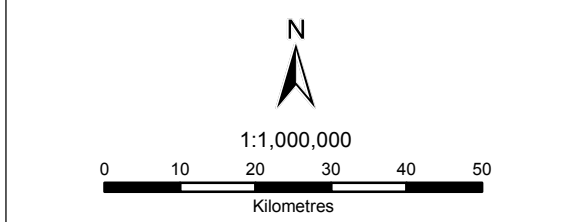
Path: C:\1217-299\285\077\03\mxd\FirstNations\EA\Fig10-2_285_077_03_FirstNations_HuIQ_160517_FINAL.mxd



Legend

-  Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory
-  Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**HUL'QUMI'NUM TREATY GROUP
ASSERTED TRADITIONAL TERRITORY**

| | |
|-------------|------------|
| Figure 10-2 | 26/05/2016 |
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APPENDIX E

Katzie First Nation

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Katzie First Nation (Katzie).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Katzie, refer to the following sections of Part C:

- Consultation with Katzie (**Section 10.1.2.10**);
- Katzie community profile (**Section 10.1.1.3**);
- Description of existing Katzie Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Katzie Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Katzie Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of Aboriginal Interests Assessment for Katzie is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Katzie Overview Table (**Appendix E2**), which provides detailed information regarding:

- Katzie’s issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Katzie’s Aboriginal Interests;
- The Ministry’s response to specific issues and concerns raised by Katzie;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry’s provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Katzie and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, EAO led two Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations. Although Katzie did not attend, materials were provided.

Katzie also participated in the completeness review of Application for an Environmental Assessment Certificate (Application) that considered whether the Application included information requirements set out in the Application Information Requirements.

It is assumed that Katzie will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Katzie in early 2014 in order to identify the nature and scope of Katzie's Aboriginal Interests and how they might be affected by the Project. Following is a summary of consultation activities led by the Ministry with Katzie. A more detailed discussion is provided under the Katzie section in **Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Funding for traditional use, traditional knowledge and other studies;
- Examples of consultation activities; and
- Concerns identified to date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Katzie. The Ministry has been working with Katzie regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during this phase include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Katzie for the preparation and submission of the traditional use study: *George Massey Tunnel Replacement: Katzie First Nation Traditional Use Study*. The purpose of such studies is to include and consider Aboriginal input and traditional knowledge in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Katzie during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities – The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of Project Description and Key Areas of Study document. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Katzie included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Katzie;
- Funding for Katzie's participation in Project consultation activities and EA process;
- Katzie participation in field studies;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment, AIR and Aboriginal Consultation Plan;
- Meetings with Katzie leadership, staff, consultants, elders and membership; and
- Response and follow up with Katzie regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities – The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study document and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Katzie included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Katzie;
- Funding for Katzie's participation in Project consultation activities and EA process;
- Meetings with Katzie leadership, staff, consultants, elders and membership;
- Katzie participation in fieldwork;
- Katzie participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Katzie regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Katzie’s concerns, identified through consultation undertaken to-date, are presented in **Appendix E2 Katzie First Nation Overview Table**. The Ministry’s response to Katzie’s key concerns regarding potential impacts on Katzie’s Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|--|---|
| Protection of Kwantlen First Nation’s rights to harvest within the Project area. | Kwantlen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Kwantlen as a result of the Project are not expected. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Cultural recognition and naming | The Ministry is committed to working with Kwantlen to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Kwantlen on these opportunities. |
| Ministry’s approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups | The Ministry is confident that the Project’s procurement process will effectively allow for benefits to be provided to Aboriginal Groups. |

| Concerns Identified to Date | Response |
|---|---|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Kwantlen and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat.</p> <p>Kwantlen’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 Atmospheric Noise, sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Kwantlen’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined. Mitigation measures are outlined in Section 5.2.4 (Marine Use Mitigation Measures) of the Application.</p> |

| Concerns Identified to Date | Response |
|---|--|
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effect | <p>The Ministry acknowledges the importance of Kwantlen’s involvement in the environmental assessment process.</p> <p>Kwantlen’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects underway is outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> |
| <p>Social effects of the Project on Kwantlen’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Kwantlen’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Katzie or through available public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |
| <p>Potential effects on Fraser River flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> |

| Concerns Identified to Date | Response |
|---|--|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation.</p> <p>During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.</p> <p>Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will ensure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile – Katzie First Nation

Katzie is governed by a chief and council with two-year terms under a custom electoral system. The current term for the four-member council expires in March 2018.

The main Katzie community resides on Katzie IR 1, on the north bank of the Fraser River, west of Port Hammond, and south of the town of Pitt Meadows. Katzie has four other reserves: Katzie IR 2, on the south bank of the Fraser River, upstream of Katzie IR 1 and opposite Port Hammond; Barnston Island IR 3, on the south shore of Barnston Island, which lies within the Fraser River; Pitt Lake IR 4, at the lower end of Pitt Lake; and Graveyard 5, the Katzie cemetery south of Lougheed Highway. Of 570 registered Katzie members, 315 live on reserve. Katzie is working toward finalizing a land code that would apply to Katzie reserve lands pursuant to the federal *Framework Agreement on First Nation Land Management* and the *First Nations Land Management Act*. The Project area does not overlap any current or former Katzie reserve lands.

Katzie describe their traditional territory as “extending south from the headwaters of the Pitt River to encompass Pitt Lake, Pitt Polder, a portion of the Fraser River, and south east to encompass the Nicomekl and Serpentine Rivers”. In the east, this territory takes in Alouette Lake, Rolley Lake, portions of Fort Langley and Hazelmere, while in the west, the territory follows the height of land north along the mountain range through Pinecone-Burke Mountain Provincial Park to encompass all tributaries of the Pitt River system. The Project area overlaps the southwestern portion of Katzie territory.

3.1 Katzie Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Katzie’s Aboriginal Interests. A more detailed discussion, including sources used, is provided under Katzie First Nation in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- Katzie has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes the Fraser River and other waterways within the Fraser River estuary, including the Nicomekl and Serpentine rivers. Katzie has identified past and ongoing effects that have altered and reduced use over time.

3.1.2 Fishing

- Freshwater clams, Eulachon, sturgeon, sockeye, and dog salmon were fished historically by Katzie in their traditional territory. Sockeye is described as Katzie's most valuable resource.
- Fishing remains central to Katzie. Of the 570 registered members of Katzie, roughly one third of those members is reportedly licenced to fish during openings on the Fraser River. An estimated 120 Katzie vessels use the Fraser River to harvest fish annually. Their fishing area is in the vicinity of their communities.
- Since 2004, Katzie appear to have been licenced to fish in this area for Chinook, sockeye, and chum salmon, steelhead, and eulachon, as well as for chum salmon specifically in the Pitt River, although the targeted species, timing, and frequency have varied year over year.

3.1.3 Hunting/Trapping

- Deer, elk, mountain goat, black bear, some smaller fur-bearing animals (e.g., beaver, marten, mink, raccoon), seals, and waterfowl have been identified by Katzie as hunted in the past.
- Katzie reports that they now have limited areas over which they can still hunt and discharge firearms given land development in their territory. While they still harvest waterfowl on Barnston Island, they currently hunt only on the north and east aspects of the island, having voluntarily stopped the practice on the south side to limit public concerns.

3.1.4 Gathering

- Summer harvest of roots and berries were important for the provision of nutritional and cultural sustenance for Katzie. Harvesting of plants was not restricted to the summer months, often also occurring in fall.
- Seasonally flooded lands in Katzie territory provided them with an abundance of bogs and marsh plants; two of the most important were the cranberry and wapato. Cranberry harvesting areas included the mouth of the Alouette River, around Sturgeon Slough, and at Widgeon Creek. Wapato was reportedly harvested on the flats north of Sturgeon Slough and around Siwash Island on the west bank of Pitt River.
- Other plants identified as traditionally harvested by Katzie include, but are not limited to, bog blueberries, strawberries, salmonberries, blackberries, blackcaps, thimbleberries, red and blue huckleberries, Saskatoons, salal-berries, the fruit of the crab-apple, oso plum, and black haw.
- Katzie reports that they also gathered cedar bark for use in manufacturing clothes and other household items.

3.1.5 Archaeology and Cultural Heritage Interests

- Katzie has previously said that the practice of traditional use, including use and activity areas, spiritual and ceremonial sites, named locations, and cultural landmarks, are all considered to be, in addition to archaeological sites, part of Katzie cultural heritage.
- Katzie has described their landscape as sacred, and the role of harvesting resources within this territory as an important means of strengthening family relations and transmitting knowledge and values to new generations. Katzie has remarked that, as access to their territory declines, each opportunity to continue practicing traditional activities becomes even more significant.

3.1.6 Other Related Interests

Other related interests were not identified for Katzie in the sources reviewed.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Katzie's Aboriginal Interests, specifically. For a more detailed description, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in sections 10.1.3.3 through 10.1.3.5, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in Section 3.0 Assessment Methodology.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.

- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Katzie’s exercise of Aboriginal Interests, during construction and operation phases, remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Katzie's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Katzie's Aboriginal Interests as summarized in Existing Conditions were identified for construction and operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects (Construction and Operation Phases)

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Project Construction | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |
| Project Operation | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |

4.5 Fishing

According to Katzie, sockeye is considered their most valuable resource. Katzie also report harvesting clams, eulachon, sturgeon, and dog salmon historically in their traditional territory. Fishing remains central to Katzie, and they report a large proportion of members fish annually in the vicinity of their communities.

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Katzie, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Katzie during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Katzie from instream construction activities are expected to be negligible. While it is acknowledged that Katzie has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Katzie. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Katzie; therefore, Potential Project-related effects on Katzie fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in Section 4.10 Atmospheric Noise are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Katzie.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Katzie is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Katzie's Aboriginal Interests related to fishing are proposed in Section 10.1.3.4 and summarized below under Mitigation.

4.6 Hunting/Trapping

Katzie reports harvesting a range of wildlife species, including large mammals such as deer and elk, some smaller fur-bearing animals, seals, and waterfowl in the past. Katzie reports that they now have limited areas over which they can still hunt and discharge firearms given land development in their territory.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Katzie as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Katzie during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Katzie from instream construction activities, are expected to be negligible. While it is acknowledged that Katzie has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Katzie resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Katzie. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Katzie; therefore, Potential Project-related effects on Katzie fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations, that overlap or are in proximity to known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Katzie.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Katzie is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Katzie's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Katzie reports gathering of plants throughout summer and fall. Plants harvested included wapato, a variety of berries and tree fruits and roots for sustenance. Katzie also reports that they also gathered cedar bark for use in manufacturing clothes and other household items.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Katzie as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Katzie during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Katzie from instream construction activities, are expected to be negligible. While it is acknowledged that Katzie has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Katzie resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Katzie; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap or are in proximity to known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Katzie.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Katzie is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Katzie's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Katzie reports that archaeological sites and the practice of traditional use, including use and activity areas, spiritual and ceremonial sites, named locations, and cultural landmarks, are part of Katzie cultural heritage. Katzie has described their landscape as sacred, and the role of harvesting resources within this territory as an important means of strengthening family relations and transmitting knowledge and values to new generations.

The proposed Project has the potential to affect Katzie's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Katzie's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Katzie's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Katzie's archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Katzie has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Katzie's archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works are within the existing Highway 99 right of way and not expected to overlap with locations related to Katzie's archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Katzie’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Katzie.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Katzie (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Katzie’s Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Katzie, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Katzie. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.

- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Katzie's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Katzie regarding proposed measures, management plans, and monitoring programs related to IC and VC assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in Section 10.1.3.4 and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Katzie's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Katzie prior to the submission of the Project Description and Key Study Areas which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Katzie during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Katzie during consultations include:

- Potential impacts to Katzie First Nation Aboriginal Interests during construction and demolition.

- Capacity funding for Traditional Use Study and to facilitate participation in the Project review process;
- Protection of archaeological and heritage resources and opportunities for cultural recognition and naming;
- Aboriginal participation and Project-related opportunities;
- Effects to fish and fish habitat and Katzie First Nation's access to the Fraser River and the potential to displace fishing vessels;
- Cumulative effects;
- Adequacy of Environmental Assessment (EA) methodology to address social and cultural effects;
- EA Process for the Project and its associated timelines;
- Social effects of the Project on Katzie's ability to transfer knowledge, language and participate in socio-cultural practices;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on flow rates after Tunnel removal;
- Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge;
- Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations;
- Potential for public safety concerns related to Ice and snow interaction with cable stays crossing the bridge deck and need for appropriate safety/suicide fencing.
- Potential effects of the bridge structure, laydown area, lighting, and noise on terrestrial wildlife, waterfowl, and migratory birds; and
- Inclusion of culturally significant plants in planting plans and opportunity for Katzie in the identification of plants, and planting work. Need for management of invasive plant species.

Based on information provided by Katzie and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Katzie's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in Section 10.1.3.3 and Section 10.1.3.4, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Katzie First Nation, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Katzie regarding proposed measures, management plans, and monitoring programs related to IC and VC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Katzie, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of Environmental Assessment (EA) methodology. | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|--------------------------------------|
| Inclusion in Environmental Assessment Office (EAO) process ensures that Katzie First Nation concerns are addressed. | Noted. | Noted | None |
| Project's EA Process and its associated timelines. Effectiveness and nature of the EA process as well as current volume of EAs underway, | Concerns relating to the EA process and its associated timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Katzie's queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Katzie title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- Fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

- Quality of experience while engaged in or tied to traditional use
- Changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
 - Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Katzie as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|---|
| <p>Potential impacts to Katzie First Nation title, Rights and culture</p> | <p>Potential Project related impacts to Katzie title, Rights and culture, the level of effect predicted, and mitigation measures are outlined in the Application. The Ministry will continue to meet with Katzie to ensure any effects are minimized.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures</p> |
| <p>Cumulative effects: Consideration of cumulative effects on Aboriginal rights. Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. Absence of a comprehensive study of cumulative effects on the Fraser River</p> | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual)</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------|-------------------------|
| | <p>cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. While the Ministry acknowledges that Katzie First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |
| <p>“Any work approval within the Katzie First Nation traditional territory is without prejudice to any positions that may be taken by the Katzie First Nation in any litigation or negotiation (including treaty negotiations) and is not intended to define, create, recognize, deny or amend any aboriginal or treaty right within the meaning of sections 25 and 35 of the Constitution Act, 1982.”</p> | <p>Noted</p> | <p>Noted</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Katzie First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Katzie’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Construction and demolition of structures within the Katzie First Nation traditional territory must not impact the ability of community members to participate in traditional activities on the land and water, specifically fishing in and around the Project area.</p> | <p>Katzie’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.X, residual effects on the exercise of Aboriginal Interests by Katzie as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Katzie First Nation requires the joint development of construction and demolition operations and mitigation plans to address this specific issue during the summer and fall fishing season.</p> | <p>The Ministry will consult with Aboriginal Groups in the development of Construction Environmental Management, Construction Traffic Management, Marine Access Management, Health and Safety, and Operation Environmental Management plans.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Adequacy of standard social and cultural impact assessment demonstrating Katzie’s use, occupancy, ties and attachment, and changes to cultural landscapes.</p> | <p>Social effects of the Project on Katzie’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Protection of Katzie First Nation’s rights to harvest within the Project area.</p> | <p>Katzie’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Katzie as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process. | Katzie received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Katzie First Nation as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Katzie may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Katzie requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed funding agreements with Katzie which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------|--|
| Opportunities for cultural recognition and naming. | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Katzie on this matter. | Ongoing | Discussion with Katzie to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Project-related employment, training, contracting, and economic development opportunities.</p> <p>Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage.</p> | <p>The Ministry is committed to working with Katzie to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Katzie to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |
| <p>The Ministry's approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups.</p> | <p>The Ministry is confident that the process will effectively allow for benefits to be provided to Aboriginal Groups.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Interest in revenue sharing opportunities from tolling</p> | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. In accordance with the provincial tolling strategy, revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways.</p> | <p>Addressed</p> | <p>None</p> |

4.1 RIVER HYDRALICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Change in flow rates after Tunnel removal. | The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 |

SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such a turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential effects of run off and drainage. | The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity in anticipated. No | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|-------------------------|
| | <p>appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | | |
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Potential effects to fish and fish habitat and spawning grounds, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, and salmon to Katzie and is committed to avoiding or mitigation any potential effects. Fish and Fish Habitat are discussed in Section 4.4. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures) of the Application |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Inclusion of mud sharks in baseline studies. | Fish species included in baseline studies were selected based on presence (or potential presence) in the study area and their potential for interaction with the Project. Mud sharks (spiny dogfish) are not known to frequent the Project area. | Addressed | None |
| Fish mortality from pile driving and blasting. | The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Fish mortality should not be a significant issue during pile driving. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Effects of pile driving on salmon migration. | The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Pile driving should not impact salmon migration. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 (Underwater Noise) and 4.4 (Fish and Fish Habitat).</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|--|
| Invasive plant species and proposed plans to manage presence during construction. | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------|---|
| Inclusion of culturally significant plants in planting plans and opportunity for Katzie in the identification of plants, and planting work. Katzie has the capacity to undertake this type of work. | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|---|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Katzie Alliance is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 (Terrestrial Wildlife) of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Katzie is concerned with the potential effects of the new bridge on species such as waterfowl and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highway will mitigate potential Project-related increase in traffic collision risk. Nesting opportunity provided by the new bridge will offset the loss of nesting habitat due to removal of the Deas Slough Bridge. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 (Terrestrial Wildlife) of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Impact of laydown areas on terrestrial wildlife.</p> | <p>The Application has been developed with the assumption that all temporary and permanent works will be included within the Project alignment. Potential staging areas that will be made available to the contractor encompass areas within the highway right-of-way that have been previously developed and disturbed.</p> <p>Any temporary or permanent works that are to take place will be subject to applicable permitting requirements, including Water Sustainability Act permitting. Applications for these permits will include detailed descriptions and locations of works to take place.</p> <p>If the contractor chooses to develop staging areas on sites other than those identified, site specific environmental permitting and approvals will be obtained by the contractor.</p> | <p>Addressed</p> | <p>Obtain site specific environmental permits and approvals</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|---|
| Potential impacts of noise from pile driving and blasting. | Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application. | Addressed | Implementation of mitigation measures as outlined in Section 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential effects of construction during fishing season on fishing activities.</p> | <p>Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction. Mitigation of these effects will include the development and implementation of a specific Katzie marine use protocol through direct consultation with Katzie. Further mitigation can be achieved through the development and implementation of a Marine Access Management Plan for inclusion of the CEMP, establishment of communications protocols, appropriate lighting and marking for safe navigation, and establishment of navigation protection zones during construction.</p> <p>The Ministry understands the importance of working closely with Katzie to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in 5.2.4 (Marine Use Mitigation Measures)</p> |
| <p>Effects of construction and decommissioning-related barging activities on Katzie First Nation fishing activities and on the test fishery.</p> | <p>Potential interference with Katzie fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|-----------------------------|
| <p>Katzie First Nation requires the joint development of construction and demolition operations and mitigation plans to address this specific concern during the summer and fall fishing seasons.</p> | <p>The Ministry understands the significance of fish and fish habitat to Katzie. The Ministry is committed to further discussions with Katzie regarding the Development of a Construction Environmental Management and a Marine Access Management Plan. Fish and Fish Habitat are discussed in Section 4.4.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Facilitation of barges and larger vessels in the South Arm channel.</p> | <p>The Project will not appreciably increase the size of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the river. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Land Use. | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Katzie has not voiced any specific issues or concerns with respect to Visual Quality | | | |

HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Katzie. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Katzie participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Katzie will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Concern that the Ministry's archaeological consultant will not work effectively with Aboriginal Groups based on experience on past projects | The Ministry worked with Katzie to resolve this concern. | Addressed | None |

HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible adverse effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible direct effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

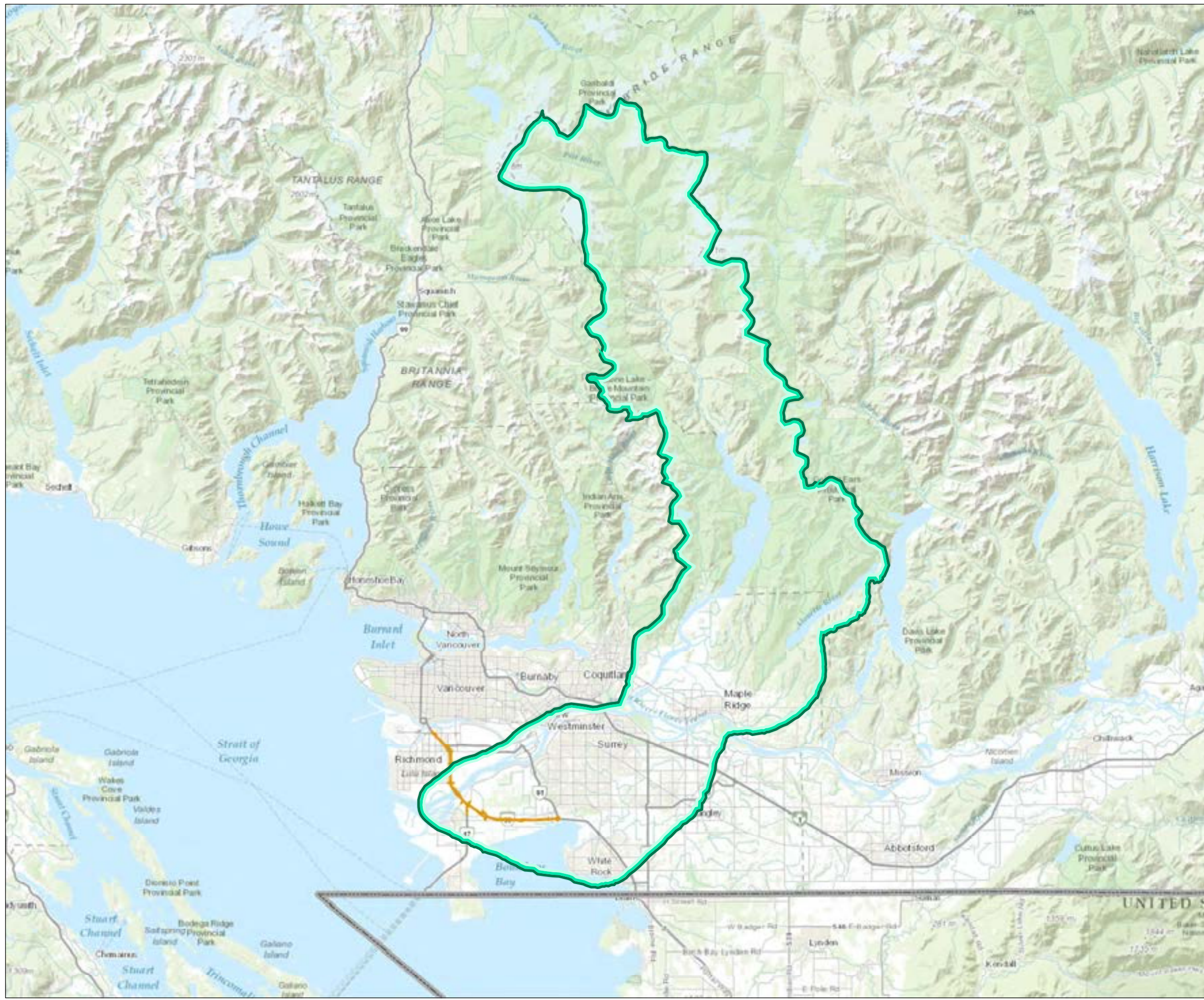
| HUMAN HEALTH | | | |
|---|--|---------------------------------|---|
| <p>During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>During operation, a negligible effect on access to instream locations for traditional use has been determined.</p> <p>During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.</p> <p>Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Katzie First Nation has experience with the Golden Ears Bridge being in proximity to the community and with the issue of suicide. Concern that there will be appropriate safety/suicide fencing on the new structure and importance of considering how the new bridge could facilitate suicide.</p> | <p>The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Katzie First Nation.</p> <p>Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application.</p> | <p>Addressed in Application</p> | <p>Development of safety barrier policy for new bridges in the Lower Mainland.</p> <p>Implementation of mitigation measures outlined in Section 7.1</p> |

| ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |




| OTHER ISSUES | | | |
|--|---|--------------------------|--|
| Consultation with Katzie First Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Length of time tolls are in place | The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |
| Potential for falling snow and ice | The design of the new bridge is similar to the Alex Fraser Bridge, with cable stays on the outside of the span. There are no cables crossing the deck. The Project design will include snow and ice control measures. | Addressed | Snow and ice control measures in Project design. |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic | Addressed in Application | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| | <p>driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application.</p> | | |
| <p>Potential for contaminants in the Tunnel and how this may affect Tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

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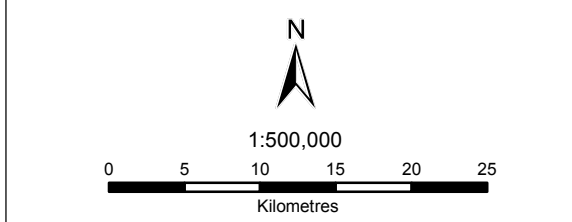


Legend

-  Katzie First Nation Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.




**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**KATZIE FIRST NATION
ASSERTED TRADITIONAL TERRITORY**

| | |
|-------------|------------|
| Figure 10-4 | 26/05/2016 |
|-------------|------------|





APPENDIX F

Kwantlen First Nation

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Kwantlen First Nation (Kwantlen).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Kwantlen, refer to the following sections of Part C:

- Consultation with Kwantlen (**Section 10.1.2.10**);
- Kwantlen community profile (**Section 10.1.1.4**);
- Description of existing Kwantlen's Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Kwantlen's Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Kwantlen's Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of Aboriginal Interests Assessment for Kwantlen is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Kwantlen First Nation Overview Table (**Appendix F2**), which provides detailed information regarding:

- Kwantlen issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Kwantlen's Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Kwantlen;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Kwantlen and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, Kwantlen attended two EAO-led Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Kwantlen in relation to the draft Application Information Requirements resulted in Aboriginal Groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence with the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Kwantlen also participated in the completeness review of the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Kwantlen will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Kwantlen in early 2014 in order to identify the nature and scope of Kwantlen's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Kwantlen. A more detailed discussion is provided under the Kwantlen section in **Section 10.1.2.10 Overview of consultation with each Schedule B Aboriginal Groups**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Kwantlen. The Ministry has been working with Kwantlen regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Kwantlen for the preparation and submission of the traditional use study *Kwantlen Land Use and Occupation in the Vicinity of Highway 99*. The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Kwantlen during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study document. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, draft Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Kwantlen included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Kwantlen;
- Funding for Kwantlen's participation in Project consultation activities and EA process;
- Kwantlen participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment, draft AIR and Aboriginal Consultation Plan;
- Meetings with Kwantlen leadership, staff, consultants, elders and membership; and
- Response and follow up with Kwantlen regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information. The main consultation activities the Ministry undertook with Kwantlen included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Kwantlen;
- Funding for Kwantlen’s participation in Project consultation activities and EA process;
- Meetings with Kwantlen leadership, staff, consultants, elders and membership;
- Kwantlen participation in fieldwork;
- Kwantlen participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Kwantlen regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Kwantlen’s concerns, identified through consultation undertaken to-date, are presented in **Appendix F2 Kwantlen First Nation Overview Table**. The Ministry’s response to Kwantlen’s key concerns regarding potential impacts on Kwantlen’s Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|--|--|
| Protection of Kwantlen First Nation’s rights to harvest within the Project area. | Kwantlen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Kwantlen as a result of the Project are not expected. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Cultural recognition and naming | The Ministry is committed to working with Kwantlen to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Kwantlen on these opportunities. |
| Ministry’s approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups | The Ministry is confident that the Project’s procurement process will effectively allow for benefits to be provided to Aboriginal Groups. |

| Concerns Identified to Date | Response |
|---|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Kwantlen and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Kwantlen’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Kwantlen’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined. Mitigation measures are outlined in Section 5.2.4 (Marine Use Mitigation Measures) of the Application.</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> Adequacy of methodology to address social and cultural effect | <p>The Ministry acknowledges the importance of Kwantlen’s involvement in the environmental assessment process.</p> <p>Kwantlen’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects underway is outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> |
| <p>Social effects of the Project on Kwantlen’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Kwantlen’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |
| <p>Potential effects on Fraser River flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> |

| Concerns Identified to Date | Response |
|---|---|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation.</p> <p>During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.</p> <p>Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will ensure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile: Kwantlen First Nation

Kwantlen First Nation is governed by a chief and council under a custom electoral system. The current chief and two councillors were appointed in November 1993.

Kwantlen's main community resides on McMillan Island 6, in the Fraser River to the north of Fort Langley. Of 269 registered members, 70 live on reserve, of which the Kwantlen have six, including McMillan Island 6, all centered on the area of confluence between the Stave River and the Fraser River. Kwantlen also share the *Pekw'Xe:y/les* (Peckquaylis) reserve, approximately 2 km upstream of the Mission Bridge, with 20 Stó:lō nations. None of these reserves overlap the proposed Project area.

Kwantlen traditional territory has been previously shown to extend from the watershed of the Stave River in the north to the international border in the south, taking in the northeastern part of Boundary Bay, the Serpentine, Nicomekl, and Salmon Rivers, as well as the Fraser River upstream of Tilbury Island to the Nicomen Slough, near Chilliwack. This territory overlaps the portion of the Project area at its westernmost extent (i.e., between Highway 17 and Highway 91), but does not overlap the Project area at or north of the Fraser River.

Since 2011, the economic arm of the Kwantlen First Nation has operated as Seyem' Qwantlen Business Group, representing five limited partnerships owned by the Nation, and providing services principally in the areas of contracting (construction, excavation, and earthworks), on and off reserve land development, and resource management (fisheries, forestry, archaeology).

3.1 Kwantlen Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes are or may be connected with the exercise of Kwantlen's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Kwantlen in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- Kwantlen has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.

3.1.2 Fishing

- Kwantlen First Nation consider the vitality of the Fraser River and its resources to be an important element of Kwantlen culture. Salmon was and remains a primary resource and is the basis of Kwantlen's economy.

- Kwantlen are among the numerous First Nations involved in the Lower Fraser River salmon fishery under food, social and ceremonial (FSC) licences issued by Fisheries and Oceans Canada (DFO).
- Kwantlen are typically licenced to fish for FSC purposes in the stretch of the Fraser River between the Port Mann Bridge and Mission, using both drift and set nets (DFO 2016); and appear to fish in this area for Chinook, sockeye, and chum salmon and eulachon.
- Fishing remains central to Kwantlen, and they have also reported use of the upper intertidal area of Mud Bay, at the northeastern aspect of Boundary Bay, for shellfish harvesting.

3.1.3 Hunting/Trapping

- Kwantlen reportedly hunted deer, elk, mountain goats and other small game (e.g., ducks, geese, and grouse), and trapped beaver and martin.
- Stave River, a tributary of the Fraser River, is said to have been important to Kwantlen for hunting and trapping and as a training area for youth.

3.1.4 Gathering

- Kwantlen have identified a former berry/plant (specifically cranberry) gathering area at a bog located in the eastern and northern portion of Lulu Island, along the south bank of the North Arm of the Fraser River.

3.1.5 Archaeology and Cultural Heritage Interests

- Kwantlen have identified several traditional transportation routes to the east of the project corridor, including, but not limited to:
 - a trail from the head of Mud Bay to the South Arm of the Fraser and to *Kikait* (*q'əq'yət*), across from New Westminster;
 - a trail/canoe route leading from the Fraser River at the west end of Barnston Island to the Serpentine River, leading to Mud Bay;
 - a trail/canoe route from the Fraser River along the Salmon River then overland to the Serpentine River, leading to Mud Bay;
 - the Nicomekl River itself (*neq'əmeqəl* and other variations);
 - a trail/canoe/portage route from the mouth of the Salmon River at the Fraser River to its source, then by portage to the upper forks of the Nicomekl River, and downriver to the mouth of the Nicomekl River (i.e., Black Spit or *stetaq*); and
 - a trail leading from the headwaters of the Nicomekl River southward across Langley Prairie to Campbell River, then following this river to its mouth at Semiahmoo Bay.

- Kwantlen have reported that they understand their cultural heritage sites to include “any geographically-defined site (on land or water) used for the purposes of settlement, occupation, cultural use, resource gathering, transportation, or similar activity,” and note that while these sites “may lack the physical evidence of human-made artifacts or structures,” they are still of cultural significance (Kwantlen First Nation 2015).
- Kwantlen say that some of the “most highly significant” cultural heritage sites are associated with fishing on the Fraser River (Kwantlen First Nation 2015).

3.1.6 Other Related Interests

- No other related interests in addition to those summarized above were identified from *Kwantlen Land Use and Occupation in the Vicinity of Highway 99* or in publicly available sources reviewed for the Project.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Kwantlen’s Aboriginal Interests, specifically. For a more detailed description of the methodology and a summary of the results, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.

- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs and ICs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Kwantlen's exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Kwantlen's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Kwantlen's Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect |
|--|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

According to Kwantlen, fishing is the most frequently practiced resource harvesting activity by its members on the Fraser River, with salmon being the key species. Other species of interest harvested throughout their traditional territory include eulachon, herring, smelt, halibut, eulachon, trout, and sturgeon. Kwantlen also reports harvesting a variety of bivalves and other seafood. Kwantlen are typically licenced to fish for FSC purposes in the stretch of the Fraser River between the Port Mann Bridge and Mission, and also appear to fish in this area for Chinook, sockeye, and chum salmon and eulachon.

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Kwantlen, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Kwantlen during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Kwantlen from instream construction activities are expected to be negligible. While it is acknowledged that Kwantlen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Kwantlen. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in Section 4.2 Sediment and Water Quality and Section 4.9 Air Quality are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Kwantlen; therefore, Potential Project-related effects on Kwantlen fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Kwantlen.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Kwantlen is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Kwantlen's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Kwantlen report harvesting a range of wildlife species, including mammals such as deer and elk and a number of species of wildfowl. Harvesting has taken place on the river banks, marshes, and meadows throughout the Fraser delta including the foreshore areas adjacent to the Kwantlen reserve on Canoe Pass and those adjacent to Tsawwassen Lands. Kwantlen reportedly hunted deer, elk, mountain goats and other small game (e.g., ducks, geese, and grouse), and trapped beaver and martin.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Kwantlen as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Kwantlen during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Kwantlen from instream construction activities, are expected to be negligible. While it is acknowledged that Kwantlen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Kwantlen resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Kwantlen. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Kwantlen; therefore, Potential Project-related effects on Kwantlen fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Kwantlen.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Kwantlen is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Kwantlen's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Kwantlen also report harvesting terrestrial plant foods including wapato, camas lily, various berries and Pacific crabapple. Kwantlen report kelp as an important food and medicinal plant, and other intertidal species of interest include cattail, tule, and grasses. Kwantlen identify Brunswick Point, Westham Island, Canoe Pass, portions of Lulu Island, Kwantlen Indian Reserve 4, and Ladner as key harvesting areas.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Kwantlen as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Kwantlen during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Kwantlen from instream construction activities, are expected to be negligible. While it is acknowledged that Kwantlen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Kwantlen resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Kwantlen; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Kwantlen.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Kwantlen is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Kwantlen's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Kwantlen identify several traditional transportation routes to the east of the project corridor. Kwantlen say that some of the “most highly significant” cultural heritage sites are associated with fishing on the Fraser River.

The proposed Project has the potential to affect Kwantlen's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Kwantlen's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Kwantlen's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Kwantlen's archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Kwantlen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Kwantlen's archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Kwantlen's archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in Section 4.10 Atmospheric Noise would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Kwantlen's archaeological and cultural heritage interests, that overlap or are in proximity to known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Kwantlen.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Kwantlen (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Kwantlen's Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of

experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Kwantlen, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Kwantlen. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Kwantlen's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Kwantlen regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in Section 10.1.3.4 and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Kwantlen's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Kwantlen prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Kwantlen during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Kwantlen during consultations include:

- Kwantlen's participation and Project-related opportunities, including employment, training and contracting;
- Effects to fish and fish habitat;
- Cumulative effects;
- Trend in development of the lower Fraser River;
- EAO process and timelines and adequacy of Environmental Assessment (EA) methodology to address social and cultural effects;
- Social effects of the Project on Kwantlen's ability to transfer knowledge, language and participate in socio-cultural practices;
- Consideration of cumulative effects on Aboriginal rights;
- Absence of a comprehensive study of cumulative effects on the Fraser River;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on flow rates after Tunnel removal; and
- Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge;
- Protection of archaeological and heritage resources;
- Consideration of Aboriginal knowledge and importance of Aboriginal Traditional Knowledge (ATK) to a more holistic assessment;

- Appropriate use of information shared by Kwantlen First Nation as it relates to confidentiality and dissemination;
- Opportunities for cultural recognition;
- Funding capacity for Project participation;
- Potential effects on wildlife; and
- Use of culturally significant plants.

Based on information provided by Kwantlen and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Kwantlen has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Kwantlen's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Kwantlen First Nation, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses

- Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Kwantlen regarding proposed measures, management plans, and monitoring programs related to VCs and ICs assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Kwantlen, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Social and cultural effects and the adequacy of Environmental Assessment (EA) methodology. | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Addressed | None |

ABORIGINAL INTERESTS

There are potential Project related impacts to Kwantlen title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Instream locations (during construction)

Quality of experience while engaged in or tied to traditional use

- cultural landscape
- Instream locations (during construction)

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations (during construction)
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Kwantlen as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Kwantlen First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Kwantlen’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Kwantlen First Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Kwantlen’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| | <p>Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | | |
| <p>Protection of Kwantlen First Nation’s rights to harvest within the Project area.</p> | <p>Kwantlen’s rights to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Kwantlen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process. | Kwantlen received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Kwantlen First Nation as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Kwantlen may be considered confidential. The Ministry is subject to the provisions of the <i>Freedom of Information and Protection of Privacy Act</i> . However, subject to the requirements of applicable laws, the Ministry will respect Kwantlen requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|-----------------------------------|---|---------------|--------------------------------|
| Funding for Traditional Use Study | The Ministry signed funding agreements with the members of the Kwantlen which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project. Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------|--|
| Opportunities for cultural recognition and naming. | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Kwantlen on this matter. | Ongoing | Discussion with Kwantlen to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Project-related employment, training, contracting, and economic development opportunities.</p> <p>Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage.</p> | <p>The Ministry is committed to working with Kwantlen to identify potential opportunities to benefit from the Project and is confident that the Project’s procurement process will effectively allow this commitment to be met. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Kwantlen to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |
| <p>The Ministry’s approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups.</p> | <p>The Ministry is confident that the Project’s procurement process will effectively allow for benefits to be provided to Aboriginal Groups.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Cumulative effects: Consideration of cumulative effects on Aboriginal rights. Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. Absence of a comprehensive study of cumulative effects on the Fraser River</p> | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---|--------|-------------------------|
| | <p>operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. While the Ministry acknowledges that Kwantlen First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Change in flow rates after Tunnel removal.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics and Morphology Mitigation Measures)</p> |

| 4.8 TERRESTRIAL WILDLIFE | | | |
|---|---|--------------------------|--|
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential light and noise effects on wildlife and fish. | The Ministry understands that Kwantlen is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) |
| Potential effects of the bridge structure on species such as waterfowl and migratory birds. | The Ministry understands that Kwantlen is concerned with the potential effects of the new bridge on species such as waterfowl and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highway will mitigate potential Project-related increase in traffic collision risk. Nesting opportunity provided by the new bridge will offset the loss of nesting habitat due to removal of the Deas Slough Bridge. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of run off and drainage.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, has been determined. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|-------------------------|
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Potential effects to fish and fish habitat and spawning grounds, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Kwantlen. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Importance of habitat restoration and Kwantlen’s interest in participating in all aspects of these works</p> | <p>The Ministry notes Kwantlen’s interest in participating in habitat restoration work.</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Invasive plant species and proposed plans to manage presence during construction.</p> | <p>Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |
| <p>Inclusion of culturally significant plants in planting plans and opportunity for Kwantlen in the identification of plants, and planting work.</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>The Ministry will develop planting plans with consultation from Aboriginal Groups</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

- A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

- Minimize potential effects through Project design.
- Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.
- There is a low, long-term probability of barn owl mortality.
- No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|----------------------------------|---------------|--------------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Terrestrial Wildlife. | | | |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|--|
| <p>Potential effects of construction during fishing season on fishing activities.</p> | <p>Potential interference with Kwantlen fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |
| <p>Effects of construction and decommissioning-related barging activities on Kwantlen First Nation fishing activities and on the test fishery.</p> | <p>Potential interference with Kwantlen fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a MarineAccess Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Visual Quality | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|--|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Kwantlen. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports</p> | <p>Kwantlen participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed</p> | <p>Kwantlen will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

| 7.0 HUMAN HEALTH | | | |
|---|----------------------------------|---------------|--------------------------------|
| <p>During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>During operation, a negligible effect on access to instream locations for traditional use has been determined.</p> <p>During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.</p> <p>Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Kwantlen has not voiced any specific issues or concerns with respect to Human Health. | | | |

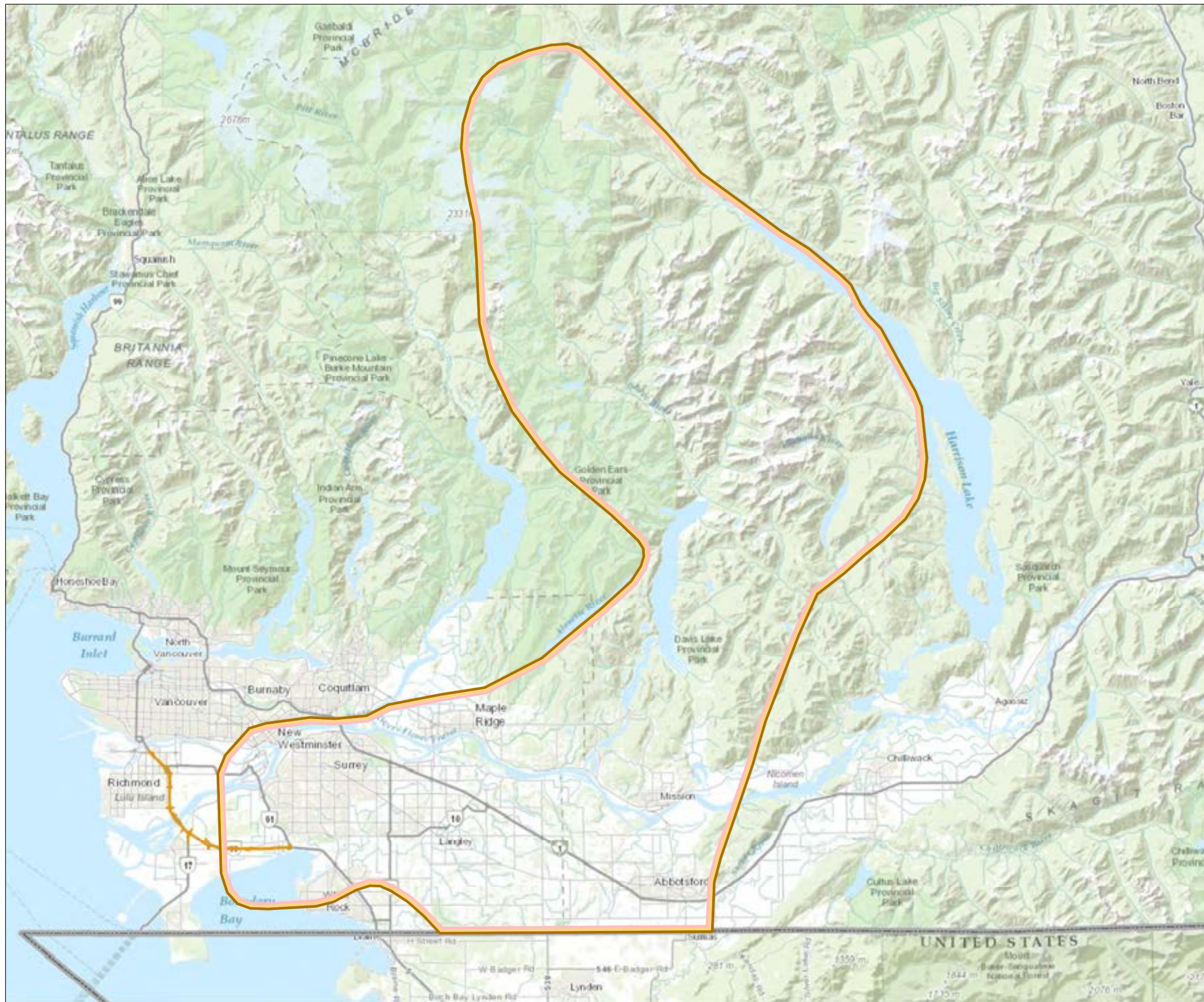
8.0 ACCIDENTS AND MALFUNCTIONS

Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.




In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|----------------------------------|---------------|--------------------------------|
| Kwantlen has not voiced any specific issues or concerns with respect to Accidents and Malfunctions. | | | |

| OTHER ISSUES | | | |
|--|---|---------------|--------------------------------|
| Consultation with Kwantlen First Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application. | Addressed | None |

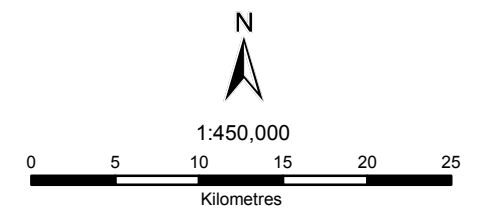


Legend

-  Kwantlen First Nation Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Kwantlen First Nation and BC (Province of British Columbia), 2012. Kwantlen First Nation Forest and Range Consultation and Revenue Sharing Agreement, April 10, 2012.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

KWANTLEN FIRST NATION
ASSERTED TRADITIONAL TERRITORY

Figure 10-5

26/05/2016

APPENDIX G

Lake Cowichan First Nation

1.0 Introduction

Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Lake Cowichan First Nation (Lake Cowichan).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Lake Cowichan First Nation, refer to the following sections of Part C:

- Consultation with Lake Cowichan (**Section 10.1.2.10**);
- Lake Cowichan community profile (**Section 10.1.1.5**);
- Description of existing Lake Cowichan First Nation's Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Lake Cowichan First Nation's Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Lake Cowichan First Nation's Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of Aboriginal Interests Assessment for Lake Cowichan is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Lake Cowichan Overview Table (**Appendix G2**), which provides detailed information regarding:

- Lake Cowichan's issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Lake Cowichan's Aboriginal Interests;

- The Ministry’s response to specific issues and concerns raised by Lake Cowichan;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry’s provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Lake Cowichan and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, EAO led two Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations. Although Lake Cowichan did not attend, materials were provided.

Lake Cowichan also participated in the completeness review of the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Lake Cowichan will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Lake Cowichan in early 2014 in order to identify the nature and scope of Lake Cowichan First Nation’s Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Lake

Cowichan First Nation. A more detailed discussion is provided under the Lake Cowichan section in **Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Lake Cowichan First Nation. The Ministry has been working with Lake Cowichan regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Lake Cowichan for the preparation and submission of the traditional use study *Ts'uubaasatx Interest: George Massey Tunnel*. The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Lake Cowichan during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study. The focus of the Initial

Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, draft Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Lake Cowichan included:

- Sharing of Project-related information including focused presentation on topics of interest and/or concern to Lake Cowichan;
- Funding for Lake Cowichan's participation in Project consultation activities and EA process;
- Lake Cowichan participation in field studies;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, draft AIR, Heritage Resources Assessment and Aboriginal Consultation Plan;
- Meetings with Lake Cowichan leadership, staff, consultants, elders and membership; and
- Response and follow up with Lake Cowichan regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information. The main consultation activities the Ministry undertook with Lake Cowichan included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Lake Cowichan;
- Funding for Lake Cowichan's participation in Project consultation activities and EA process;
- Meetings with Lake Cowichan leadership, staff, consultants, elders and membership;
- Lake Cowichan participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Lake Cowichan regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Lake Cowichan First Nation’s concerns, identified through consultation undertaken to-date, are presented in **Appendix G2 Lake Cowichan Overview Table**. The Ministry’s response to Lake Cowichan First Nation’s key concerns regarding potential impacts on Lake Cowichan First Nation’s Aboriginal Interests are outlined below:

Table 1 **Concerns Identified to Date**

| Concerns Identified to Date | Response |
|---|---|
| Protection of Lake Cowichan First Nation’s rights to harvest within the Project area. | Lake Cowichan’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Lake Cowichan as a result of the Project are not expected. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Importance of Łæqtinəs/TI’uqtinus (was a “little New York”) near the Project area for trade both in terms of historic and current/future significance • Revenue from tolling | The Ministry is committed to working with Lake Cowichan to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Lake Cowichan on these opportunities. The Ministry notes Lake Cowichan’s comments regarding the importance of Łæqtinəs/TI’uqtinus. The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways. |

| Concerns Identified to Date | Response |
|---|---|
| <p>Consideration of cumulative effects on Aboriginal rights</p> | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> |
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Lake Cowichan and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Lake Cowichan’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |

| Concerns Identified to Date | Response |
|--|--|
| <p>Impact on marine mammals such as the Stellar Sea Lion</p> | <p>Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km. Standard industry and best management practices will be applied to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to. Marine Mammals are addressed in Section 4.6 of the Application.</p> |
| <p>Increase in traffic, and consequent increase in associated noise and vibration due to the increases capacity of the new bridge</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> |
| <p>Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Lake Cowichan fishing.</p> | <p>Lake Cowichan’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8). Mitigation measures are outlined in Section 5.2.4 (Marine Use Mitigation Measures) of the Application.</p> |

| Concerns Identified to Date | Response |
|---|--|
| Potential effects on Fraser River flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics). |
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation.</p> <p>During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciate change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.</p> <p>Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile – Lake Cowichan First Nation

Lake Cowichan is governed by a four-member council under a custom electoral system. The current chief and one councillor were appointed in October 1977, while two other councillors were appointed in March 1999.

Lake Cowichan membership takes descent from both Ditidaht (Nuu-chah-nulth) ancestors and *Hul'qumi'num*' ancestors known as the Somenos (or Saumni, Samena, Saumina and other variations), one of seven village groups comprising the Cowichan Tribes. The community is based on a single reserve on the northeastern shore of Cowichan Lake, approximately 30 km west of Duncan (on the east coast of Vancouver Island), and less than 20 km east of Nitinat Lake (on the west coast of Vancouver Island). In 1860, the community was significantly affected by a smallpox epidemic; the population has remained small, with only 12 of 20 registered members living on reserve. The Project area does not overlap any current or former Lake Cowichan reserve lands.

Lake Cowichan have stated that Cowichan Lake has always been their primary home, and that their traditional territory is centred on the lake, taking in surrounding lands, streams, and other waters, including the uppermost part of the Cowichan River. They have also stated that their use of this territory has continued to the present day. A three-year Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia, dated 2011, identifies this Vancouver Island-based territory.

Based on their affiliation with the Hul'qumi'num Treaty Group, the Lake Cowichan has also been associated with a larger, collective traditional territory with the other member First Nations of that group. The core territory of the Hul'qumi'num Treaty Group overlaps the Project area at the Tunnel crossing. The other members of the Hul'qumi'num Treaty Group – namely, Cowichan Tribes, Halalt First Nation, Penelakut Tribe, and Stz'uminus First Nation – are working jointly on their Fraser River interests through the Cowichan Nation Alliance. Lake Cowichan is engaging with the Ministry on the Project separately from the Cowichan Nation Alliance.

3.1 Lake Cowichan Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes are or may be connected with the exercise of Lake Cowichan First Nation's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Lake Cowichan in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- The Project area intersects with the claimed core territory or “title lands” of the member bands of the Hul’qumi’num Treaty Group, with which the Lake Cowichan has been affiliated. This area includes *Tl’uqtinus*, in the vicinity of the north end of the George Massey Tunnel.
- A Lake Cowichan community member recently stated that they have not used any resources from the George Massey Tunnel area since 1960, but that they do occasionally access the area.

3.1.2 Fishing

- Lake Cowichan followed a seasonal round of resource use and regional settlement. Within this round, the Fraser River estuary has been described as the “most important economically”. Species harvested historically on the South Arm of the Fraser River included salmon, sturgeon, eulachon, shellfish, and marine mammals (particularly seals).
- Dried clams and other foodstuffs (e.g., camas) were traded to other First Nations.
- Areas within the wider Fraser River estuary were also utilized by *Hul’qumi’num’*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore.
- Access to sockeye for Hul’qumi’num Treaty Group member nations for food, social, and ceremonial (FSC) purposes is said to be provided annually by Fisheries and Oceans Canada (DFO) in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008.
- Lake Cowichan currently participates in the Hul’qumi’num Fisheries Limited Partnership (HFLP), a commercial fishing business, along with Cowichan Nation Alliance member groups and Lyackson First Nation. Species harvested under commercial licences through this enterprise are crab, prawn, prawn, halibut, herring, rockfish, sablefish, and salmon. Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island.

3.1.3 Hunting/Trapping

- Large game harvested by Lake Cowichan likely included deer and black bear.
- Small game, fur-bearing mammals, and waterfowl were harvested from aquatic settings along sloughs and wetlands. Species targeted would have included beaver, muskrat, otters, mink, ducks, geese, and swans.

- Lake Cowichan have reported they are harvesting ducks, specifically mallards and coots (mud hens), at Roberts Bank. They have previously expressed concern regarding the diminishing numbers of marine birds in the area.

3.1.4 Gathering

- Lake Cowichan has reported gathering eelgrass at Roberts Bank in the intertidal zone.
- Other member bands of the Hul'qumi'num Treaty Group have reported that berries and other plants were gathered and cultivated by *Hul'qumi'num' Mustimuhw* ancestors at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included cranberries, blueberries, blackberries, wapato, and bulrushes/reeds (*stth'equn*)

3.1.5 Archaeology and Cultural Heritage Interests

- No information on Lake Cowichan's interests with respect to archaeology and cultural heritage were identified in the study prepared for this Project, *Ts'uubaasatx Interest: George Massey Tunnel*, or in publicly available sources.

3.1.6 Other Related Interests

- Members of the Lake Cowichan community are actively working to find members that have dispersed from the community, and they have expressed their desire to, at some time in the future, visit the Project area with these new members in order to renew their relationship with and learn about their "traditional rights" in the area.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Lake Cowichan First Nation's Aboriginal Interests, specifically. For a more detailed description of the methodology and a summary of the results, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**

- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs and ICs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Lake Cowichan's exercise of Aboriginal Interests, during construction and operation phases, remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Lake Cowichan’s Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Lake Cowichan’s Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Project Construction | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Project Operation | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |

4.5 Fishing

According to Lake Cowichan, the Fraser River estuary is an economically important component in their seasonal round. Species harvested historically on the South Arm of the Fraser River included salmon, sturgeon, eulachon, shellfish, and marine mammals (particularly seals).

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Lake Cowichan, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Lake Cowichan during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Lake Cowichan from instream construction activities are expected to be negligible. While it is acknowledged that Lake Cowichan has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Lake Cowichan. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Lake Cowichan; therefore, Potential Project-related effects on Lake Cowichan fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lake Cowichan.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Lake Cowichan is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Lake Cowichan's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Lake Cowichan report harvesting a range of wildlife species, including mammals such as deer and black bear, small game, fur-bearing mammals and a number of species of wildfowl.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Lake Cowichan as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Lake Cowichan during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Lake Cowichan from instream construction activities, are expected to negligible. While it is acknowledged that Lake Cowichan has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Lake Cowichan resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Lake Cowichan. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Lake Cowichan; therefore, Potential Project-related effects on Lake Cowichan fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lake Cowichan.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Lake Cowichan is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Lake Cowichan's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Sources reviewed provided limited information on Lake Cowichan's harvesting practices. Lake Cowichan reports gathering eelgrass at Roberts Bank in the intertidal zone. Other member bands of the Hul'qumi'num Treaty Group have reported that berries, wapato and bulrushes/reeds were gathered and cultivated by ancestors at *Tl'uqtinus*.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Lake Cowichan as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Lake Cowichan during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Lake Cowichan from instream construction activities, are expected to be negligible. While it is acknowledged that Lake Cowichan has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Lake Cowichan resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Lake Cowichan; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lake Cowichan.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Lake Cowichan is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Lake Cowichan's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

No information on Lake Cowichan's interests with respect to archaeology and cultural heritage were identified in the study prepared for this Project, *Ts'uubaasatx Interest: George Massey Tunnel*, or in publicly available sources; however, the proposed Project has the potential to affect Lake Cowichan's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Lake Cowichan's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Lake Cowichan's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Lake Cowichan’s archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Lake Cowichan has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Lake Cowichan’s archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Lake Cowichan’s archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Lake Cowichan’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lake Cowichan.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Lake Cowichan (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Lake Cowichan’s Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Lake Cowichan, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Lake Cowichan First Nation. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Lake Cowichan First Nation's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Lake Cowichan regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Lake Cowichan First Nation's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Lake Cowichan prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Lake Cowichan during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Lake Cowichan during consultations include:

- Capacity funding for Traditional Use Study and to facilitate participation in the Project review process;
- Protection of archaeological and heritage resources and opportunities for cultural recognition and naming;
- Aboriginal participation and Project-related opportunities;
- Effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon;
- Social effects of the Project on Lake Cowichan's ability to transfer knowledge, language and participate in socio-cultural practices;
- Consideration of cumulative effects on Aboriginal rights;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on flow rates after Tunnel removal;
- Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge;
- Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations;
- Potential for public safety concerns related to potential for creation of increased criminal activity and need for appropriate safety/suicide fencing;

- Potential effects of the bridge structure, lighting, and noise on terrestrial wildlife, marine mammals, waterfowl, and migratory birds;
- Inclusion of culturally significant plants in planting plans and opportunity for Lake Cowichan in the identification of plants, and planting work. Need for management of invasive plant species;
- Increase in traffic, and consequent increase in associated noise and vibration due to the increases capacity of the new bridge;
- Concern with increased water temperatures in the Fraser River and the importance of opportunities to provide additional shade along the river; and
- Potential effect of removing the Tunnel on marshes along the river.

Based on information provided by Lake Cowichan and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Lake Cowichan has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Lake Cowichan First Nation's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Lake Cowichan First Nation, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance

- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Lake Cowichan regarding proposed measures, management plans, and monitoring programs related to IC and VC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Lake Cowichan, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|--------------------------------------|
| In addition to the funding provided by the Proponent, Lake Cowichan requires funding for participation in EAO's own process. | The Ministry provided funding to Lake Cowichan for the Pre-Application Phase. Funding for the Application Review Phase will be provided. Funding provided by the proponent is inclusive of EAO-led activities. | Addressed | Funding for Application Review Phase |

| ABORIGINAL INTERESTS | | | |
|--|--|---------------|--------------------------------|
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Consideration of cumulative effects on aboriginal rights | The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|-----------------------------|
| <p>Importance of maintaining and protecting traditional historical access to the Project area. Future aspirations of Ts'uubaasatx to learn about and exercise their rights in the Project area as the community grows.</p> <p>"Ts'uubaasatx members not only want to maintain and assert their aboriginal right to camp, hunt, fish and otherwise move about in the area of the George Massey Tunnel, they hope someday, the area will be restored as a healthy habitat that they can utilize for food gathering purposes, once again."</p> | <p>The Ministry will work closely with Aboriginal Groups to ensure the protection of Aboriginal rights within the project area.</p> <p>The Ministry will work with Aboriginal Groups on Project components, such as environmental enhancement, in an effort to support healthy habitat for current and future use by Ts'uubaasatx and other Aboriginal Groups.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Importance of Project area for trade both in terms of historic and current/future significance (ł̓aq̓tinəs/Tl'uqtinus was a "little New York")</p> | <p>Noted</p> | <p>Noted</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Protection of Lake Cowichan’s rights to harvest within the Project area. “Our people used to go over to the Fraser river delta area to fish and hunt, every year, but we haven’t done that for years. Still, our right to access the area needs to be maintained. In the future it might be that area will be restored to a healthy state and we could practice our rights to camp and fish there”. “Even though the tunnel area is full of people now, and we can’t hunt or fish there, we still need to protect our rights to be there and gather food.”</p> | <p>Lake Cowichan’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Lake Cowichan as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |
| <p>Revenue sharing opportunities from tolling</p> | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | <p>Addressed</p> | <p>None</p> |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Lake Cowichan received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Lake Cowichan First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Lake Cowichan may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Lake Cowichan requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Funding for Traditional Use Study | The Ministry signed funding agreements with the members of the Lake Cowichan which provided funding for a Traditional Use Study. | Addressed | None |
| Importance of continued engagement with Aboriginal Groups on matters of importance and on success of mitigation and enhancements. “There is a need for reporting out on post-construction monitoring. This should be provided to us in the form of meetings and in writing” | Mitigation and environmental protection programs are addressed in the Application. Reporting requirements will be determined. The Ministry will undertake further discussions with Aboriginal Groups regarding post-construction monitoring and reporting. | Addressed | Ongoing consultation |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components
- Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will work with Lake Cowichan on this matter. | Ongoing | Discussion with Lake Cowichan to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage. | The Ministry is committed to working with Lake Cowichan to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Lake Cowichan to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |
| Adequate training time to take full advantage of potential future Project work activities. Opportunities for training related to traditional activities. | The Ministry is committed to working with Lake Cowichan First Nation to identify potential opportunities to benefit from the Project. The Ministry has initiated discussions with Lake Cowichan First Nation regarding Project-related benefits and opportunities. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics and River Morphology Mitigation Measures)</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures) |
| Impacts of the River from potential pollutants and contaminants on the Tunnel walls if left in place | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|-------------------------|
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Lake Cowichan. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Fish mortality from pile driving and blasting | The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Fish mortality should not be a significant issue during pile driving. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |
| Effects of pile driving on salmon migration | Pile driving should not have an impact on salmon migration. | Addressed in Application | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |
| Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon | Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conservation interest, including southern resident killer whales, do not occur in the Fraser River.

Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.

Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Impact on marine mammals such as the Stellar Sea Lion</p> | <p>Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 mms. Standard industry and best management practices will be applied to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to. Marine Mammals are addressed in Section 4.6 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.6.4</p> |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Inclusion of culturally significant plants in planting plans and opportunity for Lake Cowichan in the identification of plants, and planting work. Lake Cowichan has the capacity to undertake this type of work.</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>Develop planting plans with consultation from Aboriginal Groups</p> |
| <p>Ministry’s hydro-seeding spray contains invasive grasses that will damage new plants and add to the problem of invasive plants.</p> | <p>The Ministry will review its hydro seed mixes.</p> | <p>Addressed</p> | <p>Review hydro-seed mixes</p> |
| <p>Potential effect of removing the Tunnel on marshes along the river</p> | <p>Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. Creating comparable habitat within the Project alignment will offset unavoidable potential Project-related effect, which is limited to a small reduction in area of the cattail marsh that overlaps with Project components. Vegetation is addressed in Section 4.7 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Lake Cowichan is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Lake Cowichan is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|-------------------------|
| <p>Congestion and air quality issues – support for improved transit and anything that reduces idling.</p> | <p>Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Potential impacts of noise from pile driving and blasting | The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Mitigation in accordance with the Ministry's 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.10.4 |

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic, and consequent increase in associated noise and vibration due to the increases capacity of the new bridge</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

, a negligible effect on access to instream locations for traditional use has been determined.

, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Lake Cowichan fishing.</p> | <p>Potential interference with Lake Cowichan fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Lake Cowichan has not voiced any specific issues or concerns with respect to Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Lake Cowichan has not voiced any specific issues or concerns with respect to Visual Quality. | | | |

6.1 HERITAGE RESOURCESE

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites.</p> <p>Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area. No more tolerance for further disturbance of archaeological sites in the overdeveloped Lower Mainland. This includes disturbed and intact sites.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Lake Cowichan.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports. Importance of having a cultural person, known to LCFN and LFN, participate in archaeological work. | Lake Cowichan participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Lake Cowichan will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.

Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| New bridge will result in increased suicide attempts | <p>The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Lake Cowichan.</p> <p>Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application.</p> | Addressed | <p>Development of safety barrier policy for new bridges in the Lower Mainland.</p> <p>Implementation of mitigation measures outlined in Section 7.1</p> |

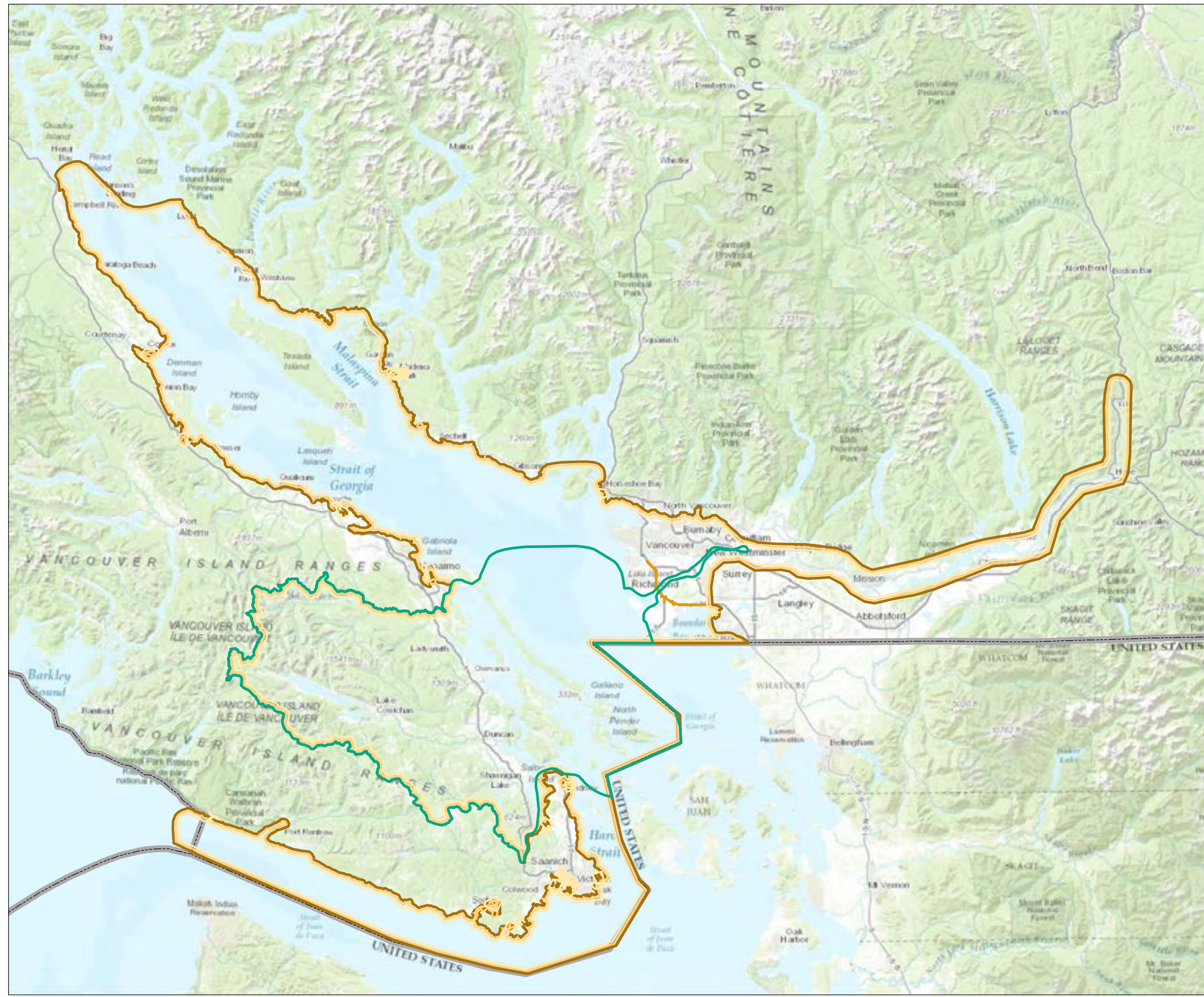
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>Creation of areas of increased criminal activity, particularly attraction of the shadow population/marginalized groups</p> <p>“Elders have expressed concern that bridge footings and covered areas will create places used by drug users and prostitutes”.</p> <p>“The tunnel is a bottleneck and removing it will bring in more drug trafficking into Delta. I am shocked that the municipalities haven’t stood up on this one”.</p> | <p>While not assessed as a Value Component in the Application, the potential for “at-risk populations” to use/congregate in areas near the bridge will be considered in Section 7.1 of the Application.</p> | <p>Addressed</p> | <p>None</p> |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|--|---|---------------|--------------------------------|
| Consultation with Kwantlen First Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|-----------------------------------|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

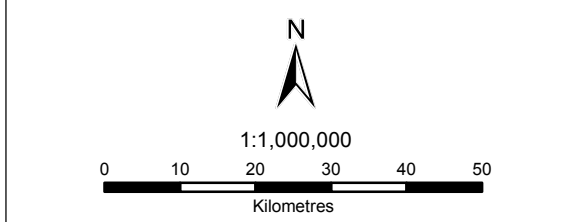
Path: Q:\1217-299\285\077\03\mxd\FirstNations\EA\Fig10-2_285_077_03_FirstNations_HuIQ_160517_FINAL.mxd



Legend

-  Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory
-  Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**HUL'QUMI'NUM TREATY GROUP
ASSERTED TRADITIONAL TERRITORY**

| | |
|-------------|------------|
| Figure 10-2 | 26/05/2016 |
|-------------|------------|



APPENDIX H

Lyackson First Nation

Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Lyackson First Nation (Lyackson).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Lyackson, refer to the following sections of Part C:

- Consultation with Lyackson (**Section 10.1.2.10**);
- Lyackson community profile (**Section 10.1.1.6**);
- Description of existing Lyackson Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Lyackson Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Lyackson Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of Aboriginal Interests Assessment for Lyackson is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Lyackson Overview Table (**Appendix H2**), which provides detailed information regarding:

- Lyackson's issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Lyackson's Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Lyackson;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

EAO-led Consultation Activities

Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

Participation in Working Group

EAO invited Lyackson and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, Lyackson attended two EAO-led Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Lyackson in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence within the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Lyackson also participated in the completeness review of the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Lyackson will continue as an active member of the Working Group through the environmental assessment process.

Proponent-led Consultation Activities

The Ministry began consultation with Lyackson in early 2014 in order to identify the nature and scope of Lyackson’s Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Lyackson. A more detailed discussion is provided under the Lyackson section in Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Lyackson. The Ministry has been working with Lyackson regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Lyackson for the preparation and submission of the traditional use study “*Preliminary Lyackson Use and Occupancy Mapping Study for BC MOTI’s George Massey Tunnel Replacement Project*”. The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry’s understanding of Aboriginal Interests and Aboriginal Group’s past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

Examples of Consultation Activities

A number of consultation activities were undertaken with Lyackson during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key

Areas of Study. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, draft Application Information Requirements (dAIR). The main consultation activities the Ministry undertook with Lyackson included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Lyackson;
- Funding for Lyackson’s participation in Project consultation activities and EA process;
- Site visit;
- Review of draft EA documents such as the Project Description, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment, dAIR and Aboriginal Consultation Plan;
- Meetings with Lyackson staff and consultants; and
- Response and follow up with Lyackson regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Lyackson included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Lyackson;
- Funding for Lyackson’s participation in Project consultation activities and EA process;
- Meetings with Lyackson leadership, staff, consultants, elders and membership;
- Lyackson participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements (AIR), Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Lyackson regarding the identification and resolution of issues.

Concerns Identified to Date

As outlined above, Lyackson’s concerns, identified through consultation undertaken to-date, are presented in **Appendix H2 Lyackson First Nation Overview Table**. The Ministry’s response to Lyackson’s key concerns regarding potential impacts on Lyackson’s Aboriginal Interests are outlined below:

Table 1: Concerns Identified to Date

| Concerns Identified to Date | Response |
|---|--|
| Protection of Lyackson First Nation’s rights to harvest within the Project area. | Lyackson’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Lyackson as a result of the Project are not expected. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> ○ Potential employment, training, contracting and economic development opportunities ○ Community preparedness ○ Importance of ʔəqtinəs/TI’uqtinus (was a “little New York”) near the Project area for trade both in terms of historic and current/future significance ○ Cultural recognition and naming | The Ministry is committed to working with Lyackson to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry notes Lyackson’s comments regarding the importance of ʔəqtinəs/TI’uqtinus. The Ministry is exploring opportunities for cultural recognition and naming and will work with Lyackson on these opportunities. |
| Environmental Assessment (EA): <ul style="list-style-type: none"> ○ Adequacy of methodology to address social and cultural effects ○ Process and associated timelines ○ Current volume of EAs underway ○ Strength of claim | The Ministry acknowledges the importance of Lyackson’s involvement in the environmental assessment process. Lyackson’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects, process and associated timelines, volume of EAs underway, and strength of claim are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO). |
| Consideration of cumulative effects on Aboriginal rights | The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, |

| Concerns Identified to Date | Response |
|---|--|
| | <p>identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> |
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> ○ Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon ○ Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Lyackson and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Lyackson's Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Impact on marine mammals such as the Stellar Sea Lion</p> | <p>Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no</p> |

| Concerns Identified to Date | Response |
|--|--|
| | more than 7.5 kms. Standard industry and best management practices will be applied to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to. Marine Mammals are addressed in Section 4.6 of the Application. |
| Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Lyackson fishing. | Lyackson's access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8). Mitigation measures are outlined in Section 5.2.4 (Marine Use Mitigation Measures) of the Application. |
| Potential effects on Fraser River flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics). |
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation.</p> <p>During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.</p> <p>Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will ensure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |
| New bridge will result in increased suicide | The Ministry is in the process of developing a policy in which new bridges in the Lower |

| Concerns Identified to Date | Response |
|--|--|
| attempts | Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Lyackson. Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application. |
| Creation of areas of increased criminal activity, particularly attraction of the shadow population/marginalized groups | While not assessed as a Value Component in the Application, the potential for “at-risk populations” to use/congregate in areas near the bridge will be considered in Section 7.1 of the Application. |

Community Profile: Lyackson First Nation

The Lyackson First Nation has three reserves, all on Valdes Island (*Le’eyqsun*), which lies approximately 45 km west of the Project area on the east side of the Strait of Georgia, directly opposite the mouth of the Fraser River. Over 90% of Lyackson First Nation’s registered membership lives off reserve, principally on southeastern Vancouver Island. The Project area does not overlap any current or former Lyackson First Nation reserve lands.

The Lyackson First Nation has described *Le’eyqsun* as their homeland and ancestral territory, one in which they continue to engage in traditional practices on a seasonal basis.

Based on their affiliation with the Hul’qumi’num Treaty Group, the Lyackson First Nation has been associated with a collective traditional territory with the other member First Nations of that group. The core territory of the Hul’qumi’num Treaty Group overlaps the Project area at the Tunnel crossing.

The other members of the Hul’qumi’num Treaty Group – namely, Cowichan Tribes, Halalt First Nation, Penelakat Tribe, and Stz’uminus First Nation – are working jointly on their Fraser River interests through the Cowichan Nation Alliance. Lyackson First Nation is engaging with the Ministry on the Project separately from the Cowichan Nation Alliance.

Lyackson Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be

connected with the exercise of Lyackson’s Aboriginal Interests. A more detailed discussion, including sources used, is provided under Lyackson in Section 10.1.3.2 Existing Conditions.

Fishing

- *Hul’qumi’num Mustimuhw*, which includes the Lyackson First Nation, resided around the Fraser River estuary for all or part of the annual salmon runs (April through October).
- The Fraser River, from its mouth up to Seabird Island (east of Chilliwack), has been described as a key fish and shellfish harvesting area for Lyackson, with Canoe Passage (*Hwlhits’um*) identified as particularly important for salmon fishing. Areas within the wider Fraser River estuary were also utilized by *Hul’qumi’num*-speaking peoples for fishing salmon, sturgeon, groundfish, halibut, and other marine resources on the foreshore.
- Access to sockeye for Hul’qumi’num Treaty Group member bands for food, social, and ceremonial (FSC) purposes is said to be provided annually by Fisheries and Oceans Canada (DFO) in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008.
- Lyackson First Nation has said that the mouth and South Arm of the Fraser River is currently the source of over 50% of their current subsistence salmon catch; however, they say fishing in the Fraser River area has become largely unavailable to them due in part to low present-day fish populations and the cost of boats and technology.
- Lyackson First Nation currently participates in the Hul’qumi’num Fisheries Limited Partnership (HFLP), a commercial fishing business. Species harvested through this enterprise are crab, prawn, halibut, herring, rockfish, sablefish, and salmon. Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island. Lyackson First Nation also hold, independently of the HFLP, a commercial licence for red sea urchin and geoduck.

Hunting/Trapping

- Lyackson report that, in the past, they hunted for ducks and geese in the Project area, while deer were hunted farther up the Fraser River.
- Lyackson report currently harvesting ducks, deer, and grouse at Porlier Pass, which they say remains a particularly important marine and terrestrial resource harvesting area for Lyackson given the range of resources that occur there.

Gathering

- Lyackson First Nation has said that members recall harvesting berries (including salmonberries and huckleberries), cattails, and fiddleheads in the Project area.
- Berry-picking sites are said to be currently available to Lyackson at Porlier Pass.

Archaeology and Cultural Heritage Interests

- Lyackson First Nation has identified a number of culturally important places, including *S'utl'qulus* (or *s7etl'keles*), meaning “facing outside,” for the east side of *Le'eyqsun*, and *Kw'ukw'iyukwun*, a fishing area off the southeastern end of *Le'eyqsun*, in the Strait of Georgia. A newly constructed youth camp, where the canoes of their ancestors once lined up in preparation for trips to Fraser River, is also located on the eastern side of *Le'eyqsun*.
- This area includes *Tl'uqtinus*, in the vicinity of the north end of the George Massey Tunnel, opposite Tilbury Island. Lyackson Elders and knowledge holders have described *Tl'uqtinus* as having a powerful and permanent *Hul'qumi'num* *Mustimuhw* trading centre for a number of commodities.

Other Related Interests

- No other related interests in addition to those summarized above were identified from in the sources reviewed for the Project.

Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Lyackson's Aboriginal Interests, specifically. For a more detailed description, refer to Section 10.1.3.3. Potential Effects.

Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**

- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2: Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:

- Minor (minimal or temporary modifications may be required to use preferred options),
- Moderate (more frequent or longer term modifications may be required to use preferred options), or
- Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects on with the potential to result in an adverse effect Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Lyackson’s exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3: Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4: Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| Construction | Operation | Residual Potential Effects |
|--------------|-----------|----------------------------|
|--------------|-----------|----------------------------|

| | Negligible | Measurable | Negligible | Measurable | |
|--|------------|------------|------------|------------|--|
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5: Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6: Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| Construction | Operation | Residual Potential Effects |
|--------------|-----------|----------------------------|
|--------------|-----------|----------------------------|

| | Negligible | Measurable | Negligible | Measurable | |
|---|------------|------------|------------|------------|--|
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

Potential Project-Related Effects on Lyackson's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Lyackson's Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7: Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect |
|---|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, | <ul style="list-style-type: none"> Potential temporary direct (minor) effect on quality of |

| Indicator | Potential Project-Related Effect |
|--|---|
| of Aboriginal Interests | experience related to construction-related noise <ul style="list-style-type: none"> • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

Fishing

Lyackson has said that the mouth and South Arm of the Fraser River is currently the source of over 50% of their current subsistence salmon catch. Lyackson currently participates in the Hul'qumi'num Fisheries Limited Partnership (HFLP), a commercial fishing business, Species harvested through this enterprise are crab, prawn, halibut, herring, rockfish, sablefish, and salmon. Commercial fisheries for halibut and sablefish are generally undertaken off the west coast of Vancouver Island. Lyackson also hold, independently of the HFLP, a commercial licence for red sea urchin and geoduck.

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Lyackson, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Lyackson during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Lyackson from instream construction activities are expected to be negligible. While it is acknowledged that Lyackson has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Lyackson. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Lyackson; therefore, Potential Project-related effects on Lyackson fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lyackson.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Lyackson is fishing. As this

landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Lyackson's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

Hunting/Trapping

Lyackson report currently harvesting ducks, deer, and grouse at Porlier Pass, which they say remains a particularly important marine and terrestrial resource harvesting area for Lyackson given the range of resources that occur there.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Lyackson as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Lyackson during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Lyackson from instream construction activities, are expected to be negligible. While it is acknowledged that Lyackson has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Lyackson resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Lyackson. Therefore, Project-related effects on

hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Lyackson; therefore, Potential Project-related effects on Lyackson fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lyackson.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Lyackson is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Lyackson's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

Gathering

Lyackson has said that members recall harvesting berries, cattails, and fiddleheads in the Project area. Berry-picking sites are said to be currently available to Lyackson at Porlier Pass.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Lyackson as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Lyackson during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Lyackson from instream construction activities, are expected to be negligible. While it is acknowledged that Lyackson has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Lyackson resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Lyackson; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lyackson.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Lyackson is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Lyackson's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

Archaeology and Cultural Heritage Interests

Lyackson has identified a number of culturally important places in the Strait of Georgia. A newly constructed youth camp, where the canoes of their ancestors once lined up in preparation for trips to Fraser River, is also located on the eastern side of *Le'eyqsun*. Lyackson also notes the importance of *Tl'uqtinus*, in the vicinity of the north end of the George Massey Tunnel, opposite Tilbury Island. Lyackson Elders and knowledge holders have described *Tl'uqtinus* as having a powerful and permanent *Hul'qumi'num* *Mustimuhw* trading centre for a number of commodities.

The proposed Project has the potential to affect Lyackson's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Lyackson's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Lyackson's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Lyackson’s archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Lyackson has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Lyackson’s archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Lyackson’s archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Lyackson’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Lyackson.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Lyackson (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Lyackson’s Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Lyackson, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Lyackson. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Lyackson's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Lyackson regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Lyackson's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Lyackson prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Lyackson during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Lyackson during consultations include:

- Adequacy of Environmental Assessment (EA) methodology to address social and cultural effects;
- Proper context of village site is not considered nor is the village site as a trade centre accurately characterized;
- Lyackson's access to the Fraser River and the potential to displace fishing vessels;
- Cumulative effects;
- Capacity funding for Traditional Use Study and to facilitate participation in the Project review process;
- Protection of archaeological and heritage resources and opportunities for cultural recognition and naming;
- Aboriginal participation and Project-related opportunities;
- Effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon;
- Social effects of the Project on Lyackson's ability to transfer knowledge, language and participate in socio-cultural practices;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on flow rates, salt wedge and sedimentation after Tunnel removal;

- Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge;
- Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations;
- Potential for public safety concerns related to potential for creation of increased criminal activity and need for appropriate safety/suicide fencing;
- Potential effects of the bridge structure, lighting, and noise on terrestrial wildlife, marine mammals, waterfowl, and migratory birds;
- Inclusion of culturally significant plants in planting plans and opportunity for Lyackson in the identification of plants, and planting work. Need for management of invasive plant species;
- Concern with increased water temperatures in the Fraser River and the importance of opportunities to provide additional shade along the river; and
- Potential effect of removing the Tunnel on marshes along the river.

Based on information provided by Lyackson and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Lyackson has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Lyackson's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Lyackson First Nation, except in the following potentially measurable cases:

- Project construction:

- Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Lyackson regarding proposed measures, management plans, and monitoring programs related to IC and VC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Lyackson, as a result of the Project, are expected.

| ENVIRONMENTAL ASSESSMENT PROCESS | | | |
|---|---|-----------------|--------------------------------------|
| <p>An environmental assessment of the Project is required under the B.C. <i>Environmental Assessment Act</i> (B.C. <i>EAA</i>), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. <i>EAA</i> sets out the criteria for reviewable projects.</p> <p>On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. <i>EAA</i>, and that it requires an EAC.</p> <p>The Project as proposed is not subject to review under the <i>Canadian Environmental Assessment Act, 2012</i>, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.</p> <p>EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the <i>Environmental Assessment Act</i>.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| In addition to the funding provided by the Proponent, Lyackson First Nation requires funding for participation in EAO's own process. | The Ministry provided funding to Lyackson First Nation for the Pre-Application Phase. Funding for the Application Review Phase will be provided. Funding provided by the proponent is inclusive of EAO-led activities. | Referred to EAO | Funding for Application Review Phase |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Lyackson's queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway. | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Lyackson to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Lyackson is working on. Support to date | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--------------------------------------|
| | has included Pre-Application capacity funding. | | |
| Lack of resources and funding for First Nations communities. “It is like 100 referrals in one spread out over a number of years.” | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |
| Strength of Claim assessment and related depth of consultation. Proper context of Village site is not considered nor is the Village site as a trade centre accurately characterized. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Lack of EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessment of VCs that are directly linked to the exercise of those Aboriginal Interests | Concerns relating to the lack of EAO requirement to assess incremental cumulative effects have been referred to EAO. | Referred to EAO | None |

| ABORIGINAL INTERESTS | | | |
|---|---|--------------------------|--|
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Lyackson First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided. “It is clear that Lyackson First Nation values, particularly those related to subsistence fishing, are likely to be directly impacted by Project construction and operation.” | Lyackson’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined. | Addressed in Application | Ongoing consultation and implementation measures outlined in Section 5.2.4 |
| Lyackson First Nation’s use of lands, waters, and resources in the area of the mouth and south arm of the Fraser River within 5 km of the Project, including the ancestral village site of the ʔəqtinəs/Tl’uqtinus and camps, cabins, and other residences in the area of Steveston and Canoe Pass, are fundamental to past, present, and future Lyackson First Nation use and occupancy, and to the ongoing practice of Lyackson First Nation culture, identity, and rights. | Noted. | Noted. | Ongoing consultation |
| Protection of Lyackson First Nation’s rights to harvest within the Project area. | Lyackson’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.5, residual effects on the exercise of Aboriginal Interests by Lyackson as a result of the Project are not expected. | Addressed in Application | Implementation of measures outlined in Section 10.1.3.5 |
| Consideration of cumulative effects on aboriginal rights | The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in | Addressed in Application | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| | <p>conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | | |
| <p>Inappropriate toll burden to access Lyackson village site, especially considering the current BC Ferries toll burden.</p> | <p>Noted.</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| ABORIGINAL CONSULTATION | | | |
|--|--|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified. Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Lyackson received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Funding for Traditional Use Study | The Ministry signed funding agreements with the members of the Lyackson which provided funding for a Traditional Use Study. | Addressed | None |

| ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES | | | |
|---|---|---------------|---|
| <p>The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.</p> <p>Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.</p> <p>The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.</p> <p>The objectives and requirements of the Aboriginal Consultation Plan are to:</p> <ul style="list-style-type: none"> • Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests • Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes • Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns • Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes • Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects • Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork. • Incorporate community and traditional knowledge in Project components <p>Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Revenue sharing opportunities from tolling | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |
| Opportunities for cultural recognition and naming. Suggestion that a Canoe be commissioned which would have paddles for each Nation showing the relationship between the Ministry and the Nations. | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Lyackson and other Aboriginal groups on this matter. Lyackson’s suggestion is noted. | Ongoing | Discussion with Aboriginal groups to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development | The Ministry is committed to working with Lyackson to identify potential opportunities to benefit from the | Ongoing | The Ministry will share information as it becomes |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| <p>opportunities. Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage.</p> | <p>Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Lyackson to identify ways to support community preparedness.</p> | | <p>available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |
| <p>Adequate training time to take full advantage of potential future Project work activities. Opportunities for training related to traditional activities.</p> | <p>The Ministry is committed to working with Lyackson First Nation to identify potential opportunities to benefit from the Project. The Ministry has initiated discussions with Lyackson First Nation regarding Project-related benefits and opportunities.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |

| 4.1 RIVER HYDRAULICS | | | |
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| <p>The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.</p> <p><u>Effects</u> A negligible effect to access to river locations for traditional use has been determined. A negligible effect on quality of experience tied to the traditional use of river locations has been determined.</p> <p><u>Mitigation</u> Monitor the riverbed within 100 metres upstream and downstream of the watermain. Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing. Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice</p> <p><u>Residual & Cumulative Effects</u> No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Change in flow rates after Tunnel removal | The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1. | Addressed | Implementation of mitigation measures outlined in Section 4.1.4 |
| Potential effect of removing the Tunnel on marshes along the river. "Marshes should be allowed to naturally occur as they are critical habitat for fish for | Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. Creating | Addressed | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| protection for predators, rest and clear water to breathe.” | comparable habitat within the Project alignment will offset unavoidable potential Project-related effect, which is limited to a small reduction in area of the cattail marsh that overlaps with Project components. Vegetation is addressed in Section 4.7 of the Application. | | |
| Post decommissioning monitoring of potential effects of Tunnel removal and importance of sharing this information with Aboriginal Groups in writing and through meetings. | Environmental monitoring will be conducted during construction of the Project and will have the key objective of ensuring construction activities are undertaken in accordance with the mitigation described within the Application and EAC, CEMP, and associated permits, licenses, and approvals. The CEMP will describe the frequency and scope of environmental monitoring and reporting that will be implemented throughout construction of the Project. Implementation of the environmental monitoring program will be overseen by a qualified environmental professional and will be carried out during all construction activities that have the potential to result in adverse environmental effects. The environmental monitor will assess the implementation of the CEMP and any permits or approvals assigned to the Project, as well the effectiveness of the mitigation applied. The environmental monitor will be authorized to suspend any activity resulting in or potentially resulting in a breach of the CEMP or associated environmental permits, licenses and approvals. The Ministry will share this information with Lyackson. | Addressed | Environmental monitoring and ongoing information sharing |

| 4.2 SEDIMENT AND WATER QUALITY | | | |
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| <p>The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.</p> <p><u>Effects</u> A negligible effect on quality of water used for cultural purposes has been determined. A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.</p> <p><u>Mitigation</u> Avoid effects through Project design. Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment. Develop Construction Environmental Management and Operational Environmental Management plans. Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site. Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams. Monitor water quality during construction. Use timing windows for undertaking in-stream works.</p> <p><u>Residual & Cumulative Effects</u> No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential effects of run off and drainage | The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking | Addressed | Implementation of mitigation measures outlined in Section 4.2.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| | in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application. | | |
| Impacts of the River from potential pollutants and contaminants on the Tunnel walls if left in place | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |

| 4.4 FISH AND FISH HABITAT | | | |
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| <p>The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.</p> <p><u>Effects</u> A negligible effect on the availability of fish resources for traditional use has been determined. A negligible effect on quality of fish resources for traditional use has been determined. A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.</p> <p><u>Mitigation</u> Avoid effects through Project design. Apply best management and environmental management practices. Develop Construction Environmental Management and Operational Environmental Management plans. Use timing windows for undertaking in-stream works. Erosion and sediment control. Habitat enhancement and offsetting.</p> <p><u>Residual & Cumulative Effects</u> There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period. No significant Project-related residual or cumulative effects on fish and fish habitat are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Lyackson. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 |
| Concern with increased water temperatures in the Fraser River and the importance of opportunities to provide additional shade along the river | The Project will not have any measureable effects on water temperatures within the Fraser River South Arm and there are limited opportunities to provide shade that could moderate water temperature within this wide mainstem channel. More specifically, the Project will extensively avoid any riparian clearing on the river and any shading provided by the new bridge will be | Addressed | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| | <p>negligible. Determined by factors functioning at a watershed-level (e.g., climate and weather), water temperatures within the lower reaches of the river are primarily determined by upstream factors and not notably influenced by riparian shading. Riparian vegetation does, however, also provide a wide range of other fish habitat functions on large river channels like the Fraser River. These fish habitat functions include, but are not limited to shoreline habitat complexity, biofiltration functions, insect drop for food, and detrital inputs which support the broader food web. Although there are limited opportunities to directly affect water temperatures within the mainstem river, the Project’s proposed restoration of Green Slough is anticipated to provide enhanced habitat for fish, including riparian vegetation that will provided shaded habitat for fish.</p> | | |
| <p>Fish mortality from pile driving and blasting</p> | <p>The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. Mitigation, including timing windows for undertaking in-stream work and other measures outline in Project-related Environmental Management Plans, will ensure that potential effects on fish and fish habitat are effectively addressed. Fish mortality should not be a significant issue during pile driving.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |
| <p>Effects of pile driving on salmon migration</p> | <p>Pile driving should not have an impact on salmon migration.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| | scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application. | | |

| 4.6 MARINE MAMMALS | | | |
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| <p>Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River.</p> <p>Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.</p> <p><u>Effects</u></p> <p>A negligible effect on the availability of marine mammal resources for traditional use has been determined.</p> <p>A negligible effect on quality of marine mammal resources for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.</p> <p><u>Mitigation</u></p> <p>Apply standard industry and best management practices to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.</p> <p>Monitor underwater noise.</p> <p><u>Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on marine mammals are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Impact on marine mammals such as the Stellar Sea Lion | Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 kms. Standard industry and best management practices will be applied to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to. Marine Mammals are addressed in Section 4.6 of the | Addressed in Application | Implementation of mitigation measures outlined in Section 4.6.4 |

George Massey Tunnel Replacement Project

ABORIGINAL CONSULTATION – Appendix H2 Lyackson First Nation Overview Table

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| | Application. | | |

| 4.7 VEGETATION | | | |
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| <p>The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development. Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, moved verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.</p> <p><u>Effects</u> A negligible effect on the availability of vegetation resources for traditional use has been determined. A negligible effect on quality of vegetation resources for traditional use has been determined. A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.</p> <p><u>Mitigation</u> Minimize potential effects through Project design. Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction. Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species. Invasive species management.</p> <p><u>Cumulative Effects</u> No significant Project-related residual or cumulative effects on vegetation are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Inclusion of culturally significant plants in planting plans and opportunity for Lyackson in the identification of plants, and planting work. Lyackson has the capacity to undertake this type of work. | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | Develop planting plans with consultation from Aboriginal Groups |
| Ministry's hydro-seeding spray contains invasive grasses that will damage new plants and add to the problem of invasive | The Ministry will review its hydroseed mixes. | Addressed | Review hydro-seed mixes |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| plants. | | | |

| 4.8 TERRESTRIAL WILDLIFE | | | |
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| <p>The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.</p> <p><u>Effects</u> A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined. A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined. A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.</p> <p><u>Mitigation</u> Minimize potential effects through Project design. Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions. Habitat enhancement and offsetting.</p> <p><u>Residual & Cumulative Effects</u> There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows. There is a low, long-term probability of barn owl mortality. No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential light and noise effects on wildlife and fish. | The Ministry understands that Lyackson is concerned with the potential effects of light and noise on species such as waterfowl, owls, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 |
| Potential effects of the bridge structure on species such as waterfowl and migratory birds. | The Ministry understands that Lyackson is concerned with the potential effects of the new bridge structure on species such as waterfowl and migratory birds. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| | Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application. | | |
| Destruction of wildlife habitat, especially for bald eagles and blue herons, due to disturbance of green space on Deas Island and other riparian areas in the Project footprint during construction and operation of the Project. | Environmental protection measures that will be implemented during Project construction and operation to prevent of minimize potential effects on vegetation, and thereby potential effects on wildlife habitat, will be outlines in a Construction Environmental Management Plan as described in Section 12.0.The Plan will include a Terrestrial Vegetation and Wildlife Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Decreased quantity of birds, especially migratory waterfowl and eagles, in the Project area due to BC Hydro power lines and other above-ground structures. | As discussed in Section 4.7 (Terrestrial Wildlife), a collision risk study was conducted to understand seasonal use and behaviours by birds, and to estimate collision risk at the new bridge crossing location. The findings of the study indicate that collision effects to birds are considered unlikely and that most birds avoid collisions by flying above or below structures | Addressed in Application | None |
| Potential for impacts to wildlife , including nesting birds, due to increased air contamination from idling vehicles and the running of BC Hydro power lines above ground (as opposed to their current location within the George Massey Tunnel). | As discussed in Section 4.9 (Air Quality), ambient air quality in the vicinity of the Highway 99 corridor is expected to improve in the future, with or without the Project. | Addressed in Application | None |

| 4.9 AIR QUALITY | | | |
|---|---|-----------|-------------------------|
| <p>Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project. The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today. Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.</p> <p><u>Effects</u> No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.</p> <p><u>Mitigation</u> Minimize effects through Project design. Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects. Measure and monitor vehicle emissions and road dust during Project operation.</p> <p><u>Residual & Cumulative Effects</u> No significant Project-related residual or cumulative effects on air quality are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Congestion and air quality issues – support for improved transit and anything that reduces idling. | Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
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| | <p>on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | | |
| <p>Increased air contamination from idling vehicles, perceivable from the Fraser River banks, resulting in disturbance of LFN use and potential adverse effects on human and animal health</p> | <p>Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

| 4.10 ATMOSPHERIC NOISE | | | |
|--|---|--------------------------|--|
| <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.</p> <p><u>Effects</u> No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined. No or negligible effect on quality of experience while engaged in or tied to traditional use as a result in ground-borne vibration has been determined.</p> <p><u>Mitigation</u> Minimize effects through Project design. Adhere to construction best practices and the Ministry’s 2014 <i>Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways</i>. Develop and implement a Noise Management Plan.</p> <p><u>Residual & Cumulative Effects</u> With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential impacts of noise from pile driving and blasting | The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Mitigation in accordance with the Ministry’s 2014 <i>Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways</i> will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.10.4 |
| Increase in traffic, and consequent increase in associated noise and vibration due to the increases capacity of the new bridge | The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current | Addressed in Application | Implementation of mitigation measures outlined in 4.10.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---|--------|-------------------------|
| | noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application. | | |

| 5.2 MARINE USE | | | |
|--|---|---------------------------------|---|
| <p>The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.</p> <p>A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.</p> <p>Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.</p> <p><u>Effects</u></p> <p>A negligible effect on access to instream locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Minimize effects through Project design.</p> <p>Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.</p> <p>Establish communications protocols to advise in-stream construction activities.</p> <p>Ensure appropriate lighting and marking for safe navigation.</p> <p>Establish navigation protection zones during construction to avoid or minimize impact on marine use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on marine access are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Lyackson fishing.</p> | <p>Potential interference with Lyackson fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |

| 5.3 LAND USE | | | |
|--|---------------------------|--------|-------------------------|
| <p>The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.</p> <p>The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.</p> <p>Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewscales.</p> <p>The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.</p> <p><u>Effects</u></p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Minimize effects through Project design.</p> <p>Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.</p> <p>Incorporate land use considerations into a Marine Access Management Plan.</p> <p>Reconnect recreational trails.</p> <p><u>Residual & Cumulative Effects</u></p> <p>There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.</p> <p>There is a high, short-term probability of disturbance to recreational uses near the new bridge.</p> <p>No significant Project-related residual or cumulative effects on marine access are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Lyackson has not voiced any specific issues or concerns with respect to Land Use. | | | |

| 5.5 VISUAL QUALITY | | | |
|---|--|-----------|-------------------------|
| <p>The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.</p> <p><u>Effects</u> During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape. During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.</p> <p><u>Mitigation</u> Minimize effects through Project design. Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.</p> <p><u>Residual & Cumulative Effects</u> There is a moderate, long-term probability of disturbance to visual quality. No significant Project-related residual or cumulative effects on marine access are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Running of BC Hydro power lines above ground (as opposed to their current location within the George Massey Tunnel). | If the BC Hydro’s transmission line is built above ground, it is expected that it will visually blend with the bridge structure. | Addressed | None |

| 6.1 HERITAGE RESOURCES | | | |
|---|---|---------------------------------|--|
| <p>The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.</p> <p><u>Effects</u></p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p>During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.</p> <p>During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.</p> <p><u>Mitigation</u></p> <p>Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.</p> <p>Undertake additional archaeological surveys.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on heritage resources are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Protection of archaeological and heritage resources, including intangible heritage sites.</p> <p>Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area. No more tolerance for further disturbance of archaeological sites in the overdeveloped Lower Mainland. This includes disturbed and intact sites.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Lyackson.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports. Importance of having a cultural person, known to LCFN and LFN, participate in archaeological work.</p> | <p>Lyackson participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed in Application</p> | <p>Lyackson will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |
| <p>Assessment of cultural significance of the</p> | <p>The cultural significance of Deas Island is noted. The</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------|-------------------------|
| site, if a run off pool is being created for the Project on Deas Island | use of biofiltration ponds will provide a benefit by improving the level of treatment of surface runoff from highway 99. | | |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improved connectivity and access, improved emergency response, and economic development opportunities. Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects. Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

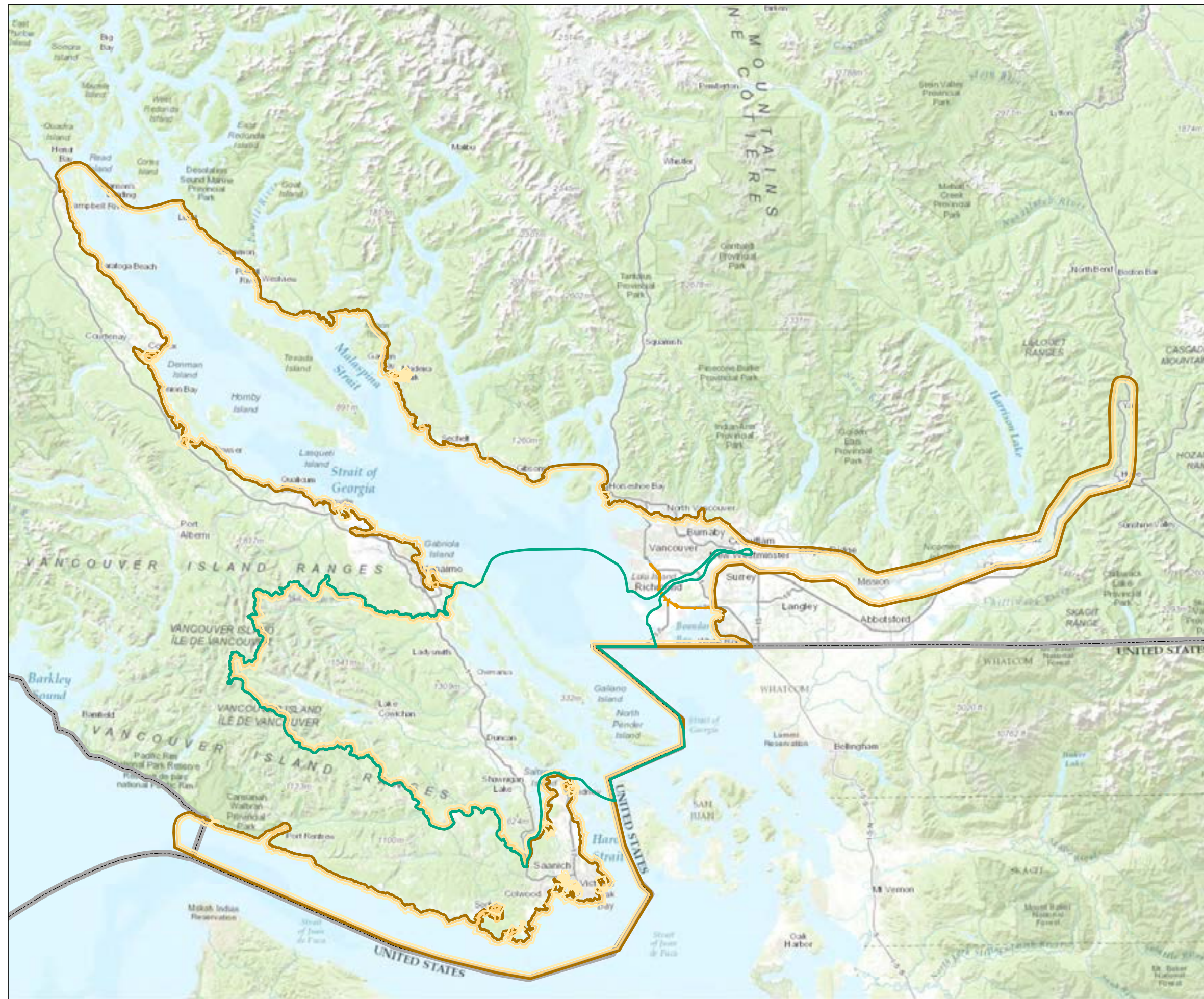
Residual & Cumulative Effects

| 7.0 HUMAN HEALTH | | | |
|--|---|--------------------------|---|
| No significant Project-related residual or cumulative effects on human health are expected. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| New bridge will result in increased suicide attempts | The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Lyackson. Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application. | Addressed in Application | Development of safety barrier policy for new bridges in the Lower Mainland. Implementation of mitigation measures outlined in Section 7.1 |
| The potential spread of social problems, including drug and sex trafficking, to more areas in the Lower Mainland due to economic change. Bottleneck at current Tunnel hampers illegal drug traffic - new Bridge will facilitate drug flow. New bridge will create proliferation of prostitution and drugs. Areas under Bridge will attract homeless population. Value added parks will not offset social impacts. | While not assessed as a Value Component in the Application, the potential for “at-risk populations” to use/congregate in areas near the bridge will be considered in Section 7.1 of the Application. | Addressed | None |





| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Section appears to focus exclusively on the construction phase. Lyackson’s concerns are with the full life cycle - construction, operations, and deconstruction. | Section 8.0 (Accidents and Malfunction) addresses all aspects of the Project including construction, Tunnel decommissioning and operations. During construction and decommissioning, construction personnel will act in accordance with the Emergency Response and Spill Contingency Plan. During operations, accidents and other types of emergencies will be managed in accordance with the Ministry’s Highway Maintenance Specifications for Emergency Maintenance and related standards. | Addressed in Application | Adherence to appropriate plans, specifications and standards. |

| OTHER ISSUES | | | |
|---|---|---------------|--------------------------------|
| Consultation with Lyackson identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Congestion at Richmond-Vancouver border | Traffic analysis shows that approximately 60 per cent of northbound morning Tunnel traffic is destined to Richmond, and that traffic volumes at the Oak Street and Knight Street bridges have been declining since 2010. While Oak Street is likely to remain congested due to signal lights at Oak Street and 70th Avenue in Vancouver, the Project is not expected to result in more traffic driving over Oak Street Bridge each day. The new replacement bridge and the Highway 99 improvements will increase the convenience of accessing transit and provide an efficient route to the Canada Line stations in Richmond for commuters continuing to Vancouver. Traffic is addressed in Section 5.1 of the Application. | Addressed | None |
| Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River. | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed | None |

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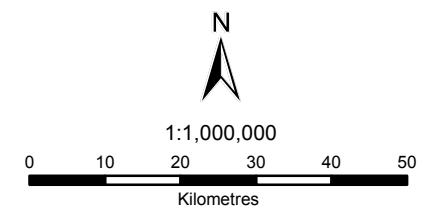


Legend

-  Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory
-  Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

HUL'QUMI'NUM TREATY GROUP ASSERTED TRADITIONAL TERRITORY

Figure 10-2

26/05/2016

APPENDIX I

Musqueam Indian Band

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Musqueam Indian Band (Musqueam).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Musqueam, refer to the following sections of Part C:

- Consultation with Musqueam (**Section 10.1.2.10**);
- Musqueam community profile (**Section 10.1.1.7**);
- Description of existing Musqueam Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Musqueam Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Musqueam Aboriginal Interests following application of mitigation (**Section 10.1.3.5**).

A summary of the Aboriginal Interests Assessment for Musqueam is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Musqueam Overview Table (**Appendix I2**), which provides detailed information regarding:

- Musqueam’s issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Musqueam’s Aboriginal Interests;
- The Ministry’s response to specific issues and concerns raised by Musqueam;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry’s provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Musqueam and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, Musqueam attended two EAO-led Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second Working Group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a

description and rationale of the assessment areas. Working Group comments raised by Musqueam in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence within the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Musqueam also participated in the completeness review of the Application for an Environmental Assessment Certificate (Application) that considered whether the Application included information requirements set out in the Application Information Requirements.

It is assumed that Musqueam will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Musqueam in early 2013 in order to identify the nature and scope of Musqueam's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Musqueam. A more detailed discussion is provided under the Musqueam section in **Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Musqueam. The Ministry has been working with Musqueam regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. It is anticipated this will be summarized in a joint Memorandum of Understanding between the Musqueam and Ministry. Consultation activities that are anticipated to be undertaken during the Application Review Phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Musqueam for the preparation and submission of the traditional use study *Salmon So Thick, That You Could Walk on Water: Preliminary Scope of Musqueam Components for the Environmental Impact Assessment of the Proposed George Massey Tunnel Replacement Project*. The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Musqueam during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of Project Description. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, draft Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Musqueam included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Musqueam;
- Funding for Musqueam's participation in Project consultation activities and EA process;
- Musqueam participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment, draft AIR and Aboriginal Consultation Plan;
- Meetings with Musqueam leadership, staff, consultants, elders and membership; and
- Response and follow up with Musqueam regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of Section 11 Order, AIR development and collection of baseline information. The main consultation activities the Ministry undertook with Musqueam included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Musqueam;
- Funding for Musqueam's participation in Project consultation activities and EA process;
- Meetings with Musqueam leadership, staff, consultants, elders and membership;
- Musqueam participation in fieldwork;
- Musqueam participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports;
- Review of draft Part C content for the Application; and
- Response and follow up with Musqueam regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Musqueam’s concerns, identified through consultation undertaken to-date, are presented in **Appendix I2 Musqueam Indian Band Overview Table**. The Ministry’s response to Musqueam’s key concerns regarding potential impacts on Musqueam’s Aboriginal Interests are outlined below:

Table 1 Concerns identified to date

| Concerns Identified to Date | Response |
|--|---|
| Musqueam’s rights to harvest under the Sparrow decision | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam’s right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River, As outlined in Sections 4.4. (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife) of the Application, the Ministry is committed to avoiding or mitigating any potential effects on fish and fish habitat. This will be achieved through the application of best practices and environmental management practices. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and training • Revenue sharing opportunities from tolling | The Ministry is committed to working with Musqueam to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Musqueam on these opportunities. The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways. |

| Concerns Identified to Date | Response |
|---|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Importance of sloughs, tributaries and riparian work for fish stocks • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, and salmon to Musqueam and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Musqueam’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat for fish and wildlife.</p> <p>Construction Environmental and Operational Construction plans will be developed. These will include the use of timing windows for undertaking in-stream works.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Process and associated timelines | <p>The Ministry acknowledges the importance of Musqueam’s involvement in the environmental assessment process and has provided funding during the Initial Consultation and Pre-Application process; it is committed to funding Musqueam’s participation in Application Review phase.</p> <p>Musqueam’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects and process and association are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> |

| Concerns Identified to Date | Response |
|--|---|
| <p>Social effects of the Project on Musqueam’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Musqueam’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C of the Application. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> <p>In summary, the following incremental Project-related effects, following mitigation measures provided in Part B, were identified for the exercise of Aboriginal Interests specifically related to cultural heritage for Musqueam:</p> <ul style="list-style-type: none"> • Project construction: <ul style="list-style-type: none"> ▫ Potential temporary direct (minor to moderate) effect on access related to instream construction activities and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access ▫ Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance • Project operation: <ul style="list-style-type: none"> ▫ Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise and a potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses <ul style="list-style-type: none"> ▫ Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

| Concerns Identified to Date | Response |
|---|--|
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Musqueam and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Musqueam or was otherwise available from publicly available sources. However, incremental cumulative effects on the exercise of Aboriginal Interests has not been considered separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. Following the implementation of mitigation measures on the relevant VCs and ICs and on the incremental potential effects on the exercise of Aboriginal Interests, the residual adverse effects on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and were not carried forward into an assessment of cumulative effects.</p> <p>While the Ministry acknowledges that Musqueam is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. The Ministry understands that Musqueam is discussing this request with other provincial and federal ministries and agencies.</p> |
| <p>Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project, including the decommissioning of the Tunnel, will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River today. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> |
| <p>Potential effects on Fraser River flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, and management of runoff from the bridge</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. The bridge will collect and direct runoff to specifically designed biofiltration marshes at the bases of the main towers (one on Deas Island and one in Richmond). The purpose of these biofiltration marshes is to naturally clean the water prior to re-entry into the ecosystem. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciate change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> |

3.0 Community Profile – Musqueam Indian Band

Musqueam is governed by a chief and council with two-year terms under an *Indian Act* electoral system. The current term for the 11-member council expires in January 2017.

Musqueam’s main community is based at the mouth of the North Arm of the Fraser River, within the limits of the City of Vancouver, where 671 of 1337 registered members reside. A second reserve is located across the river from this location, on Sea Island, within the City of Richmond, while a third reserve is located in Ladner, near Canoe Pass, off the South Arm of the Fraser River. At one time, the Musqueam had a fourth reserve (the first reserve set aside for them) further up the Fraser River at Qiqéyt (Brownsville). The Project alignment does not overlap any current or former Musqueam reserve lands, but falls almost entirely within the Musqueam’s traditional territory as described by Musqueam and provided in their Statement of Intent filed with the British Columbia Treaty Commission.

The Project area is situated approximately four km upstream of Canoe Pass, where Musqueam have an established Aboriginal right to fish for food, social, and ceremonial purposes pursuant to the Supreme Court of Canada’s decision in *R. v. Sparrow* [1990], 1 S.C.R. 1075 (SCC 1990). The Ministry understands the Musqueam take the view that their established right extends to areas beyond Canoe Pass. Musqueam territory was described in the *Sparrow* decision as “extending from the north arm of Burrard Inlet to the south shore of the main channel of the Fraser River including the waters of Burrard Inlet, the North Arm, the Middle Arm, the Main Channel, Canoe Pass (or passage) and Ladner Reach” (MIB 2015).

3.1 Musqueam Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes are or may be connected with the exercise of Musqueam’s Aboriginal Interests. A more detailed discussion, including sources used, is provided under Musqueam in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- Musqueam has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.
- The current exercise of Aboriginal Interests by Musqueam at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively high.

- Musqueam has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Musqueam has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities, including at or about but not limited to the reported location of 7uqtinus or λ'eqətines.

3.1.2 Fishing

- Musqueam has an established right to fish for food, social, and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River pursuant to *R. v. Sparrow* [1990], 1 S.C.R. 1075 (SCC 1990). The Project area lies immediately upstream of this area, and within the area where this right is considered by the Ministry to be asserted.
- Musqueam also assert an Aboriginal right to fish for food, social and ceremonial purposes in a broader area that includes, but is not limited to, all waters of the Fraser River – including its North Arm, Middle Arm, and South Arm – downstream of the Port Mann Bridge to the Strait of Georgia.
- All five species of Pacific salmon, steelhead, rockfish (rock cod, red snapper), herring and herring spawn, smelt, halibut, eulachon, trout, and sturgeon were fished historically by the Musqueam in their traditional territory, and all were important economically. The most commonly harvested marine mammals included harbour seal, sea lion, and porpoise; harvesting areas included the Fraser River estuary. At productive beaches within Musqueam traditional territory, abalone, barnacles, clams, chitons, cockles, mussels, crabs, crayfish, octopus, oysters, prawn, scallops, sea urchins, sea cucumber, shrimp, and seaweed were harvested and set aside for winter supplies; however, clams were the most abundant and heavily harvested, including at Boundary Bay.
- Fishing remains central to Musqueam, and they have specified that the waters outside Steveston, Canoe Passage, and the lower of the Fraser River, and Roberts Bank are their most intensive salmon harvesting areas. Salmon is a key species to the Musqueam, important for FSC and economic purposes.

3.1.3 Hunting/Trapping

- Musqueam report harvesting deer, wapiti (elk), bear, and mountain goat in several areas of their traditional territory, with deer and bear taken at Burns Bog within living memory, and deer harvested at areas along the South Arm of the Fraser River. Harvesting of game (e.g., deer, mountain goat) continues in more northerly parts of the traditional territory.
- Trapping of small land mammals was once common, with mink, muskrat, and otter harvested mainly for furs and beaver and rabbit harvested for both food and furs.

- More recently, hunting within Musqueam traditional territory has been focused primarily on wildfowl, including mallard, teal, widgeon, pintail, black duck, geese, grouse, and pheasant, and has taken place on the river banks, marshes, and meadows throughout the Fraser delta, including, but not limited to, the foreshore areas adjacent to the Musqueam reserve on Canoe Pass and those adjacent to Tsawwassen Lands. Musqueam identify mergansers as having specific cultural importance.

3.1.4 Gathering

- Common terrestrial plant foods consumed domestically were wapato, camas lily, huckleberry, blueberry, salmonberry, elderberry, bog cranberry, slehal (salal) berries, and Pacific crabapple. Of these, berries were particularly central. Bog cranberries were also a commodity, exchanged with other nations. Berry gathering and exchange remains important for food and ceremonial purposes.
- Musqueam report harvesting kelp, an important food and medicinal plant, throughout Roberts Bank and Sturgeon Bank historically. Kelp is currently traded for either because it cannot be found or is avoided due to contamination concerns.
- Musqueam identify Brunswick Point, which is approximately 12 km southwest of the Project corridor, as an important area for harvesting aquatic and terrestrial plants for food, medicinal, ceremonial, and manufacturing purposes. Intertidal species harvested include cattail, tule, and grasses.
- Other key harvesting areas for these plants include Westham Island, Canoe Pass, Musqueam Indian Reserve 4, and Ladner. Musqueam report that although they continue to harvest many of these resources, some are no longer accessible in former locations due in part to changing intertidal landscapes and barriers associated with commercial and industrial development.

3.1.5 Archaeology and Cultural Heritage Interests

- Musqueam identify several trails within the Fraser River estuary, including trails associated with the following place names: ʔ'eqtines (Lulu Island, across from Deas Island; sc'ələxwqən' (Ladner); and, spəxən (two trails on the eastern margins of Crescent Slough, at the western aspect of Burns Bog). They also reference a trail running north-south along the western shore of Lulu Island, to and from the Steveston area (qweya?xw, qwleyəm).

3.1.6 Other Related Interests

- Musqueam report that, historically, they could navigate from the North Arm of the Fraser River through what is currently known as Richmond (Lulu Island) and Delta, using slough channels as an alternate to ocean travel. These sloughs, which once supported fishing locations, no longer survive. Musqueam maintain that the remaining waterways have become reportedly congested with log booms and increasing vessel traffic, resulting in more vessel interactions, loss of fishing gear, and safety concerns.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Musqueam's Aboriginal Interests, specifically. For a more detailed description of the methodology and a summary of the results, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project will be publicly available on the Project's website at www.masseytunnel.ca. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs and ICs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Musqueam's exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | <p>Construction - Potential temporary direct (minor to moderate) effect on access related to instream construction activities</p> <p>Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses</p> |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses</p> |

4.4 Potential Project-Related Effects on Musqueam's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Musqueam's Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-related Effect |
|--|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor to moderate) effect on access related to instream construction activities |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • For instream locations for traditional use, potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access • Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

According to Musqueam, fishing is the most frequently practiced resource harvesting activity by its members on the Fraser River, with salmon being the key species. Other species of interest harvested throughout their traditional territory include eulachon, herring, smelt, halibut, eulachon, trout, and sturgeon. Musqueam also reports harvesting a variety of bivalves and other seafood.

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Musqueam, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Musqueam during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Musqueam from instream construction activities are expected to be episodic and of short duration. Construction-related effects could potentially disrupt Musqueam's access to preferred fishing locations.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Musqueam. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Musqueam; therefore, Potential Project-related effects on Musqueam fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Musqueam.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Musqueam is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Musqueam's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Musqueam report harvesting a range of wildlife species, including mammals such as deer and elk and a number of species of wildfowl. Harvesting has taken place on the river banks, marshes, and meadows throughout the Fraser delta including the foreshore areas adjacent to the Musqueam reserve on Canoe Pass and those adjacent to Tsawwassen Lands.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Musqueam as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Musqueam during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Musqueam from instream construction activities, are expected to be episodic and of short duration. Construction-related effects could potentially be disruptive to Musqueam's access to preferred fishing locations.

Potential changes in access to upland locations for hunting and trapping by Musqueam resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Musqueam. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Musqueam; therefore, Potential Project-related effects on Musqueam fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Musqueam.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Musqueam is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Musqueam's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Musqueam report harvesting terrestrial plant foods including wapato, camas lily, various berries and Pacific crabapple. Musqueam report kelp as an important food and medicinal plant, and intertidal species of interest include cattail, tule, and grasses. Musqueam identify Brunswick Point, Westham Island, Canoe Pass, Musqueam Indian Reserve 4, and Ladner as key harvesting areas.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Musqueam as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Musqueam during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Musqueam from instream construction activities, are expected to be episodic and of short duration. Construction-related effects could potentially be disruptive to Musqueam's access to preferred gathering locations.

Potential changes in access to upland locations for gathering by Musqueam resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Musqueam; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Musqueam.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Musqueam is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Musqueam's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Musqueam identify several trails and place names within the Fraser River estuary.

The proposed Project has the potential to affect Musqueam's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Musqueam's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Musqueam's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Musqueam’s archaeological and cultural heritage interests from instream construction activities are expected to be episodic and of short duration. Construction-related effects could potentially disrupt Musqueam’s access to locations related to Musqueam’s archaeological and cultural heritage interests.

Potential changes in access to upland locations related to Musqueam’s archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with locations related to Musqueam’s archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Musqueam’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Musqueam.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Musqueam (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Musqueam’s Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Musqueam, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.9 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Musqueam. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Musqueam's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Musqueam regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

5.0 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

6.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Musqueam's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Musqueam prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Musqueam during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Musqueam during consultations include:

- Musqueam's rights to harvest under the Sparrow decision;
- Aboriginal participation and Project-related opportunities;
- Effects to fish and fish habitat; and
- Cumulative effects;
- Trend in development of the lower Fraser River;
- Adequacy of Environmental Assessment (EA) methodology to address social and cultural effects;
- EA Process for the Project and its associated timelines;
- Social effects of the Project on Musqueam's ability to transfer knowledge, language and participate in socio-cultural practices;
- Consideration of cumulative effects on Aboriginal rights;
- Absence of a comprehensive study of cumulative effects on the Fraser River;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on flow rates after Tunnel removal; and
- Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge.

Based on information provided by Musqueam and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Musqueam has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Musqueam's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Musqueam Indian Band, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor to moderate) effect on access related to instream construction activities and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access
 - Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise and a potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Musqueam regarding proposed measures, management plans, and monitoring programs related to VC and IC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Musqueam, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Adequacy of Environmental Assessment (EA) methodology to address social and cultural effects | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Concern with the inclusion of certain Aboriginal Groups in Project consultation per Schedule B of the Section 11 Order | Consultation is being undertaken in accordance with the requirements of the Section 11 Order and as outlined in the Aboriginal Consultation Plan. Further discussion regarding the assignment of Aboriginal Groups to Schedule B of the Section 11 Order should be undertaken directly with EAO. | Referred to EAO | None |
| EA Process for the Project and its associated timelines | Concerns relating to the EA process and its associated timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Musqueam’s queries regarding the EA Process and associated timelines. | Referred to EAO | None |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|--|-----------------|-------------------------|
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Musqueam to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Musqueam is working on. Support to date has included Pre-Application capacity funding and the development of a Musqueam-specific Consultation Plan outlining agreed to consultation activities. The Ministry is working with Musqueam on a Memorandum of Understanding that is intended to further support Musqueam's involvement in the EA Process and associated consultation. | Referred to EAO | None |
| Use of MARR database for assessing Strength of Claim | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO | None |
| Standard EA methodology's use of the term "baseline" – to Musqueam this means more that current levels | The Ministry acknowledges that Musqueam's interpretation/use of the term "baseline" differs from the standard definition/use of this terminology for the purposes of this EA. | Addressed | None |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------------|--|
| Request for a Musqueam Specific Project-related study to be undertaken in advance of the start of the Application Review Phase | The Ministry funded a Musqueam Project-related study during the Initial Consultation Phase and will work with Musqueam during the Application Review Phase to support Musqueam in sharing information, knowledge and input in relation to the Project and its review process. The Ministry anticipates further discussion regarding the request for an additional study during Memorandum of Understanding (MOU)-related discussions. | Ongoing | MOU-related discussions, including the request for an additional study |
| EA guidelines including Application Information Requirements (AIR) template were developed without First Nations' consultation | This concern is beyond the scope of the Project's EA process and pertains to EAO process. Concerns related to First Nations consultation during the development of the AIR template have been referred to EAO. | Referred to EAO | None |
| Lack of resources and funding for participation in the EA Process | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. The Ministry is working with Musqueam on a MOU that is intended to support Musqueam's involvement in the EA Process and associated consultation. The Ministry understands that Musqueam wishes to address Application Review Phase funding-related needs and concerns in the context of the MOU. | Ongoing | MOU-related discussions, including Application Review Phase funding |

ABORIGINAL INTERESTS

There are potential Project related impacts to Musqueam title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Instream locations (during construction)

Quality of experience while engaged in or tied to traditional use

- cultural landscape
- Instream locations (during construction)

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations (during construction)
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Musqueam as a result of the Project are not expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Potential impacts to Musqueam title, Rights and culture | Potential Project related impacts to Musqueam title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Musqueam to ensure any effects are minimized. | Addressed in Application | Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application |
| Social effects of the Project on Musqueam’s ability to transfer knowledge, language and participate in socio-cultural practices | Social effects of the Project on Musqueam’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application. | Addressed in Application | Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Consideration of cumulative effects on Aboriginal rights | The Application includes historical context relating to changes in use over time by Musqueam and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Musqueam or was otherwise available from publicly available sources. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Musqueam is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. The Ministry understands that Musqueam is discussing this request with other provincial and federal ministries and agencies. | Addressed | None |

ABORIGINAL CONSULTATION

Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.

Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.

In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs related to the exercise of Aboriginal Interests.

Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|--|----------------|--|
| <p>Consultation with Musqueam is required for any land disposition, including surplus lands potentially sold to adjacent farmers</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Ongoing</p> | <p>Appropriate consultation will be undertaken on any disposition</p> |
| <p>Capacity funding to facilitate participation in the Project review process</p> | <p>The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. The Ministry is working with Musqueam on a Memorandum of Understanding that is intended to support Musqueam’s involvement in the EA Process and associated consultation. It is the Ministry’s understanding that Musqueam wishes to address Application Review Phase funding-related needs and concerns in the context of the MoU.</p> | <p>Ongoing</p> | <p>MOU-related discussions, including Application Review Phase funding</p> |
| <p>Appropriate use of information shared by Musqueam as it relates to confidentiality and dissemination</p> | <p>The Ministry understands and respects that certain information shared by Musqueam may be considered confidential. The Ministry is subject to the provisions of the <i>Freedom of Information and Protection of Privacy Act</i>. Subject to the requirements of applicable laws, the Ministry will respect Musqueam requests to keep information confidential.</p> | <p>Ongoing</p> | <p>MOU-related discussions, including provisions related to the use of information</p> |

| | | | |
|--|--|-----------|---|
| Musqueam requests a Musqueam-only site visit | Per this request, the Ministry undertook a site visit with Musqueam. No other Aboriginal Groups were present. | Addressed | None |
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Musqueam which provided funding for a Traditional Use Study. Musqueam submitted a Project related study to the Ministry, but did not submit a Traditional Use Study. The Ministry is working with Musqueam with respect to the sharing of Traditional Use information and expects that related discussions will occur in the context of an MOU. | Ongoing | MOU-related discussions, including the sharing of Traditional Use information and study |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components
- Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Opportunities for cultural recognition and naming, art and interpretive signage. Funding for cultural interpretation and signage</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Musqueam on these opportunities and determine any related funding requirements.</p> | <p>Ongoing</p> | <p>Further engagement with Musqueam is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage.</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Adequate training time to take full advantage of potential future Project work activities</p> | <p>The Ministry is committed to working with Musqueam to identify potential employment, training, contracting and economic development. The Ministry acknowledges that Musqueam wants to prepare its membership for employment opportunities and will work with Musqueam to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>MOU-related discussions, including identification of potential employment, training, contracting and economic development opportunities and timelines.</p> |
| <p>Interest in revenue sharing opportunities from tolling</p> | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. In accordance with the provincial tolling strategy, revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways.</p> | <p>Addressed</p> | <p>None</p> |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|--------------------------|--|
| Potential effects on salt wedge from decommissioning of the Tunnel | Potential Project-related effects of Tunnel removal on salt wedge from decommissioning the Tunnel are addressed in Sections 4.1 (River Hydraulics) and 4.4 (Fish and Fish Habitat) of the Application. The timing window during which the salinity of the water exceeds the threshold for irrigation is almost identical with and without the Tunnel. The Tunnel does not substantially protrude above the riverbed and removal will not affect the behaviour of the salt wedge in any significant way with respect to the availability of water that is suitable for irrigation or to fish and fish habitat. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Potential effects on flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures) |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Potential effects on sedimentation after Tunnel removal</p> | <p>No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures)</p> |
| <p>Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. The bridge will collect and direct runoff to specifically designed biofiltration marshes at the bases of the main towers. The purpose of these biofiltration marshes is to naturally clean the water prior to re-entry into the ecosystem. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciate change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures)</p> |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|---|--|---------------------------------|-------------------------|
| <p>Effect of shipping on carbon dioxide levels in the water, concern with effluent acidity levels and carbon outputs from ships affecting water and air quality</p> | <p>This is outside the scope of the Project. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed in Application</p> | <p>None</p> |
| <p>Use and disposal of dredged and other material in the river</p> | <p>The minimal amount of dredged sediment will be placed on a barge as will sections of the concrete mattress and brought to shore for applicable testing prior to disposal/recycling. The shot rock removed will be stored on shore and potentially reused as further protection to the Metro Vancouver watermain just downstream of the project.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|--|---|---|
| Protection of Musqueam 's rights to harvest under the Sparrow decision | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam's established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigating any potential effects on fish and fish habitat. | Acknowledged and addressed in Application | Ongoing consultation and implementation of mitigation measures in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Musqueam and is committed to avoiding or mitigation any potential effects | Addressed in Application | Implementation of mitigation measures outlined in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Importance of Musqueam Fisheries Department reviewing Green Slough concept | The Ministry will continue to meet with Musqueam's Fisheries Department on the Green Slough concept and any other component of the Project. The Green Slough concept has been shared with Musqueam, including representatives of Musqueam Fisheries Department, for input. | Ongoing | Ministry will continue to meet with Musqueam's Fisheries Department |
| Importance of sloughs, tributaries (Serpentine River), riparian work for fish stocks | Fish and fish habitat is discussed in Section 4.4 (Fish and Fish Habitat). The Ministry acknowledges the importance of sloughs, tributaries and riparian areas for fish stocks and is undertaking enhancement and riparian works. The Ministry will continue to seek Musqueam's input in the development of related plans. | Addressed in Application | Ministry will continue to seek Musqueam's input in the development of plans |

| Issue | Proponent Response | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities.</p> | <p>There will be no direct pile driving in the river. Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shallow water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Sections 4.3.4 (Underwater Noise Mitigation Measures 4.4.4 (Fish and Fish Habitat Mitigation Measures))</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|--|
| Protection of Musqueam 's Aboriginal Interests – availability, quality, experience tied to traditional use of marine mammal resources for traditional purposes.. | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam's established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigation any potential effects on marine mammals. | Acknowledged and addressed in Application | Ongoing consultation and implementation of mitigation measures in Section 4.6.4 (Marine Mammals Mitigation Measures) |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|---|
| Protection of Musqueam 's Aboriginal Interests – availability, quality, experience tied to traditional use of vegetation resources for traditional purposes. | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam's established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigation any potential effects on vegetation. | Acknowledged and addressed in Application | Ongoing consultation and implementation of mitigation measures in Section 4.7.4 (Vegetation Mitigation Measures) |
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures) of the Application |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Musqueam on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Musqueam |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

- A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

- Minimize potential effects through Project design.
- Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.
- There is a low, long-term probability of barn owl mortality.
- No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---|---|
| Protection of Musqueam’s Aboriginal Interests – availability, quality, and experience tied to traditional use of terrestrial wildlife resources for traditional purposes. | The Ministry acknowledges the Sparrow decision of May 1990 and Musqueam’s established right to fish for food, social and ceremonial purposes in the area of Canoe Pass on the South Arm of the Fraser River. The Ministry is committed to avoiding or mitigation any potential effects on terrestrial wildlife. | Acknowledged and addressed in Application | Ongoing consultation and implementation of mitigation measures in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) of the Application |

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential light effects on wildlife | The Ministry understands that Musqueam is concerned with the potential effects of light on wildlife. Lighting design will address safety requirements while still adhering to best management practices to minimize sensory disturbance to terrestrial wildlife. | Addressed in Application | Implementation of mitigation measures outlined in Sections 4.8.4 (Terrestrial Wildlife Mitigation Measures) and 4.10 (Atmospheric Noise) of the Application |
| Potential noise effects on wildlife | The Ministry understands that Musqueam is concerned with the potential effects of noise on wildlife. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. | Addressed in Application | Implementation of mitigation measures outlined in Sections 4.8.4 (Terrestrial Wildlife Mitigation Measures) and 4.10 (Atmospheric Noise) of the Application |
| Potential effects of the bridge structure on species such as mammals, waterfowl and migratory birds, particular concern for the importance of protecting eagles. | The Ministry understands that Musqueam is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) of the Application |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Consideration of the airport in air quality assessment | Vancouver International Airport and Boundary Bay Airport were taken into consideration in the assessment of baseline studies for Air Quality. | Addressed | None |
| RAA is too large to properly measure cumulative effects of “intensified” industrial development on the South Arm of the Fraser River. MIB should be consulted directly regarding necessary boundaries. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|-------|---------------------------|--------|-------------------------|
|-------|---------------------------|--------|-------------------------|

| | | | |
|--|--|--|--|
| Musqueam has not voiced specific concerns regarding Atmospheric Noise. | | | |
|--|--|--|--|

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Musqueam’s access to the Fraser River and the potential to displace fishing vessels.</p> <p>Potential interference with Musqueam fisheries during bridge construction and decommissioning of the Tunnel and the importance of working closely with Musqueam to ensure negative effects are avoided.</p> <p>Potential effects of construction during fishing season on fishing activities and access to the River.</p> <p>Impacts of Tunnel decommissioning on Musqueam fisheries, specifically as it relates to timing.</p> | <p>Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction. Mitigation of these effects will include the development and implementation of a specific MIB marine use protocol through direct consultation with MIB. Further mitigation can be achieved through the development and implementation of a Marine Access Management Plan for inclusion of the CEMP, establishment of communications protocols, appropriate lighting and marking for safe navigation, and establishment of navigation protection zones during construction.</p> <p>The Ministry understands the importance of working closely with Musqueam to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in 5.2.4 (Marine Use Mitigation Measures)</p> |
| <p>Inappropriateness/ inadequacy of marine users group for consultation with Musqueam</p> <p>Marine users group is not an appropriate format to address Musqueam concerns</p> | <p>The Ministry is continuing to work with Musqueam to better understand how they would like to participate in the development and implementation of mitigation measures in particular, in relation to alternatives to a marine users group. The Ministry has requested Musqueam input to ensure Musqueam’s concerns are discussed and addressed in an appropriate manner and looks forward to obtaining Musqueam’s feedback in this regard.</p> | <p>Ongoing</p> | <p>Ongoing consultation. The Ministry anticipates that plans related to Application Review consultation with Musqueam will be defined in the MoU.</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Project will facilitate increased development around the new Bridge and expansion of marina at Deas Slough</p> | <p>The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect overall regional growth trends of current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Impacts of staging/laydown areas. Request that the Ministry provide construction parameters to avoid impacting areas around Project footprint.</p> | <p>The Application has been developed with the assumption that all temporary and permanent works will be included within the Project alignment. Potential staging areas that will be made available to the contractor encompass areas within the highway right-of-way that have been previously developed and disturbed.</p> <p>Any temporary or permanent works that are to take place will be subject to applicable permitting requirements, including <i>Water Sustainability Act</i> permitting and archaeological investigation if required. Applications for these permits will include detailed descriptions and locations of works to take place.</p> <p>If the contractor chooses to develop staging areas on sites other than those identified, site-specific environmental permitting and approvals will be obtained by the contractor.</p> | <p>Addressed</p> | <p>Contractor will obtain permits and approvals as required</p> |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Musqueam has not voiced specific concerns regarding Visual Quality. | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area</p> | <p>The Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Musqueam. Musqueam has been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4 (Heritage Resources Mitigation Measures)</p> |

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Musqueam participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Ongoing | Musqueam will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Ministry's archaeological consultant will not work effectively with Aboriginal Groups based on experience on past projects | The Ministry worked with Musqueam to resolve this concern. | Addressed | None |
| Concern with the involvement of certain Aboriginal groups in archaeological fieldwork for the Project. | Schedule B Aboriginal groups were invited to participate in the archaeological component of the Project. | Addressed | None |

7.0 UMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

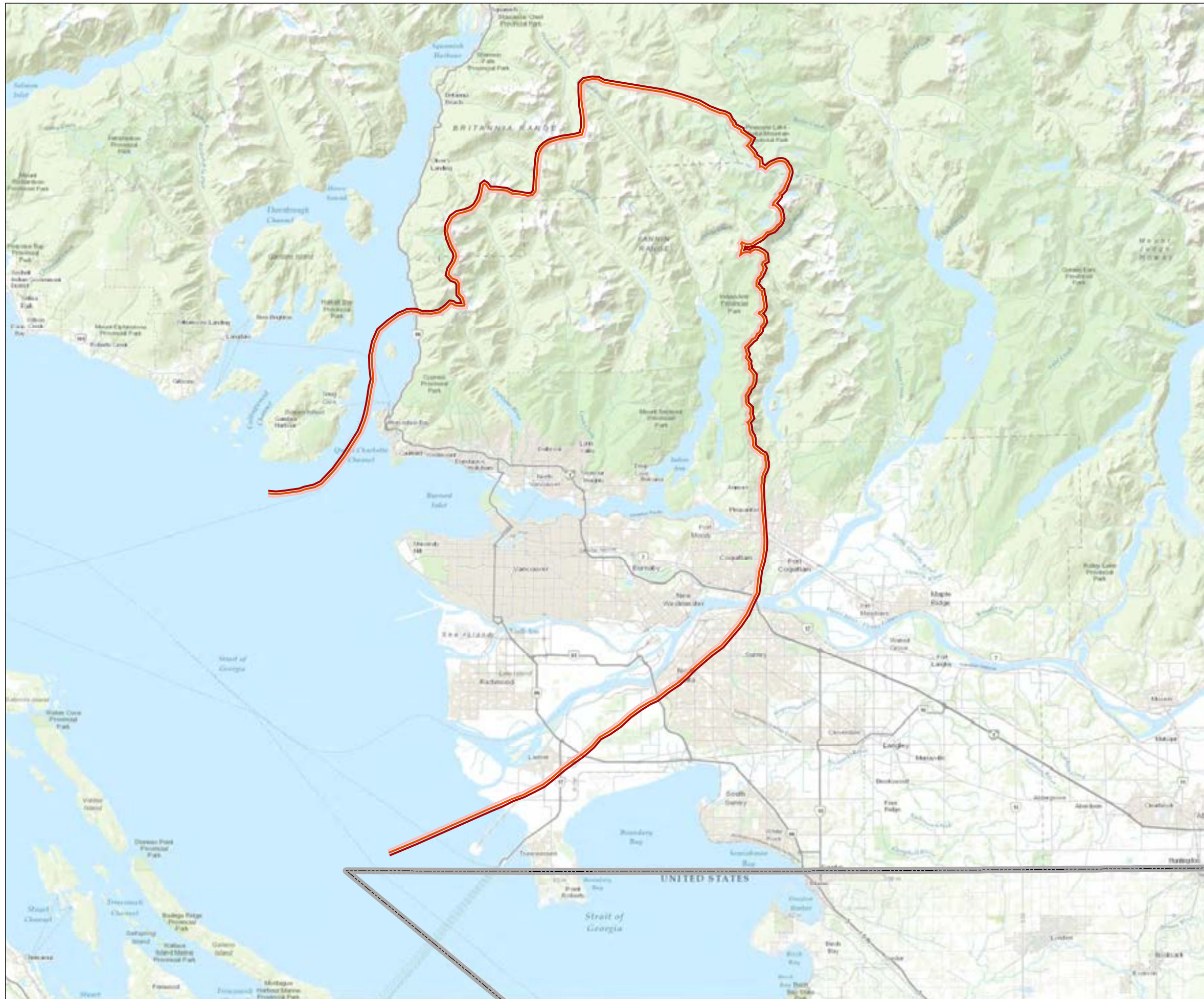
No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.




| 7.0 UMAN HEALTH | | | |
|---|---|---------------|--------------------------------|
| <p>During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>During operation, a negligible effect on access to instream locations for traditional use has been determined.</p> <p>During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.</p> <p>Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
| Consideration of municipal and regional health plans related to human health | Municipal and regional health plans were considered in the assessment of potential Project-related effects on human health, including community and social factors. | Addressed | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|---|---|---------------|--------------------------------|
| Consultation with Cowichan Nation Alliance identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
| Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommission | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River today. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed | None |

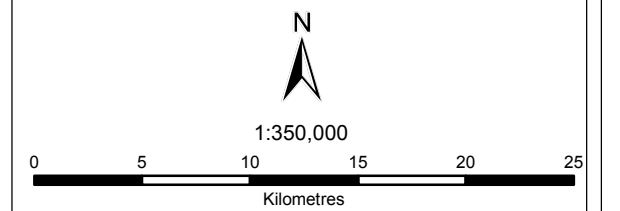



Legend

-  Musqueam Indian Band Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| MUSQUEAM INDIAN BAND ASSERTED TRADITIONAL TERRITORY | |
| Figure 10-6 | 26/05/2016 |
|  | |

APPENDIX J

Penelakut Tribe

1.0 Introduction

Penelakut Tribe engaged directly with the Ministry on the Project and also collectively with Cowichan Tribes, Halalt First Nation and Stz'uminus First Nation as member nations of the Cowichan Nation Alliance. The Ministry provided information and funding directly to Penelakut. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribe represented Cowichan Nation Alliance in correspondence, meetings and fieldwork. This overview provides information on consultation with Penelakut specifically, and with Cowichan Nation Alliance as applicable to Penelakut.

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Penelakut.

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Penelakut, refer to the following sections of Part C:

- Consultation with Penelakut (**Section 10.1.2.10**);
- Penelakut community profiles (**Section 10.1.1.8**);
- Description of existing Penelakut Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Penelakut Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Penelakut Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of the Aboriginal Interests Assessment for Penelakut is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Penelakut Tribe Overview Table (**Appendix J2**), which provides detailed information regarding:

- Penelakut issues and concerns identified to date;
- Identification of effects on VCs and ICs that relate to the assessment of effects on Penelakut's Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Penelakut;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act (BCEAA)*, that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Penelakut and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, EAO held two Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations. Halalt First Nation represented Cowichan Nation Alliance at the first meeting. Halalt First Nation and Cowichan Tribes represented Cowichan Nation Alliance at the second meeting.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Cowichan Nation Alliance in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence within the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Cowichan Nation Alliance participated in the completeness review of the Application for an Environmental Assessment Certificate (Application) that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Penelakut will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Penelakut in early 2014 in order to identify the nature and scope of Penelakut's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Penelakut. A more detailed discussion is provided under the Penelakut section in **Section 10.1.2.10 Overview of consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Penelakut. The Ministry has been working with Penelakut regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

- The Ministry provided additional funding to Penelakut for the preparation and submission of Traditional Use, Traditional Knowledge or other studies. Penelakut worked with other Cowichan Nation Alliance members and submitted the following traditional use studies: *Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015*
- *George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015*

Cowichan Nation Alliance also provided to the Ministry: *Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010.*

The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Penelakut during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study document. The focus of

the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Penelakut included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Penelakut;
- Funding for Penelakut's participation in Project consultation activities and EA process;
- Penelakut participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, AIR, Heritage Resources Assessment and Aboriginal Consultation Plan;
- Meetings with Penelakut Chief and Council, staff, consultants, and elders; and
- Response and follow up with Penelakut regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study document on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Penelakut included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Penelakut;
- Funding for Penelakut's participation in Project consultation activities and EA process;
- Meetings with Penelakut Chief and Council, staff, consultants, elders and membership and Cowichan Nation Alliance;
- Penelakut participation in fieldwork;
- Penelakut participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Penelakut regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Penelakut’s concerns, identified through consultation undertaken to-date, are presented in **Appendix J2 Penelakut Tribe Overview Table**. The Ministry’s response to Penelakut’s key concerns regarding potential impacts on Penelakut’s Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|---|---|
| Potential impacts to Cowichan Nation Alliance title, Rights and culture. | Potential Project related impacts to Cowichan Nation Alliance title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Cowichan Nation Alliance to ensure any effects are minimized. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Revenue sharing opportunities from tolling • Re-establishment of a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes • Surplus land | The Ministry is committed to working with Penelakut to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Penelakut on these opportunities. The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways. The Ministry notes Cowichan Nation Alliance’s wish to re-establish a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes. As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation |

| Concerns Identified to Date | Response |
|---|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Penelakut and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Process and associated timelines • Strength of Claim Assessment | <p>The Ministry acknowledges the importance of Penelakut’s involvement in the environmental assessment process and is committed to funding Penelakut’s participation in the Initiation Consultation and Application Review phases.</p> <p>Penelakut’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects, process and associated timelines are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Concerns relating to the Strength of Claim Assessment have been referred to EAO and MARR.</p> |
| <p>Social effects of the Project on Cowichan Nation Alliance’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Penelakut’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential</p> |

| Concerns Identified to Date | Response |
|---|--|
| | Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application. |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Penelakut e and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Penelakut or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>While the Ministry acknowledges that Penelakut is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> |
| <p>Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project, including the decommissioning of the Tunnel, will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> |
| <p>Potential effects on Fraser River flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> |

| Concerns Identified to Date | Response |
|---|---|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile: Penelakut Tribe

Penelakut Tribe is governed by a chief and council with a two-year term under an *Indian Act* electoral system. Penelakut has a 13-member council, with the current term expiring in February 2018.

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round, Penelakut's primary village (Penelakut IR 7) is on Penelakut Island, to the east of Chemainus on southeast Vancouver Island. Penelakut members also reside on Kuper, Tent and Galiano islands. Of Penelakut's 952 registered members, 525 live on reserve.. The Project area does not overlap any of Penelakut's current or former reserve lands.

Penelakut is, or has been, affiliated with the Hul'qumi'num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the "Island" dialect of Halkomelem (*Hul'q'umi'num*), and have referred to themselves collectively as *Hul'qumi'num Mustimuhw*.

The Hul'qumi'num Treaty Group member bands collectively assert a core territory or "title lands" and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to "the south arm of the Fraser River, including Canoe Pass, up to and including Douglas Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the Fraser River along Canoe Pass up to Deas Island". This area is subsumed within the broader marine or fishing territory. The core territory of the Hul'qumi'num Treaty Group overlaps the Project area at the Tunnel crossing.

Penelakut, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia. The territorial maps attached to these agreements typically include areas on the western side of the Strait of Georgia only.

Locations along the South Arm of the Fraser River of importance to Penelakut, along with the Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhits'um* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites. A member

First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uqtinus* for residential and/or commercial purposes. Cowichan Nation Alliance's *Tl'uqtinus* claim area is shown in **Section 10.1.3.2 Existing Conditions**.

3.1 Penelakut Tribe Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Penelakut's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Penelakut in **Section 10.1.3.2 Existing Conditions**. In this summary, specific information on Penelakut's traditional use has been supplemented with general information on traditional use by Cowichan Nation Alliance and Hul'qumi'num Treaty Group Nation Alliance member First Nations.

3.1.1 General

- Penelakut has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.
- Penelakut followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round. The seasonal round is described in Part C.
- Penelakut has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests.
- A Cowichan Nation Alliance member First Nation has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl'uqtinus* for residential and/or commercial purposes.

3.1.2 Fishing

- Penelakut harvested the following species historically on the South Arm of the Fraser River: sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while they were resident on the Fraser River.
- Cowichan Nation Alliance reports that *Tl'uqtinus* was used seasonally for harvesting purposes, with Halalt reporting that they used the area specifically in July to fish for sockeye and pink salmon. Penelakut also used other habitation sites in the area,

including ones at the southern extent of No. 4 Road, and on a little bay just below Brunswick Point, on the south side of the western entrance to Canoe Pass.

- Areas within the wider Fraser River estuary were also utilized by *Hul'q'umi'num*'-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations.
- The Hul'q'umi'num Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul'q'umi'num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area. The Hul'q'umi'num Treaty Group have also reported that government regulations introduced in the same era had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul'q'umi'num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century.
- Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO). Access to sockeye for member First Nations is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008. In those years, the specific locations in the South Arm in which member First Nations of the Hul'q'umi'num Treaty Group fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River.
- The Hul'q'umi'num Fisheries Limited Partnership (HFLP) is a commercial fishing business in which some of the Cowichan Nation Alliance member groups participate (Halalt, Penelakut, and Stz'uminus). Species harvested through this enterprise are crab, prawn, halibut, herring, rockfish, sablefish, and salmon.

3.1.3 Hunting/Trapping

- Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species.
- Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round.
- The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm.

The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area.

- Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted.

3.1.4 Gathering

- Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth'equn*) were once harvested.
- Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed. With respect to berry plants at *Tl'uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees”.
- Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl'uqtinus*, which is currently surrounded by blueberry farms, Cowichan Nation Alliance has raised the potential for their former berry grounds to be re-established.

3.1.5 Archaeology and Cultural Heritage Interests

- Locations along the South Arm of the Fraser River of importance to the Penelakut in the vicinity of the Project include, but are not limited to, *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhits'um* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites.
- Penelakut has specifically noted the importance of archaeological site DgRs-17.

3.1.6 Other Related Interests

- Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl'uqtinus*, and given where *Tl'uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. Cowichan Nation Alliance has advised that it is also working to re-establish culturally integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl'uqtinus*.
- The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Penelakut's Aboriginal Interests, specifically. For a more detailed description, refer to **Section 10.1.3.3.**

Potential Effects.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**

- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.

- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Penelakut's exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise |
| Ground-borne vibration | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Penelakut's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Penelakut's Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect |
|---|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> None identified |

| Indicator | Potential Project-Related Effect |
|--|---|
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

Penelakut harvested the following s historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while resident on the Fraser River. Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations. Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO).

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Penelakut, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Penelakut during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Penelakut from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Penelakut. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Penelakut; therefore, Potential Project-related effects on Penelakut fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in in Section 4.10 Atmospheric Noise are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Penelakut.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Penelakut is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Penelakut's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Cowichan Nation Alliance reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species. Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round. The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Penelakut as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Penelakut during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Penelakut from instream construction activities, are expected to negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Penelakut resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Penelakut. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Penelakut; therefore, Potential Project-related effects on Penelakut fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Penelakut.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Penelakut is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Penelakut's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits'um*, or place for cutting (cattails) – as well as in the area of *Tl'uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and

rushes (*stth'equn*) were once harvested. Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl'uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth'equn*), as well as seaweed. Tree species available in the vicinity of the Fraser River and traditionally used by the Cowichan Tribes for manufacturing include crabapple, willow, alder, cottonwood, cedar, spruce, aspen, yew, hemlock, and vine maple.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Penelakut as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Penelakut during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Penelakut from instream construction activities, are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Penelakut resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Penelakut; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Penelakut.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Penelakut is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Penelakut's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Locations along the South Arm of the Fraser River of importance to the Penelakut in the vicinity of the Project include, but are not limited to, *Tl'uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhits'um* or *Xwulit'sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites.

The proposed Project has the potential to affect Penelakut’s Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Penelakut’s archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Penelakut’s interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Penelakut’s archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Penelakut’s archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Penelakut’s archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Penelakut’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Penelakut.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Penelakut (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Penelakut's Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Penelakut, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Penelakut. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Penelakut’s Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Penelakut regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in Section 10.1.3.4 and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Penelakut’s Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Penelakut prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Penelakut during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Penelakut during consultations include:

- Potential impacts to Penelakut title, rights and culture;
- Consideration for future uses should include Penelakut’s plans;
- Aboriginal participation and Project-related opportunities (e.g., potential employment, training, contracting and economic development opportunities);
- Potential effects to air quality, particularly in relation to terrestrial wildlife;
- Effects to fish and fish habitat, and importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon;
- Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities;
- Adequacy of EA methodology to address social and cultural effects;
- EA process and associated timelines;
- Strength of claim;

- Social effects of the Project on Penelakut's ability to transfer knowledge, language and participate in socio-cultural practices;
- Cumulative effects;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on Fraser River flow rates after Tunnel removal; and
- Potential effects of run off and drainage.

Based on information provided by Cowichan Nation Alliance and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Penelakut has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Penelakut's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Penelakut, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance

- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Penelakut regarding proposed measures, management plans, and monitoring programs related to VC and IC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Penelakut, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--------------------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project's EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Penelakut Tribe's queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA's underway, the Ministry has and will continue to work with Penelakut Tribe to support their participation in this particular Project's review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Penelakut Tribe is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Penelakut Tribe's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Penelakut Tribes as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential impacts to Penelakut Tribe’s title, Rights and culture. Identification of future developments should include potential Penelakut Tribe’s title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Penelakut Tribe’s title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Penelakut Tribe to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Penelakut Tribe and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on λəqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Penelakut Tribe’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Penelakut Tribe’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Penelakut Tribe’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Penelakut Tribe’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| | <p>predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application.</p> | | |
| <p>Protection of Penelakut Tribe’s rights to harvest within the Project area.</p> | <p>Penelakut Tribe’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Penelakut Tribe as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities.</p> | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Penelakut Tribe is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Penelakut Tribe received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Penelakut Tribe as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Penelakut Tribe may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Penelakut Tribe requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed funding agreements with Penelakut Tribe which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Penelakut Tribe received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Penelakut Tribe as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Penelakut Tribe may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Penelakut Tribe requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed funding agreements with Penelakut Tribe which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components
- Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Penelakut Tribe on this matter. | Ongoing | Further engagement with Penelakut Tribe is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Project-related employment, training, contracting, and economic development opportunities.</p> <p>Equity and revenue sharing for Penelakut Tribe and importance of initiating related discussions with Penelakut Tribe during Pre-Application Stage.</p> <p>Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Penelakut Tribe to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Penelakut Tribe wants to prepare its membership for employment opportunities and will work with Penelakut Tribe to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Penelakut Tribe on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |
| <p>Interest in surplus Agricultural Land Reserve (ALR) lands being provided to Penelakut Tribe for creation of a gas station or other businesses</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |
| <p>Penelakut Tribe, must be consulted for any land disposition - specific concern regarding surplus lands being sold to adjacent farmers</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|--|
| Importance of Fraser Richmond Lands/Cowichan Village site to Cowichan Nation Alliance, particularly Penelakut Tribe, and the importance of considering future land recovery in land use and Project planning | Noted | Noted | None |
| City of Richmond’s land use planning process does not consider the Cowichan Nation Alliance’s potential future reclamation of the Fraser Richmond Lands - City of Richmond is working with the Ministry, but not with the Penelakut Tribe with respect to land use planning | Noted. Penelakut Tribe concerns have been referred to the City of Richmond | Addressed | None |
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Penelakut Tribe to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Penelakut Tribe to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Factoring in extreme weather events in River Hydraulics model</p> | <p>Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |
| <p>Effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>The Ministry is following up with Penelakut Tribe to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river.</p> | <p>Ongoing</p> | <p>Clarification regarding concern</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |
| Improved ditches will result in less filtering of deleterious materials | Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River. | Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application. | Addressed in Application | None |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Penelakut Tribe. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Penelakut Tribe has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will be included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Invasive plant species and proposed plans to manage presence during construction</p> | <p>Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4</p> |
| <p>Culturally significant plants should be used in planting plans</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>The Ministry will develop planting plans with consultation from Aboriginal Groups</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Penelakut Tribe is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Penelakut Tribe is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Penelakut Tribe fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|---|
| Interest in surplus Agricultural Land Reserve (ALR) lands being provided to Penelakut Tribe for creation of a gas station or other businesses | As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation. | Addressed | Determination of surplus lands and consultation |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the ǻǻqtinǻs/TI'uqtinus site and potential archaeological values at interchanges</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Penelakut Tribe.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports</p> | <p>Penelakut Tribe participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports.</p> | <p>Addressed</p> | <p>Penelakut Tribe will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |
| <p>Ethnographical content in reports does not accurately reflect Penelakut Tribe's historical presence within the Project area</p> | <p>The Ministry noted Penelakut Tribe's concern that ethnographical content in Project reports does not accurately reflect Penelakut Tribe's historical presence within the Project area. The Ministry continues to work with Penelakut Tribe to address this concern.</p> | <p>Ongoing</p> | <p>Ongoing consultation</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

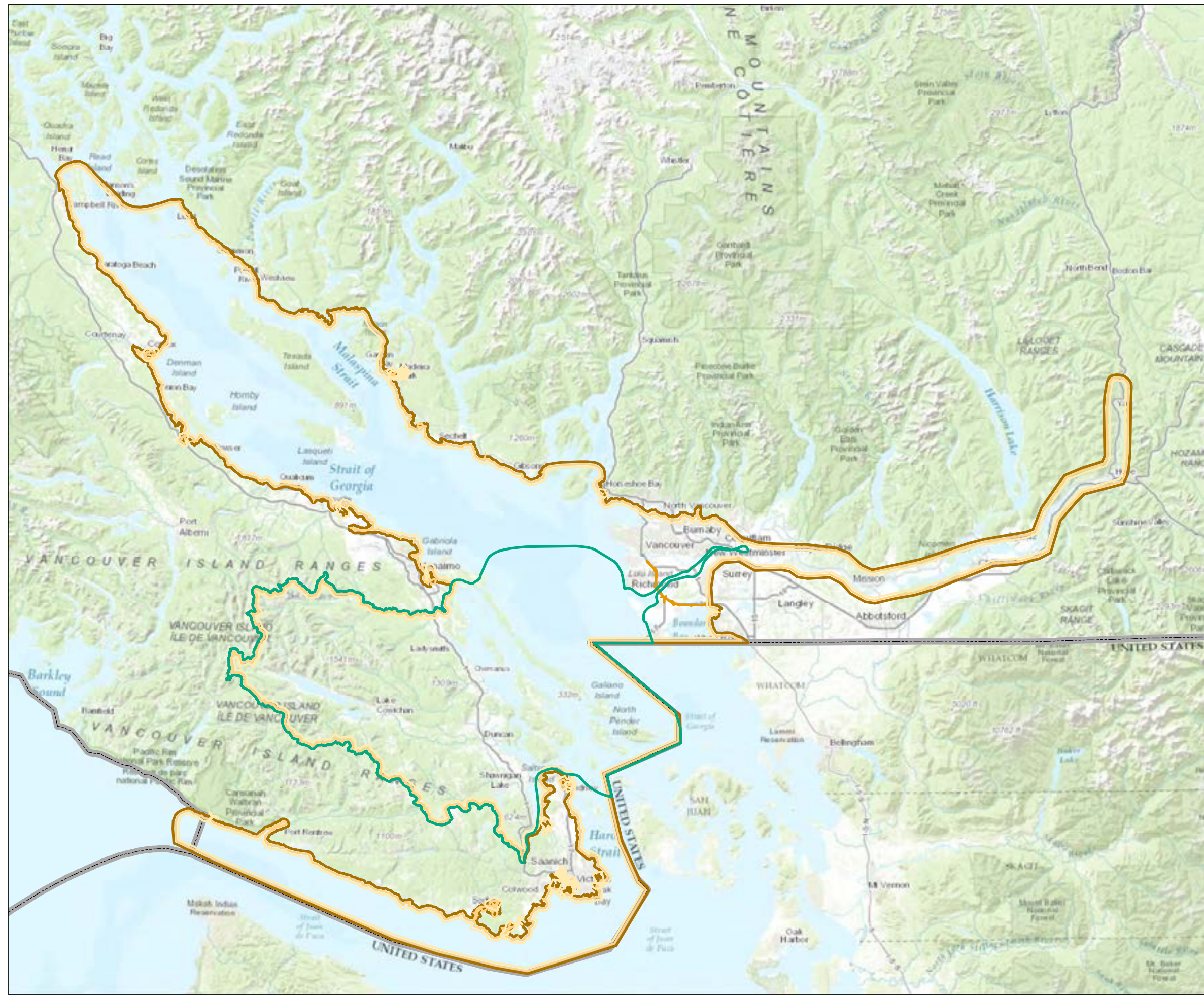
Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|--|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|-------------------------|
| | Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects. | | |
| New Bridge could “unleash pent-up demand” and create even more congestion | The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing. | Addressed | None |

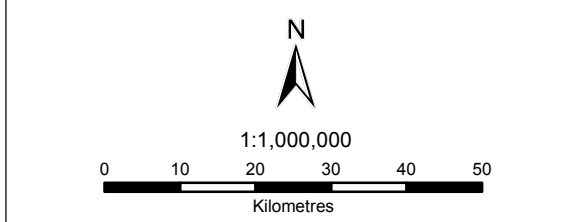
Path: Q:\1217-299\285\077\03\mxd\FirstNations\EA\Fig10-2_285_077_03_FirstNations_HuIQ_160517_FINAL.mxd



Legend

-  Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory
-  Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**HUL'QUMI'NUM TREATY GROUP
ASSERTED TRADITIONAL TERRITORY**

| | |
|-------------|------------|
| Figure 10-2 | 26/05/2016 |
|-------------|------------|



APPENDIX K

Semiahmoo First Nation

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Semiahmoo First Nation (Semiahmoo).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Semiahmoo, refer to the following sections of Part C:

- Consultation with Semiahmoo (**Section 10.1.2.10**);
- Semiahmoo community profile (**Section 10.1.1.8**);
- Description of existing Semiahmoo Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Semiahmoo Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Semiahmoo Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of Aboriginal Interests Assessment for Semiahmoo is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Semiahmoo Overview Table (**Appendix K2**), which provides detailed information regarding:

- Semiahmoo's issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Semiahmoo's Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Semiahmoo;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Semiahmoo and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, Semiahmoo attended two EAO-led Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Semiahmoo in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence within the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Semiahmoo also participated in the completeness review of the Application for an Environmental Assessment Certificate (Application) that considered whether the Application included information requirements set out in the Application Information Requirements.

It is assumed that Semiahmoo will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Semiahmoo in early 2013 in order to identify the nature and scope of Semiahmoo's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Semiahmoo. A more detailed discussion is provided under the Semiahmoo section in **Section 10.1.2.10 Overview of consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Phase Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Semiahmoo. The Ministry has been working with Semiahmoo regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review Phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

During Initial Consultation meetings, Semiahmoo identified the need for capacity funding to support Semiahmoo's involvement in Project consultation activities, review of EA-related documents and participation in the Pre-Application phase of the EA process. Semiahmoo also identified the need for funding for a Semiahmoo First Nation traditional use study and the Ministry and Semiahmoo worked together to finalize a funding agreement. The agreement specifies the activities covered under the agreement and Project/EA-related documents for Semiahmoo's review and comment. Semiahmoo did not submit a traditional use study.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Semiahmoo during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study document. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, draft Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Semiahmoo included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Semiahmoo;
- Funding for Semiahmoo's participation in Project consultation activities and EA process;
- Semiahmoo participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment, draft AIR, and Aboriginal Consultation Plan;
- Meetings with Semiahmoo leadership, staff, consultants, elders and membership; and
- Response and follow up with Semiahmoo regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information. The main consultation activities the Ministry undertook with Semiahmoo included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Semiahmoo;
- Funding for Semiahmoo's participation in Project consultation activities and EA process;
- Meetings with Semiahmoo leadership, staff, consultants, elders and membership;
- Semiahmoo participation in fieldwork;
- Semiahmoo participation in the EA Working Group;
- Review of draft EA documents such as the AIR, Aboriginal Consultation Plan, and Aboriginal Consultation Reports;
- Review of draft Part C content for the Application; and
- Response and follow up with Semiahmoo regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Semiahmoo’s concerns, identified through consultation undertaken to-date, are presented in **Appendix K2 Semiahmoo Indian Band Overview Table**. The Ministry’s response to Semiahmoo’s key concerns regarding potential impacts on Semiahmoo’s Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|--|---|
| Protection of Semiahmoo First Nation’s rights to harvest within the Project area. | Semiahmoo’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Semiahmoo as a result of the Project are not expected. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Revenue from tolling | The Ministry is committed to working with Semiahmoo to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Semiahmoo on these opportunities. Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. |

| Concerns Identified to Date | Response |
|---|---|
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Process and associated timelines | <p>The Ministry acknowledges the importance of Semiahmoo’s involvement in the environmental assessment process and is committed to funding Semiahmoo’s participation in the Initiation Consultation and Application Review phases.</p> <p>Semiahmoo’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects and process and associated timeline are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> |
| <p>Ministry’s approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups</p> | <p>The Ministry is confident that the Project’s procurement process will effectively allow for benefits to be provided to Aboriginal Groups.</p> |
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Semiahmoo and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Semiahmoo’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |

| Concerns Identified to Date | Response |
|---|--|
| <p>Social effects of the Project on Semiahmoo’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Semiahmoo’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |
| <p>Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Semiahmoo fishing.</p> | <p>Semiahmoo’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8). Mitigation measures are outlined in Section 5.2.4 (Marine Use Mitigation Measures) of the Application.</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Semiahmoo and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Semiahmoo or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>While the Ministry acknowledges that Semiahmoo is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. The Ministry understands that Semiahmoo is discussing this request with other provincial and federal ministries and agencies.</p> |

| Concerns Identified to Date | Response |
|--|---|
| Potential effects on Fraser River flow rates and sediment transport and disposition in Boundary and Semiahmoo Bays after Tunnel removal. | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics). |
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation.</p> <p>During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.</p> <p>Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will ensure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile – Semiahmoo First Nation

Semiahmoo First Nation is governed by a chief and council with two-year terms under an *Indian Act* electoral system. The current term for the three-member council expires in December 2016.

Semiahmoo First Nation has one reserve, fronting Semiahmoo Bay (part of Boundary Bay) at the Canada-United States border, about 1 km southeast of White Rock. The reserve, covering 129.10 ha, is home to 51 of the nation's 97 registered members. Originally 158.64 ha, portions of the reserve have been successively taken up for public purposes, including for the construction of Highway 99 in 1962. While the Highway 99 corridor runs adjacent to the eastern border of the reserve, the Project area does not include that section of the corridor.

Semiahmoo traditional territory has been previously represented as centred on Boundary Bay, taking in eastern portions of the Point Roberts peninsula, Mud Bay, and the lands and waters in and around the Serpentine, Nicomekl, and Campbell rivers. Semiahmoo First Nation has recently presented a more extensive territory that, still centred on Boundary Bay, takes in the Lower Fraser River and adjacent lands downstream of the confluence with the Sumas River, all of the Gulf Islands south of Gabriola Island, the San Juan Islands, most of Bellingham Bay, and the Nooksack River. The boundaries of this territory largely take in almost the entire Project area.

3.1 Semiahmoo Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes are or may be connected with the exercise of Semiahmoo's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Semiahmoo in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- Semiahmoo has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.
- The current exercise of Aboriginal Interests by Semiahmoo at locations or in relation to resources that may be potentially affected by Project construction or operation is relatively low.
- Semiahmoo has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests.

3.1.2 Fishing

- Semiahmoo has reported that they once fished for salmon, sturgeon, halibut, eulachon, herring, smelts, sea mammals (including hair seals, sea lions, and porpoises), and a range of beach foods.
- Important salmon fishing areas have been previously identified as including but not limited to Cannery Point on the southeast tip of the Point Roberts Peninsula and the Nicomekl and Little Campbell rivers that feed into Boundary Bay, where sturgeon was also taken.
- Semiahmoo said that they practiced their fishing rights in the Fraser River in the summer season at *Tl'ektines*, in the vicinity of the north end of the George Massey Tunnel. They have previously “acknowledged that Cowichan Tribes fished in the South Arm of the Fraser River and that access to this area was gained by the Semiahmoo First Nation via a series of marriage ties between Semiahmoo First Nation and Cowichan Tribes”.
- Semiahmoo First Nation has also said that they have access rights to the Salmon River and Kanaka Creek, which both join the Fraser River in the vicinity of MacMillan Island, near Fort Langley.
- Shellfish were also important to the Semiahmoo, and Boundary Bay has been characterized as formerly one of the most productive shellfish harvesting locations on the Pacific coast. This feature is said to have made it a key shellfish harvesting location for the Semiahmoo and other First Nations, who reportedly shared the area for this purpose.
- Semiahmoo reports that the focus of their sea mammal harvesting was on seals. They have said that seals travelled as far up the Fraser River as Harrison Lake in pursuit of salmon.
- Semiahmoo reports that they are not currently engaged in commercial salmon fisheries.
- Sturgeon and eulachon once served as an important substitute for other fisheries; however, current conservation measures prohibit retention of these species.
- Semiahmoo reports that currently they are not participating in the commercial crab fishery, but has conveyed an interest in becoming involved in commercial shellfish harvesting, particularly of geoduck, and in developing aquaculture and commercial harvesting of sea cucumber .

3.1.3 Hunting/Trapping

- Semiahmoo hunting has been previously reported as concentrated in and around lands to the east of Boundary Bay, on both the Canadian and American sides of the border.
- Beaver is also said to have been taken at the heads of the Serpentine and Nicomekl rivers (present-day Surrey and Langley), as well as bear.

- Mountain goat was reportedly accessed outside of Semiahmoo territory, specifically on the north side of the Fraser River, via a trail along Kanaka Creek.
- Cranes, ducks, geese, swans, and other migratory birds were reportedly harvested for food, while ducks and duck down were also utilized for ceremonial and textile purposes.

3.1.4 Gathering

- Semiahmoo reports harvesting camas in the past on Waldron Island in Washington State, which is across Boundary Pass from South Pender and Saturna islands.
- Aquatic plants were also harvested, including bulrushes, tule rushes, and grasses. These were reportedly used extensively in the manufacture of mats, which were in turn used for a variety of purposes.
- Semiahmoo reportedly practiced selective burning to boost berry plant growth, which also had the effect of increasing the availability of deer.
- Blackberries, blueberries, dew berries, huckleberries, salmon berries, Saskatoon berries, and thimbleberries were important summer harvests for Semiahmoo; gooseberries, raspberries, and strawberries were also consumed, but were not as common.
- Semiahmoo First Nation has said cranberry harvesting provided seasonal employment for their members following non-Aboriginal settlement.
- Among other plants used traditionally by Semiahmoo has identified as devil's club, rose hip, stinging nettle, and the wood, bark, or roots of various tree species (e.g., cedar, cherry, fir, spruce, willow, and yew), for a variety of purposes.
- The lower Fraser River, in the vicinity of Deas and Tilbury Islands, has previously been identified as an area where current plant harvesting by Semiahmoo may still occur.

3.1.5 Archaeology and Cultural Heritage Interests

- Semiahmoo has said that the use of lands and resources, access to which they report as now limited, has a spiritual and sacred element not readily separated from practical considerations.
- Legendary stories, which relay that people related to the first ancestors, who descended from the sky, were transformed by Khaals (i.e., a mythical leader) into physical and biological elements of the landscape, and who remain relatives of the Semiahmoo.
- The Semiahmoo considers themselves part of the landscape, of their territory, and this landscape serves as their sacred place, their history book, their storehouse of raw materials, as well as their training ground.

- Named places in the vicinity of the Project area previously reported by Semiahmoo include *SĆUOŦEN*, or Semiahmoo, as well as three sites on the eastern aspect of the Point Roberts Peninsula, fronting Boundary Bay, as follows from north to south:
 - *ŦESEWEL*;
 - *ŚAWOM*; and
 - *ĆEL,ŁTENEM* (also rendered Chelhtenem or Tsel-Ihtenem, at Cannery or Lily Point).
- *ĆEL,ŁTENEM* has been previously identified as a summer residence of the Semiahmoo, as well as an important reef-net location for sockeye, while another summer residence of the Semiahmoo, where clams were harvested, has been previously identified in the vicinity of *ŦESEWEL* and *ŚAWOM*.
- Another named place has also been previously identified along the main stem of the Fraser River upstream of the Port Mann Bridge, at *KITEY*, or Katzie.

3.1.6 Other Related Interests

- Semiahmoo has reported that their ability to pursue a traditional economy has been “severely limited” by urbanization and contamination of their food supply within their traditional territory. They are seeking to restore or maintain, within that territory, the conditions necessary to promote the exercise of ancestral uses in the future.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Semiahmoo’s Aboriginal Interests, specifically. For a more detailed description of the methodology and a summary of the results, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**

- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined Section 3.0 Assessment Methodology.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.

- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs and ICs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to have an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Semiahmoo's exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Semiahmoo's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Semiahmoo's Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Project Construction | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |
| Project Operation | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |

4.5 Fishing

Semiahmoo has reported that they once fished for salmon, sturgeon, halibut, eulachon, herring, smelts, sea mammals (including hair seals, sea lions, and porpoises), and a range of beach foods. Semiahmoo said that they fished in the Fraser River in summer at *Tl'ektines*, in the vicinity of the north end of the George Massey Tunnel. Other important salmon fishing areas have been previously identified as including the southeast tip of the Point Roberts Peninsula and the Nicomekl and Little Campbell rivers that feed into Boundary Bay. Semiahmoo report that Boundary Bay was particularly productive for shellfish.

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Semiahmoo, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Semiahmoo during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Semiahmoo from instream construction activities are expected to be negligible. While it is acknowledged that Semiahmoo has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Semiahmoo. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Semiahmoo; therefore, Potential Project-related effects on Semiahmoo fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Semiahmoo.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Semiahmoo is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Semiahmoo's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Semiahmoo hunting has been previously reported as concentrated in and around lands to the east of Boundary Bay, on both the Canadian and American sides of the border. Species harvested in proximity to the Project area include beaver, waterfowl and migratory birds.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Semiahmoo as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Semiahmoo during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Semiahmoo from instream construction activities, are expected to be negligible. While it is acknowledged that Semiahmoo has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Semiahmoo resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Semiahmoo. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Semiahmoo; therefore, Potential Project-related effects on Semiahmoo fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Semiahmoo.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Semiahmoo is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Semiahmoo's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Semiahmoo report that the lower Fraser River, in the vicinity of Deas and Tilbury Islands, has previously been identified as an area where gathering may still occur. Semiahmoo report gathering various species of aquatic plants, berries, devil's club, rose hip, stinging nettle, and the wood, bark, or roots of various tree species. Semiahmoo reportedly practiced selective burning to boost berry plant growth.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Semiahmoo as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Semiahmoo during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Semiahmoo from instream construction activities, are expected to be negligible. While it is acknowledged that Semiahmoo has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Semiahmoo resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Semiahmoo; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in Section 4.10 Atmospheric Noise address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap or are in proximity to known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Semiahmoo.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Semiahmoo is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Semiahmoo's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Semiahmoo has said that the use of lands and resources has a spiritual and sacred element not readily separated from practical considerations. Legendary stories, which relay that people related to the first ancestors, who descended from the sky, were transformed by Khaals (i.e., a mythical leader) into physical and biological elements of the landscape, and remain relatives of the Semiahmoo. Semiahmoo report named places in the vicinity of the Project area.

The proposed Project has the potential to affect Semiahmoo's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Semiahmoo's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Semiahmoo's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Semiahmoo's archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Semiahmoo has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Semiahmoo's archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Semiahmoo's archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Semiahmoo's archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Semiahmoo.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Semiahmoo (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Semiahmoo's Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Semiahmoo, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Semiahmoo. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.

- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Semiahmoo's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Semiahmoo regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Semiahmoo's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Semiahmoo prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Semiahmoo during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Semiahmoo during consultations include:

- EAO process;

- Protection of Semiahmoo First Nation’s rights to harvest within the Project area;
- Semiahmoo First Nation’s access to the Fraser River and the potential to displace fishing vessels;
- Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided;
- Social and cultural effects of the Project such as Semiahmoo First Nation’s knowledge transmission, language loss, dependency and social interaction;
- Potential effects from the Project on shellfish in Boundary Bay and on Semiamoo’s plans related to aquaculture;
- Capacity funding to facilitate participation in the EA process;
- Opportunities for cultural recognition and naming;
- Assessment of cumulative effects ;
- Potential increase in vessel traffic on the Fraser River as a result of decommissioning the Tunnel;
- Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations;
- Protection of archaeological, heritage, and cultural resources, including intangible heritage sites;
- Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon;
- Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon;
- Potential effects on wildlife;
- Traffic;
- Invasive plant species;
- Use of culturally significant plants in planting plans; and
- Potential effects of runoff and drainage.

Based on information provided by Semiahmoo and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Semiahmoo has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Semiahmoo's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Semiahmoo First Nation, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Semiahmoo regarding proposed measures, management plans, and monitoring programs related to VC and IC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Semiahmoo, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|--------------------------------|
| Concern with the effectiveness of the EAO-led process to address Semiahmoo First Nation's concerns | Concerns relating to the effectiveness of the Environmental Assessment Process have been referred to EAO. | Referred to EAO | None |
| EA Studies are not meaningful and, instead, are check boxes | Comment noted. The Ministry does not share Semiahmoo First Nation's view of the value of EA studies and welcomes further discussion regarding this concern. | Noted | Further discussion |

ABORIGINAL INTERESTS

There are potential Project related impacts to Semiahmoo's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations (during construction)
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Semiahmoo as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Protection of Semiahmoo First Nation’s rights to harvest within the Project area</p> | <p>Semiahmoo’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Semiahmoo as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |
| <p>Semiahmoo’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided</p> | <p>Semiahmoo’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Social effects of the Project such as Semiahmoo First Nation’s knowledge transmission, language loss, dependency and social interaction</p> | <p>Social effects of the Project on Semiahmoo’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Capacity funding to facilitate participation in the Project review process.</p> | <p>Semiahmoo received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase.</p> | <p>Addressed</p> | <p>Consultation regarding funding for the Application Review Phase</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|-------------------------|
| <p>Revenue sharing opportunities from tolling</p> | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | | |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights. • Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. • Absence of a comprehensive study of cumulative effects on the Fraser River | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---------------|---|---------------|--------------------------------|
| | <p>effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed. While the Ministry acknowledges that Semiahmoo is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |

| ABORIGINAL CONSULTATION | | | |
|--|--|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Semiahmoo First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Funding for the Application Review Phase. |
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Semiahmoo First Nation which provided funding for a Traditional Use Study. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|---|
| <p>Opportunities for cultural recognition and naming</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will to work with Semiahmoo and other Aboriginal groups on this matter.</p> | <p>Ongoing</p> | <p>Discussion with Semiahmoo and other Aboriginal groups to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Semiahmoo First Nation and importance of initiating related discussions with Semiahmoo First Nation during Pre-Application Stage. Adequate training time to take full advantage of potential future Project work activities and a request to consider providing an Aboriginal Training Fund Request for Project impact benefit agreement</p> | <p>The Ministry is committed to working with Semiahmoo to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Semiahmoo to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful.</p> |
| <p>Ministry’s approach to procurement for the Project will not result in meaningful benefits to Aboriginal Groups</p> | <p>The Ministry is confident that the process will effectively allow for benefits to be provided to Aboriginal Groups.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------|--|
| Opportunities for cultural recognition and naming. | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Semiahmoo on this matter. | Ongoing | Discussion with Semiahmoo to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Aboriginal Groups and importance of initiating related discussions with Aboriginal Groups during the Pre-Application Stage. | The Ministry is committed to working with Semiahmoo to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Semiahmoo to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal, inclusion of high flow period in River Hydraulic model. Effects of Tunnel removal on sediment transport.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential effects of runoff and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will ensure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |
| <p>Potential effects on Fraser River flow rates and sediment transport and disposition in Boundary and Semiahmoo Bays after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> <p>Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures)</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Semiahmoo. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Semiahmoo has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Use of culturally significant plants in planting plans and importance of obtaining input from Semiahmoo on plant selection | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed in Application | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife</p> | <p>The Ministry understands that Semiahmoo is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl, migratory birds and bats</p> | <p>The Ministry understands that Semiahmoo is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| <p>Effects of change in air quality resulting from increase in traffic volume due to the Project</p> | <p>Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on atmospheric noise are expected

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|-------------------------------------|--|-----------|--|
| Potential noise effects on wildlife | The Ministry understands that Semiahmoo is concerned with the potential effects of noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on Marine Access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|--|
| Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing | Potential interference with Semiahmoo fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided. | Addressed in Application | Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on Land Use are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Semiahmoo has not voiced any specific issues or concerns with respect to Land Use. | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on Visual Quality are expected

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Semiahmoo has not voiced any specific issues or concerns with respect to Visual Quality. | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Semiahmoo. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports | Semiahmoo participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Semiahmoo will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Concern that the Ministry's archaeological consultant will not work effectively with Semiahmoo First Nation based on experience on past projects | The Ministry worked with Semiahmoo to resolve this concern. | Addressed | None |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

| 7.0 HUMAN HEALTH | | | |
|---|----------------------------------|---------------|--------------------------------|
| <p>A negligible effect on quality of experience tied to access of instream locations for traditional has been determined. A negligible effect on access to upland locations for traditional use has been determined. A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u> Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects. Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u> No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Semiahmoo has not voiced any specific issues or concerns with respect to Human Health. | | | |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|--------------------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|---|--|--------------------------|---|
| Consultation with Semiahmoo First Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential for contaminants in the tunnel and how this may affect tunnel decommissioning | The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities. If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97. | Addressed in Application | Implementation of mitigation measures outlined in 4.1.4 and 4.2.4 |
| Project will lead to increased traffic near the Peace Arch border crossing and that this will impact Semiahmoo First Nation's access to their community. | The Ministry understands that Semiahmoo First Nation currently has issues with respect to access to their community. The Project is not expected to result in an increase in traffic by the Peace Arch Border or to further contribute to existing community access issues. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|-------------------------|
| <p>Restricted access for emergency vehicles due to border traffic and from changes resulting from the Project.</p> | <p>The Ministry understands that Semiahmoo First Nation currently has issues with respect to access to their community. The Project is not expected to result in an increase in traffic by the Peace Arch Border or to further contribute to existing community access issues.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Length of time tolls are in place</p> | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | <p>Addressed</p> | <p>None</p> |

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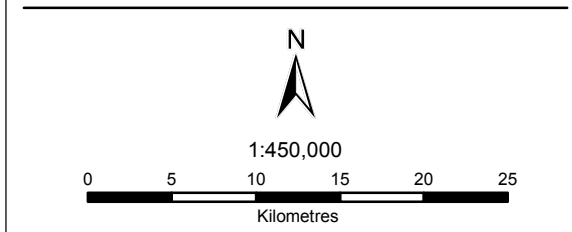


Legend

- Semiahmo First Nation Asserted Traditional Territory
- Project Alignment
- Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**SEMAHMO FIRST NATION
ASSERTED TRADITIONAL TERRITORY**

| | |
|-------------|------------|
| Figure 10-7 | 26/05/2016 |
|-------------|------------|

APPENDIX L

Squamish Nation

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Squamish Nation (Squamish).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Squamish, refer to the following sections of Part C:

- Consultation with Squamish (**Section 10.1.2.10**);
- Squamish community profile (**Section 10.1.1.9**);
- Description of existing Squamish Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Squamish Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Squamish Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of Aboriginal Interests Assessment for Squamish is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Squamish Overview Table (**Appendix L2**), which provides detailed information regarding:

- Squamish’s issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Squamish’s Aboriginal Interests;
- The Ministry’s response to specific issues and concerns raised by Squamish;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry’s provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Squamish and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group. Squamish was invited to two EAO-led Working Group meetings, but did not attend.

Squamish also participated in the completeness review of the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Squamish will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Squamish in early 2014 in order to identify the nature and scope of Squamish's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Squamish. A more detailed discussion is provided under the Squamish section in Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Squamish. The Ministry has been working with Squamish regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Squamish for the preparation and submission of the traditional use study *Review of George Massey Tunnel Project April 2016*. The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Squamish during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of Project Description and Key Areas of Study document. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Areas of Study, draft Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Squamish included:

- Meetings with Squamish Nation staff and consultants;
- Sharing of Project-related materials;
- Sharing of draft documents for review and comment; and
- Provision of capacity funding to support participation in consultation activities, review of documents, and submission of comments and a Squamish Nation report.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information. The main consultation activities the Ministry undertook with Squamish included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Squamish;
- Funding for Squamish's participation in Project consultation activities and EA process;
- Meetings with Squamish leadership, staff, consultants, elders and membership;
- Squamish participation in fieldwork;
- Squamish participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Squamish regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Squamish’s concerns, identified through consultation undertaken to-date, are presented in **Appendix L2 Squamish Nation Overview Table**. The Ministry’s response to Squamish’s key concerns regarding potential impacts on Squamish’s Aboriginal Interests are outlined below:

Table 1: Concerns Identified to Date

| Concerns Identified to Date | Response |
|--|---|
| Protection of Squamish First Nation’s rights to harvest within the Project area. | Squamish’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Squamish as a result of the Project are not expected. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming | The Ministry is committed to working with Squamish to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Squamish on these opportunities. |

| Concerns Identified to Date | Response |
|---|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Squamish and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Squamish’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Social effects of the Project on Squamish’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Squamish’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |

| Concerns Identified to Date | Response |
|--|--|
| Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Squamish fishing. | Squamish’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8). Mitigation measures are outlined in Section 5.2.4 (Marine Use Mitigation Measures) of the Application. |
| Increased shipping | The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. |
| Potential effects on Fraser River flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics). |
| Potential effects of run off and drainage | The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciate change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application. |

3.0 Community Profile: Squamish Nation

Skwxwú7mesh Úxwumixw (Squamish Nation) describe themselves as the descendants of Coast Salish ancestors that lived in what are now known as the Greater Vancouver area, Gibson's Landing, and Squamish River watershed. The ancestral language of the Squamish Nation is *Skwxwú7mesh sníchim*.

Squamish Nation (*Skwxwú7mesh Úxwumixw*) has 24 reserves, with 2,232 of 4,176 registered members residing on Squamish Nation's reserve lands. The largest proportion of these on-reserve members live on the Squamish Nation's several urban reserves in the cities of Vancouver, North Vancouver, and West Vancouver, and the District of Squamish, with the most populated reserve being Mission 1, on the north shore of Burrard Inlet, bounded on the north and east by the City of North Vancouver. The Project area does not overlap any current or former Squamish Nation reserve lands.

Squamish Nation traditional territory, as described in their Statement of Intent filed with the British Columbia Treaty Commission, takes in the area from Point Grey in the south to Roberts Creek in the west; then north along the height of land to the Elaho River headwaters including all the islands and drainages in Howe Sound; then southeast to the confluence of the Soo and Green rivers north from Whistler; then south along the height of land to the Port Moody area including the entire Mamquam River and Indian Arm drainages; then west along the height of land to Point Grey. This territorial boundary, as updated from time to time, is asserted by Squamish Nation to extend farther south than described above, and specifically to the South Arm of the Fraser River, taking in all of Lulu Island. This area overlaps the northern half of the Project corridor, including the Tunnel crossing.

Xay Temixw (sacred land), the Squamish Nation's Land Use Plan, describes the Squamish Nation's vision for the future of the forests and wilderness of their traditional territory, with the stated objective to ensure the land is protected and managed for the benefit of present and future generations. *Xay Temixw* has established four land use zones: a forest stewardship zone, sensitive areas, restoration areas, and *Kwa kwayx welh-aynexws* (wild spirit places). *Xay Temixw* has also set management objectives that define how the lands, waters, and territory must be managed. Squamish Nation report that they are also undertaking planning for traditional fishing areas, but, due to the sensitivity of the information, may not be mapped or described in the plan.

The Squamish Nation owns and operates several businesses, including the Mosquito Creek Marina, Lynnwood Marina, Marina Grill, North Vancouver Smoke Shop at Mosquito Creek, Squamish Valley Gas LP, Superstore Gas Bar, North Vancouver, Capilano River RV Park, West Vancouver, and the Northwest Squamish Forestry LP. In addition to revenue generated from existing leases and businesses, the Squamish Nation plans to develop various parcels of lands, including proposed developments at Seymour, Capilano, Kitsilano, Chekwelp and Stawamus. The Squamish Nation also currently generates revenue from a three-year Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia, signed in March 2015.

3.1 Squamish Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes are or may be connected with the exercise of Squamish's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Squamish in Section 10.1.3.2 Existing Conditions.

3.1.1 Fishing

- Squamish does not currently fish directly in the Fraser River for food, social or ceremonial (FSC) purposes based on information previously reported by Squamish and a review of Fisheries and Oceans Canada (DFO) records. According to those DFO records, Howe Sound and the Squamish River have been the key areas for Squamish salmon harvesting, and specifically within Pacific Fishery Management Area (PFMA) 28, subareas 28-2 to 28-4.
- Squamish has also been licenced to harvest crab, prawn, and shrimp for FSC purposes in PFMA 28-2 to 28-4, which is well north of the Fraser River.
- Squamish report that, historically, they harvested Fraser River sockeye, based on family ties with other First Nations, and that Squamish presence on the Fraser River is well documented in historic accounts, including one from 1827. They have said that there is no other source for sockeye in Squamish Nation territory, and that fishing sockeye on the Fraser is integral to Squamish Nation culture. Accordingly, for many years, including initiating a formal request to DFO in 2011, Squamish Nation say they have sought an increase to their Fraser River sockeye allocation for FSC purposes through an extension of their FSC fishing area to include the Lower Fraser River. Squamish Nation has said that by expanding their FSC fishing area to include the Lower Fraser River, they would be able to fish Fraser River sockeye the way their ancestors did (i.e., directly) and re-establish their historical connections to the area.

3.1.2 Hunting/Trapping

Past, present, or desired future hunting or trapping of resources by the Squamish Nation in the vicinity of the Project area was not identified in sources reviewed.

3.1.3 Gathering

Past, present, or desired future gathering of terrestrial resources by the Squamish Nation in the vicinity of the Project area was not identified in sources reviewed.

3.1.4 Archaeology and Cultural Heritage Interests

Archaeology and cultural heritage interests were not identified for Squamish in the vicinity of the Project area identified in the sources reviewed.

3.1.5 Other Related Interests

Other related interests were not identified for Squamish in the sources reviewed.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Squamish's Aboriginal Interests, specifically. For a more detailed description of the methodology and a summary of the results, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**

- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.

- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Squamish’s exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Squamish's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Squamish's Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect |
|--|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

Squamish does not currently fish directly in the Fraser River for food, social or ceremonial (FSC) purposes; however, Squamish report that they harvested Fraser River sockeye historically, based on family ties with other First Nations. Squamish also note that fishing sockeye on the Fraser is integral to Squamish Nation culture and have sought to increase to their Fraser River sockeye allocation for FSC purposes through an extension of their FSC fishing area to include the Lower Fraser River.

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Squamish, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Squamish during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Squamish from instream construction activities are expected to be negligible. While it is acknowledged that Squamish has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Squamish. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Squamish; therefore, Potential Project-related effects on Squamish fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Squamish.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Squamish is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Squamish's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Past, present, or desired future hunting or trapping of resources by the Squamish Nation in the vicinity of the Project area was not identified in sources reviewed.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Squamish as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Squamish during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Squamish from instream construction activities, are expected to be negligible. While it is acknowledged that Squamish has reported a desire for higher levels of use in this portion of the river based on historic use, the

episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Squamish resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Squamish. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Squamish; therefore, Potential Project-related effects on Squamish fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Squamish.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Squamish is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Squamish's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Past, present, or desired future gathering of terrestrial resources by the Squamish Nation in the vicinity of the Project area was not identified in sources reviewed.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Squamish as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Squamish during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Squamish from instream construction activities, are expected to be negligible. While it is acknowledged that Squamish has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Squamish resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in Section 4.2 Sediment and Water Quality and Section 4.9 Air Quality are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Squamish; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Squamish.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Squamish is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Squamish's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Archaeology and cultural heritage interests were not identified for Squamish in the vicinity of the Project area identified in the sources reviewed.

The proposed Project has the potential to affect Squamish's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Squamish's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Squamish's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Squamish’s archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Squamish has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Squamish’s archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Squamish’s archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Squamish’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Squamish.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Squamish (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Squamish’s Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Squamish, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Squamish. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Squamish's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Squamish regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Squamish's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Squamish prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Squamish during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Squamish during consultations include:

- Protection of Squamish First Nation's rights to harvest within the Project area.
- Aboriginal participation and Project-related opportunities
- Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon;
- Evaluation on impacts to ecological services for all ecosystems within the vicinity of the Project;
- Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon;
- Disturbance to benthic and aquatic invertebrates and their habitat;
- Social effects of the Project on Squamish's ability to transfer knowledge, language and participate in socio-cultural practices;
- Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Squamish fishing;
- Increased shipping;
- Potential effects on Fraser River flow rates after Tunnel removal; and
- Potential effects of run off and drainage.

Based on information provided by Squamish and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Squamish's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for VCs or ICs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Squamish Nation, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Squamish regarding proposed measures, management plans, and monitoring programs related to VCs and ICs assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Squamish, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding the Environmental Assessment Process. | | | |

ABORIGINAL INTERESTS

There are potential Project related impacts to Squamish's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Instream locations (during construction)

Quality of experience while engaged in or tied to traditional use

- cultural landscape
- Instream locations (during construction)

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations (during construction)
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- Fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Protection of Squamish Nation’s right to fish within the Project area.</p> | <p>Squamish’s rights to fish within the Project area is addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.4 (Fish and Fish Habitat), residual effects on the exercise of Aboriginal Interests by Squamish as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures in Section 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Access to the Fraser River and the potential to displace fishing vessels. Squamish gets their food fish from the Project area and is concerned with any impacts that would harm this.</p> | <p>Squamish’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Social effects of the Project such as Squamish Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Squamish’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |

| ABORIGINAL CONSULTATION | | | |
|---|--|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Squamish received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Funding for Project Report | The Ministry signed a funding agreement with Squamish Nation which provided funding for a GMT Project Report. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns.

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes.

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------|--|
| Opportunities for cultural recognition and naming, specifically interpretive signage by highway including road signs and kiosks | The Ministry is exploring opportunities for cultural recognition and naming and will to work with Squamish on this matter. | Ongoing | Discussion with Squamish to explore opportunities related to cultural recognition and naming, art and interpretive signage |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--|
| Project-related employment, training, contracting, and economic development opportunities. | The Ministry is committed to working with Squamish to identify potential opportunities to benefit from the. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Squamish to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Change in flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures) |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential effects of run off and drainage - innovative stormwater solutions and bioengineering techniques</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Water quality and sediment issues: comprehensive understanding of potential ecological impacts and core sampling</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. New studies have proven that hard surface runoff from roads will kill salmon within two hours of exposure.</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to the Squamish. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Evaluation on impacts to ecological services for all ecosystems within the vicinity of the Project</p> | <p>Pacific salmon species selected for Project-related baseline studies include Chinook salmon, Chum salmon, Coho salmon, Pink salmon, and Sockeye salmon. Using existing scientific and literature, baseline conditions will be described for all life history stages of each salmon species, with emphasis on those life history stages that use aquatic habitats within the Project Area. Fish sampling focused on potential rearing values within drainage ditches in Richmond and Delta, for which limited existing inventory information exists, has been incorporated into the baseline studies.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Disturbance to benthic and aquatic invertebrates and their habitat</p> | <p>Aquatic habitats, which include habitat for fish and other aquatic species (including benthic and aquatic invertebrates), will be a primary area of focus for the environmental assessment of the Project.</p> <p>Potential disturbance to benthic and aquatic invertebrates is not, on its own, proposed as a key area of study given the nature of the project and the aquatic habitats it overlaps with. Aquatic habitats overlapping with the Project occur within a section of the Fraser River that is dynamic, influenced by large flow variations and downstream transport of sand and organic matter. Therefore, aquatic and benthic invertebrate communities in the Project Area are expected to be resilient to physical disturbance. Given the temporary and short-term changes in flow and water quality expected from Project activities, it is anticipated that the benthic and aquatic invertebrates will recover rapidly from disturbance.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

- A negligible effect on the availability of marine mammal resources for traditional use has been determined.
- A negligible effect on quality of marine mammal resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

- Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
- Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
- Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding Marine Mammals | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail march that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|---|
| Use of culturally significant plants in planting plans and importance of obtaining input from Squamish on plant selection | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed in Application | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

- A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

- Minimize potential effects through Project design.
- Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Squamish is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Potential effects of the bridge structure on species such as waterfowl and migratory birds. | The Ministry understands that Squamish is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.8.4 |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding the Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on atmospheric noise are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding the Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> | <p>Potential interference with Squamish fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Fishing patterns and practices have adapted to the Tunnel in the riverbed. Removal of the Tunnel would impact these established patterns and practices</p> | <p>As discussed in Section 4.4 (Fish and Fish Habitat) of the Application, potential effects on habitat quality associated with decommissioning of the existing Tunnel are considered negligible. Sensitive life stages of salmonids migrating through or foraging in this section of the river tend to occupy the upper water column, and eulachon spawning habitat is absent near the Tunnel crossing, while sturgeon overwintering habitat will continue to be present after the trench has naturally infilled. As a result, potential Project-related effects associated with fish habitat alteration are not considered further in the assessment.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Squamish did not voice any issues or concerns regarding Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Squamish has not voiced specific concerns regarding Visual Quality. | | | |

| 6.1 HERITAGE RESOURCES | | | |
|--|--|---------------------------------|---|
| <p>The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.</p> <p><u>Effects</u> A negligible effect on access to upland locations for traditional use has been determined. A negligible effect on quality of experience tied to access of upland locations for traditional has been determined. No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape. A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.</p> <p><u>Mitigation</u> Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation. Undertake additional archaeological surveys.</p> <p><u>Residual & Cumulative Effects</u> No significant Project-related residual or cumulative effects on heritage resources are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Protection of archaeological and heritage resources, including intangible heritage sites. Protection of cultural and archaeological sites that are known to exist or may be discovered within the Project area.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Squamish. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Squamish participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Squamish will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been

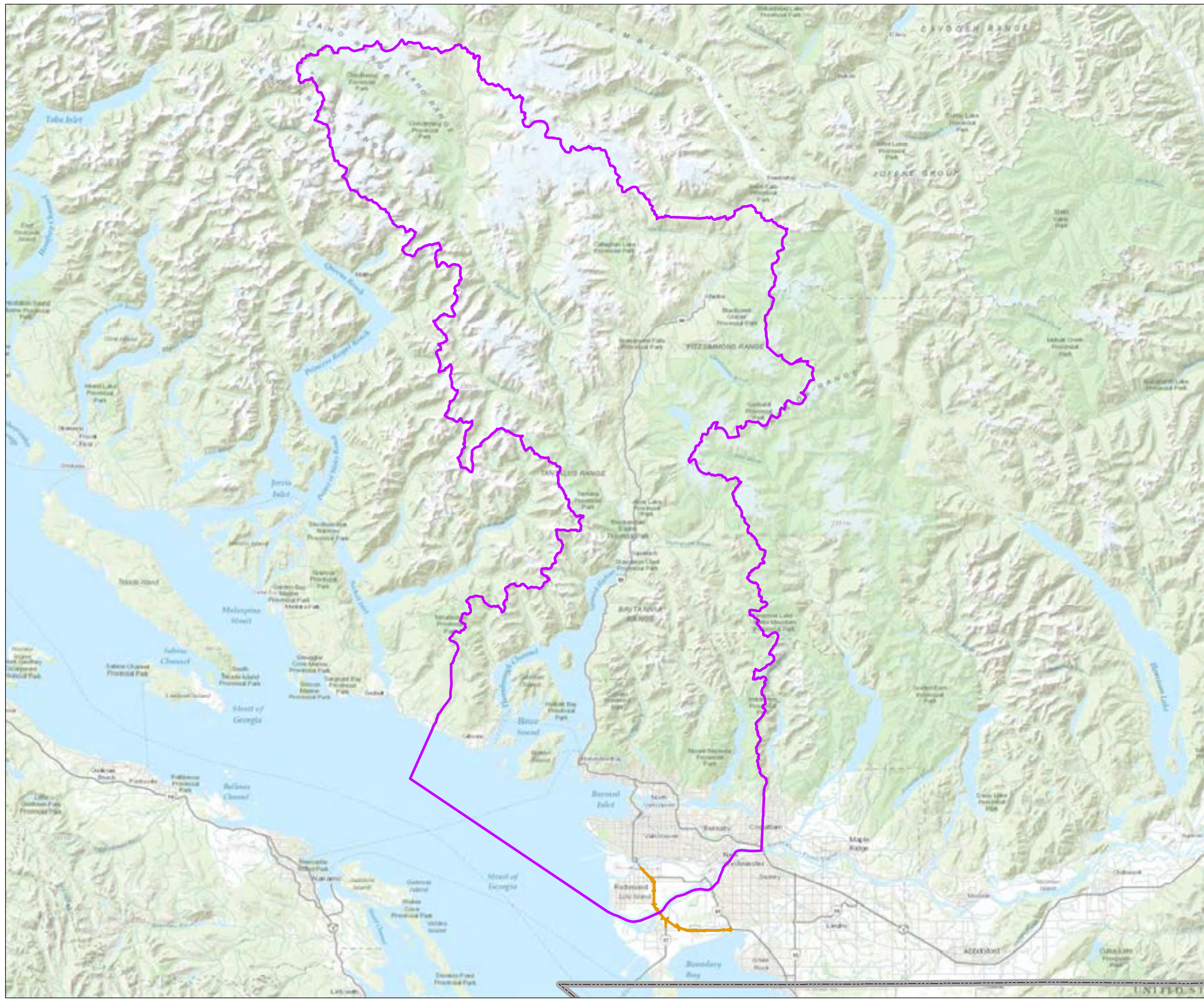
| 7.0 HUMAN HEALTH | | | |
|---|---|------------------|--------------------------------|
| <p>determined.</p> <p>During operation, a negligible effect on access to instream locations for traditional use has been determined.</p> <p>During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.</p> <p>Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>While many contaminants are expected to remain stable or drop, two specifically are a concern (DFO Canadian Scientific Advisory Report 2015-002, FVRD Highlights of Emission Trends 1990-2013):</p> <ul style="list-style-type: none"> • Diesel particulate matter levels in the FRVD post a health risk for developing cancer at more than 20x the Health Canada acceptable threshold • Acrolein levels in the FVRD poses a risk for non-cancer outcomes more than 15x times the Health Canada threshold | <p>Section 7.0 of the Application includes an assessment of potential Project-related effects on human health. The Human Health Risk Assessment (HHRA) conducted in support of the environmental assessment will include a consideration of air contaminants near Highway 99.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| <p>Scope of pollution testing was one km from work zone. However, increases in traffic from this route will have a long ranging, long term impact through the East to the Fraser Valley. The projection graphs do not predict what the maximum capacity of the route once completed. Is such a projection available to ascertain outcomes?</p> | <p>The future conditions for the Air Quality Assessment used the reference year 2031 to make effective use of the vehicle fleet emissions forecasts set out by Metro Vancouver, and the Regional Transportation Model. Metro Vancouver’s emission inventory was used. Metro Vancouver conducts an emission inventory, and forecasts emissions, and the latest emission forecasting by Metro Vancouver includes emission forecasts to 2031. Forecasting emissions, and resulting air quality, further into the future will have more uncertainty as projections of what future regulations may be implemented and available vehicle technologies for new vehicles built are unknown. Therefore, 2031 represents a conservative projection of what air quality is expected to be like in the future with and without the Project.</p> | <p>Addressed</p> | <p>None</p> |




| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|--|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|--|---|---------------|--------------------------------|
| Consultation with Squamish Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Increased shipping | The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. | Addressed | None |

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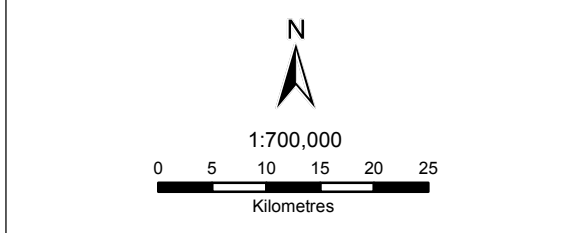



Legend

-  Squamish Nation Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. Squamish Nation Traditional Territory Boundary provided by Ministry by Squamish Nation during consultation on the Project.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| SQUAMISH NATION ASSERTED TRADITIONAL TERRITORY | |
| Figure 10-8 | 26/05/2016 |
|  | |

APPENDIX M

Stz'uminus First Nation

1.0 Introduction

Stz’uminus First Nation engaged directly with the Ministry on the Project and also collectively with Cowichan Tribes, Halalt First Nation and Penelakut Tribe as member nations of the Cowichan Nation Alliance. The Ministry provided information and funding directly to Stz’uminus. However, Cowichan Nation Alliance provided feedback and participated in meetings and fieldwork. Unless noted otherwise, Cowichan Tribe represented Cowichan Nation Alliance in correspondence, meetings and fieldwork. This overview provides information on consultation with Stz’uminus specifically, and with Cowichan Nation Alliance as applicable to Stz’uminus.

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Stz’uminus.

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Stz’uminus, refer to the following sections of Part C:

- Consultation with Stz’uminus (**Section 10.1.2.10**);
- Stz’uminus community profiles (**Section 10.1.1.11**);
- Description of existing Stz’uminus Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Stz’uminus Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Stz’uminus Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of the Aboriginal Interests Assessment for Stz'uminus is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Stz'uminus Overview Table (**Appendix M2**), which provides detailed information regarding:

- Stz'uminus issues and concerns identified to date;
- Identification of effects on VCs and ICs that relate to the assessment of effects on Stz'uminus' Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Stz'uminus;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act (BCEAA)*, that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Stz'uminus and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, EAO held two Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations. Halalt First Nation represented Cowichan Nation Alliance at the first meeting. Halalt First Nation and Cowichan Tribes represented Cowichan Nation Alliance at the second meeting.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Cowichan Nation Alliance in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence within the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Cowichan Nation Alliance participated in the completeness review of the Application for an Environmental Assessment Certificate (Application) that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Stz’uminus will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Stz’uminus in early 2014 in order to identify the nature and scope of Stz’uminus’ Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Stz’uminus. A more detailed discussion is provided under the Stz’uminus section in **Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Stz’uminus. The Ministry has been working with Stz’uminus regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

- The Ministry provided additional funding to Stz’uminus for the preparation and submission of Traditional Use, Traditional Knowledge or other studies. Stz’uminus worked with other Cowichan Nation Alliance members and submitted the following traditional use studies: *Cowichan Nation Traditional, Current, and Planned Future Use of the George Massey Tunnel Replacement Bridge Project Area, prepared by Candace Charlie for Cowichan Tribes, on behalf of the Cowichan Nation Alliance, August 9, 2015*
- *George Massey Tunnel Replacement Project: Cowichan Occupation and Use of the Project Lands, prepared by Dorothy Kennedy for David Robbins of Woodward and Co., Counsel for the Cowichan Tribes, on behalf of the Cowichan Tribes, August 25, 2015*

Cowichan Nation Alliance also provided to the Ministry: *Historical Geography of Cowichan Land Use and Occupancy Lower Fraser River: Map Series and Report, prepared for Woodward and Company and the Cowichan Tribes by Kenneth G. Brealey, May 31, 2010.*

The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry’s understanding of Aboriginal Interests and Aboriginal Group’s past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Stz’uminus during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study document. The focus of

the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Stz’uminus included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Stz’uminus;
- Funding for Stz’uminus’ participation in Project consultation activities and EA process;
- Stz’uminus participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, AIR, Heritage Resources Assessment and Aboriginal Consultation Plan;
- Meetings with Stz’uminus Chief and Council, staff, consultants, and elders; and
- Response and follow up with Stz’uminus regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study document on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of the Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Stz’uminus included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Stz’uminus;
- Funding for Stz’uminus’ participation in Project consultation activities and EA process;
- Meetings with Stz’uminus Chief and Council, staff, consultants, elders and membership and Cowichan Nation Alliance;
- Stz’uminus participation in fieldwork;
- Stz’uminus participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Stz’uminus regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Stz’uminus’ concerns, identified through consultation undertaken to-date, are presented in **Appendix M2 Stz’uminus Overview Table**. The Ministry’s response to Stz’uminus’ key concerns regarding potential impacts on Stz’uminus’ Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|--|--|
| <p>Potential impacts to Cowichan Nation Alliance title, Rights and culture.</p> | <p>Potential Project related impacts to Stz’uminus title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Cowichan Nation Alliance to ensure any effects are minimized.</p> |
| <p>Aboriginal participation and Project-related opportunities</p> <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Revenue sharing opportunities from tolling • Re-establishment of a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes • Surplus land | <p>The Ministry is committed to working with Stz’uminus to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness.</p> <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Stz’uminus on these opportunities.</p> <p>The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways.</p> <p>The Ministry notes Cowichan Nation Alliance’s wish to re-establish a site on ʔəqtinəs/Tl’uqtinus site for residential and/or commercial purposes.</p> <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Stz’uminus and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Process and associated timelines • Strength of Claim Assessment | <p>The Ministry acknowledges the importance of Stz’uminus’s involvement in the environmental assessment process and is committed to funding Stz’uminus’s participation in the Initiation Consultation and Application Review phases.</p> <p>Stz’uminus’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects, process and associated timelines are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Concerns relating to the Strength of Claim Assessment have been referred to EAO.</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Social effects of the Project on Cowichan Nation Alliance’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Stz’uminus’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Stz’uminus and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Stz’uminus or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>While the Ministry acknowledges that Stz’uminus is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> |
| <p>Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project, including the decommissioning of the Tunnel, will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> |

| Concerns Identified to Date | Response |
|---|---|
| Potential effects on Fraser River flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics). |
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile: Stz’uminus First Nation

Stz’uminus is governed by a chief and council, but under a custom electoral system, with the current three-year term for the ten-member council expiring in April 2017.

While the First Nations affiliated with the Cowichan Nation Alliance have explained that they traditionally resided on both sides of the Strait of Georgia as part of a seasonal round, Stz’uminus’ main present-day community is located in Ladysmith on southeast Vancouver Island. Of 1,296 registered members, 712 live on reserve. The Project area does not overlap any of Stz’uminus’ current or former reserve lands.

Stz’uminus is, or has been, affiliated with the Hul’qumi’num Treaty Group, along with the other three Cowichan Nation Alliance members, Lake Cowichan First Nation and Lyackson First Nation. These First Nations have been described as speakers of the “Island” dialect of Halkomelem (*Hul’q’umi’num*), and have referred to themselves collectively as *Hul’qumi’num Mustimuhw*.

The Hul’qumi’num Treaty Group member bands collectively assert a core territory or “title lands” and a wider marine or fishing territory, as described in its Statement of Intent to the British Columbia Treaty Commission. Core areas over which title is asserted include but are not limited to “the south arm of the Fraser River, including Canoe Pass, up to and including Douglas Island, with lands on the north shore of the south arm up to Sapperton Channel (New Westminster), the islands in the south arm of the Fraser River and the south bank of the Fraser River along Canoe Pass up to Deas Island”. This area is subsumed within the broader marine or fishing territory. The core territory of the Hul’qumi’num Treaty Group overlaps the Project area at the Tunnel crossing.

Stz’uminus, along with each of the other Cowichan Nation Alliance member First Nations, has a Forest Consultation and Revenue Sharing Agreement with the Province of British Columbia. In the map for the Stz’uminus’ 2013 agreement, the territory depicted is equivalent to the collective core territory of the Hul’qumi’num Treaty Group.

Locations along the South Arm of the Fraser River of importance to Stz’uminus, along with the Cowichan Nation Alliance member First Nations, in the vicinity of the Project include but are not limited to *Tl’uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhits’um* or *Xwulit’sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites. A member First Nation of the organization has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl’uqtinus* for residential and/or commercial purposes. Cowichan Nation Alliance’s *Tl’uqtinus* claim area is shown in **Section 10.1.3.2**

Existing Conditions.

3.1 Stz’uminus First Nation Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Stz’uminus’ Aboriginal Interests. A more detailed discussion, including sources used, is provided under Stz’uminus First Nation in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- Stz’uminus has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.
- Stz’uminus followed a seasonal round of resource use and regional settlement that took them from their winter residences on Vancouver Island and the Gulf Islands across the Strait of Georgia to the Fraser River estuary, where they resided for all or part of the annual salmon runs (April to through October), or, in some instances, year-round. The seasonal round is described in Part C.
- Stz’uminus has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests.
- A Cowichan Nation Alliance member First Nation has previously reported that the Cowichan Nation Alliance is working to re-establish a permanent land base at *Tl’uq̓tinus* for residential and/or commercial purposes.

3.1.2 Fishing

- Stz’uminus harvested the following species historically on the South Arm of the Fraser River: sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while they were resident on the Fraser River.
- Cowichan Nation Alliance reports that *Tl’uq̓tinus* was used seasonally for harvesting purposes, with Halalt reporting that they used the area specifically in July to fish for sockeye and pink salmon. Stz’uminus also used other habitation sites in the area, including one at Steveston.
- Areas within the wider Fraser River estuary were also utilized by *Hul’q’umi’num’*-speaking peoples for fishing salmon, sturgeon, groundfish, and other marine resources on the foreshore (e.g., Tsawwassen, Point Roberts, Boundary Bay). Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations.

- The Hul’qumi’num Treaty Group have reported that during the reserve creation era in the late nineteenth century, government officials were aware of *Hul’qumi’num Mustimuhw* fishing interests at the Fraser River; however, no reserves were set aside for them in the area. The Hul’qumi’num Treaty Group have also reported that government regulations introduced in the same era had the effect of restricting their access to fishing in the Fraser River. Despite these changes, *Hul’qumi’num Mustimuhw* say they continued to use the Fraser River for fishing, including commercially, into the early twentieth century.
- Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO). Access to sockeye for member First Nations is said to be provided by DFO annually in Johnstone Strait and “off the mouth of the Fraser River”. In the vicinity of the Project area, however, access has been subject to negotiations with First Nations local to the lower Fraser River, and has been limited, occurring only in 2005, 2006, and 2008. In those years, the specific locations in the South Arm in which member First Nations of the Hul’qumi’num Treaty Group fished for food, social, and ceremonial (FSC) purposes under communal licences was below the Port Mann Bridge generally, as well as specifically, on some occasions, below the easterly point of Kirkland Island (i.e., downstream of the Project area). The Cowichan Nation Alliance has stated that it is in ongoing, active litigation over its asserted fishing rights on the South Arm of the Fraser River.
- The Hul’qumi’num Fisheries Limited Partnership (HFLP) is a commercial fishing business in which some of the Cowichan Nation Alliance member groups participate (Halalt, Penelakut, and Stz’uminus). Species harvested through this enterprise are crab, prawn, halibut, herring, rockfish, sablefish, and salmon.

3.1.3 Hunting/Trapping

- Cowichan Nation Alliance has previously reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species.
- Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round.
- The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm. The Cowichan Nation Alliance as a group has stated a desire to resume the harvest of traditional resources in the Project area.
- Cowichan Nation Alliance has also stated that its members revere bald eagles, which were not hunted. Their Elders have indicated that eagle numbers in the Richmond area have been dwindling each year. Breeding habitat along the Highway 99 corridor on Lulu Island has been previously noted.

3.1.4 Gathering

- Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits’um*, or place for cutting (cattails) – as well as in the area of *Tl’uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth’equn*) were once harvested.
- Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl’uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth’equn*), as well as seaweed. With respect to berry plants at *Tl’uqtinus* specifically, a 1979 map produced by Environment Canada noted an “Indian residence” at this location, accompanied by the caption (not attributed to any specific Aboriginal group): “It is known that the Indians who lived here for several thousand years harvested berries from the bogs and used fire to maintain open areas for the berry bushes by preventing encroachment from pine trees”.
- Cowichan Nation Alliance has indicated that they wish to see existing bogs on Lulu Island near the Highway 99 corridor – specifically, one near Williams Road (which runs perpendicular to Highway 99) and another near the Richmond Nature Park (bisected by Highway 99 at Westminster Highway) – protected to support future use of traditional resources, like berries and other bog ecosystem flora. At *Tl’uqtinus*, which is currently surrounded by blueberry farms, Cowichan Nation Alliance has raised the potential for their former berry grounds to be re-established.

3.1.5 Archaeology and Cultural Heritage Interests

- Locations along the South Arm of the Fraser River of importance to the Cowichan Nation Alliance in the vicinity of the Project include, but are not limited to, *Tl’uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhits’um* or *Xwulit’sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites.
- Cowichan Nation Alliance has specifically noted the importance of archaeological site DgRs-17.

3.1.6 Other Related Interests

- Cowichan Nation Alliance has stated that it asserts Aboriginal title to *Tl’uqtinus*, and given where *Tl’uqtinus* is reportedly situated, to the Project footprint. The Cowichan Nation Alliance has expressed its view that this title includes the right to manage the land, determine the uses to which it can be put, and obtain any economic benefits from it. Cowichan Nation Alliance has advised that it is also working to re-establish culturally

integral practices (e.g., harvesting fish, waterfowl, plants) on the South Arm and at the mouth of the Fraser River, including at and about *Tl’uq̓tinus*.

- The Cowichan Nation Alliance has previously reported that for the last generation its member First Nations have been rejuvenating their access to the waterways that once served as the highways for their ancestors, working with the currents and tides to travel for FSC purposes. The Cowichan Nation Alliance has expressed concern regarding the contaminants and the sustainability of vital habitats that are necessary to support their members.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Stz’uminus’ Aboriginal Interests, specifically. For a more detailed description, refer to **Section 10.1.3.3.**

Potential Effects.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**

- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|--|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in |

| Indicator | Rationale for Selection |
|---|---|
| | public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-

related effects and level of effect predicted in relation to Stz’uminus’ exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Stz’uminus’ Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Stz’uminus’ Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect |
|--|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |

| Indicator | Potential Project-Related Effect |
|--|---|
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

Stz’uminus harvested the following s historically on the South Arm of the Fraser River included sockeye and pink salmon, sturgeon, shellfish, and marine mammals. Cowichan Nation Alliance has previously reported that now filled-in sloughs and streams in or near Highway 99 once supported coho and eulachon, which were also harvested while resident on the Fraser River. Certain species (e.g., sockeye and pink salmon, sturgeon, eulachon, trout, flounder) could only be obtained in, or were preferred to be taken at, Fraser River-based locations. Member First Nations of the Cowichan Nation Alliance have been attempting to restore former fisheries within the Fraser River through Fisheries and Oceans Canada (DFO).

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Stz’uminus, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Stz’uminus during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Stz’uminus from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Stz’uminus. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Stz’uminus; therefore, Potential Project-related effects on Stz’uminus fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in in Section 4.10 Atmospheric Noise are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Stz’uminus.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Stz’uminus is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Stz’uminus’ Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Stz’uminus reported that Highway 99 was built on what was once a prime harvesting location for deer, ducks, and geese, among other species. Along the Fraser River, including Canoe Pass, as well as elsewhere in their collective territory, brant goose, canvasback duck, common merganser, and mallard have been specifically identified as harvested species by Cowichan Tribes, and that this harvesting would have taken place in the fall. Canada goose, northern shoveler, and green-winged teal would have been available to the Cowichan people year-round. The south shore of Lulu Island, along the South Arm of the Fraser River, has been reported as a prime spot for trapping beaver, mink, and muskrat; bear, grouse, elk, squirrel, and porcupine were also hunted by the Cowichan people on the South Arm.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Stz’uminus as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Stz’uminus during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Stz’uminus from instream construction activities, are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Stz’uminus resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Stz’uminus. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Stz’uminus; therefore, Potential Project-related effects on Stz’uminus fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Stz’uminus.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Stz’uminus is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Stz’uminus’ Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Cowichan Nation Alliance report that in the marshy areas south of Canoe Passage near Brunswick Point – in the area of *Xwulits’um*, or place for cutting (cattails) – as well as in the area of *Tl’uqtinus* and across the Fraser River on Tilbury Island, several varieties of cattails and rushes (*stth’equn*) were once harvested. Berries and other plants were gathered and cultivated by the ancestors of the Cowichan Nation Alliance member bands at *Tl’uqtinus*, and were harvested from other locations in the Project area. These plants included wild rose, rose hips, crabapples, elderberries, horsetail, labrador tea, Indian hemp, trembling aspen, mock orange, oregon grape, maple leaves, cranberries, blueberries, blackberries, wapato, bulrushes/reeds (*stth’equn*), as well as seaweed. Tree species available in the vicinity of the Fraser River and traditionally used by the Cowichan Tribes for manufacturing include crabapple, willow, alder, cottonwood, cedar, spruce, aspen, yew, hemlock, and vine maple.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Stz’uminus as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Stz’uminus during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Stz’uminus from instream construction activities, are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Stz’uminus resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Stz’uminus; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Stz’uminus.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Stz’uminus is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Stz’uminus’ Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Locations along the South Arm of the Fraser River of importance to the Stz’uminus in the vicinity of the Project include, but are not limited to, *Tl’uqtinus*, spanning the north shore from opposite Deas Island to opposite Tilbury Island, and *Hwlhitsu’um* or *Xwulit’sum*, on Canoe Pass. Both of these areas are considered by Cowichan Nation Alliance member bands as ancestral village and resource sites.

The proposed Project has the potential to affect Stz’uminus’s Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Stz’uminus’s archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Stz’uminus’s interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Stz’uminus’s archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Cowichan Nation Alliance has reported a desire for higher levels of use in

this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Stz’uminus’s archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Stz’uminus’s archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Stz’uminus’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Stz’uminus.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Stz’uminus (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Stz’uminus’s Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Stz’uminus, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Stz’uminus. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Stz’uminus’s Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Stz’uminus regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in Section 10.1.3.4 and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Stz’uminus’s Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Stz’uminus prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Stz’uminus during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Stz’uminus during consultations include:

- Potential impacts to Stz’uminus title, rights and culture;
- Consideration for future uses should include Stz’uminus’s plans;
- Aboriginal participation and Project-related opportunities (e.g., potential employment, training, contracting and economic development opportunities);
- Potential effects to air quality, particularly in relation to terrestrial wildlife;
- Effects to fish and fish habitat, and importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon;
- Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities;
- Adequacy of EA methodology to address social and cultural effects;
- EA process and associated timelines;
- Strength of claim;
- Social effects of the Project on Stz’uminus’s ability to transfer knowledge, language and participate in socio-cultural practices;
- Cumulative effects;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on Fraser River flow rates after Tunnel removal; and
- Potential effects of run off and drainage.

Based on information provided by Stz’uminus and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Stz’uminus has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Stz’uminus’s Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Stz’uminus, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Stz’uminus regarding proposed measures, management plans, and monitoring programs related to VC and IC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Stz’uminus, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. Environmental Assessment Act (B.C. EAA), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. EAA sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. EAA, and that it requires an EAC.

The Project as proposed is not subject to review under the Canadian Environmental Assessment Act, 2012, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the Environmental Assessment Act.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|-------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Project’s EA Process and its associated timelines. | Concerns relating to the EA process and its associates timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Stz’uminus First Nation’s queries regarding the EA Process and associated timelines. | Referred to EAO | None |
| Effectiveness and nature of the EA process as well as current volume of EAs underway | Concerns relating to the broad concern related to the effectiveness and nature of the Environmental Assessment Process have been referred to EAO. While the Ministry is unable to address the concern related to the current volume of EA’s underway, the Ministry has and will continue to work with Stz’uminus First Nation to support their participation in this particular Project’s review process and to plan for consultation activities in a manner that is mindful of the current volume of referrals that Stz’uminus First Nation is working on. Support to date has included Pre-Application capacity funding. | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--------------------------------------|
| Lack of resources and funding for First Nations communities. | The Ministry provided funding for the Pre-Application Phase and has committed to providing funding for the Application Review Phase. | Addressed | Funding for Application Review Phase |

ABORIGINAL INTERESTS

There are potential Project related impacts to Stz’uminus First Nation’s title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Stz’uminus First Nation as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential impacts to Stz’uminus First Nation’s title, Rights and culture. Identification of future developments should include potential Stz’uminus First Nation’s title and rights resulting from treaty negotiations or proof of title.</p> | <p>Potential Project related impacts to Stz’uminus First Nation’s title, Rights and culture, the level of effect predicted, and mitigation measures are outlined the Application. The Ministry will continue to consult with Stz’uminus First Nation’s to ensure any effects are minimized.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Identification of “other requirements that are relevant to the Project, including international agreements or other agreements” should be included in the Crown’s Constitutional obligations to First Nations“</p> | <p>The Crown’s constitutional obligations are fundamental to consultation with Stz’uminus First Nation and the EA process. The obligations within the context of the EA are addressed in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |
| <p>“Consideration for future uses should include Cowichan Nation Alliance’s plans to re-establish a site on Łæqtinəs/Tl’uqtinus site for residential and/or commercial purposes.”</p> | <p>Noted</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Stz’uminus First Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel.</p> | <p>Stz’uminus First Nation’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as Stz’uminus First Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Stz’uminus First Nation’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in all sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| | <p>predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of the Application.</p> | | |
| <p>Protection of Stz’uminus First Nation’s rights to harvest within the Project area.</p> | <p>Stz’uminus First Nation’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Stz’uminus First Nation as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and Implementation of measures outlined in Section 10.1.3.4</p> |
| <p>Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities.</p> | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Concern that the overlapping construction period of GMT and Pattullo projects needs to be considered in the assessment. | Rehabilitation of the Pattullo Bridge will be completed by October 2016. The replacement of the Pattullo bridge is in planning stages and a construction period has yet to be established. | Addressed | None |
| Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline | The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. | Addressed | None |
| Absence of a comprehensive study of cumulative effects on the Fraser River | While the Ministry acknowledges that Stz’uminus First Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|-------------------------|
| Length of time tolls are in place | <p>The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |
| Revenue sharing opportunities from tolling | <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> | Addressed | None |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Stz’uminus First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Stz’uminus First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Stz’uminus First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Stz’uminus First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Stz’uminus First Nation which provided funding for a Traditional Use Study. | Addressed | None |
| Capacity funding to facilitate participation in the Project review process | Stz’uminus First Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Stz’uminus First Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Stz’uminus First Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Stz’uminus First Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Traditional Use Study | The Ministry signed a funding agreement with Stz’uminus First Nation which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project’s Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests

Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes

Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns

Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes

Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects

Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.

Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry’s Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Opportunities for cultural recognition and naming</p> | <p>The Ministry is exploring opportunities for cultural recognition and naming and will to work with Stz’uminus First Nation on this matter.</p> | <p>Ongoing</p> | <p>Further engagement with Stz’uminus First Nation is planned to explore opportunities related to cultural recognition and naming, art and interpretive signage</p> |
| <p>Project-related employment, training, contracting, and economic development opportunities. Equity and revenue sharing for Stz’uminus First Nation and importance of initiating related discussions with Stz’uminus First Nation during Pre-Application Stage. Aboriginal procurement policy.</p> | <p>The Ministry is committed to working with Stz’uminus First Nation to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Stz’uminus First Nation wants to prepare its membership for employment opportunities and will work with Stz’uminus First Nation to identify ways to support community preparedness.</p> | <p>Ongoing</p> | <p>The Ministry will share information including identification of potential employment, training, contracting and economic development opportunities as it becomes available to support community preparedness. The Ministry welcomes input from Stz’uminus First Nation on the type of information that would be useful.</p> |
| <p>Interest in land recovery at Green Slough</p> | <p>As part of the Project, agricultural land will be protected as much as practical. Once the project is completed, there will be a determination of surplus lands, if any, and disposition will follow the appropriate process including consultation.</p> | <p>Addressed</p> | <p>Determination of surplus lands and consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------|--|
| Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Stz’uminus First Nation to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Stz’uminus First Nation to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Factoring in extreme weather events in River Hydraulics model</p> | <p>Extreme weather events are considered and planned for. River Hydraulics and River Morphology are addressed in Section 4.1.4.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|--|
| <p>Potential for contaminants in the tunnel and how this may affect tunnel decommissioning.</p> | <p>The Ministry will consult with Fisheries and Oceans Canada and Port Metro Vancouver regarding Tunnel decommissioning, and will incorporate the requirements of these agencies in the planning and implementation of decommissioning activities.</p> <p>If potentially hazardous building materials are identified in the Tunnel, a detailed plan for removing and appropriately disposing of such material will be developed prior to initiating decommissioning activities. Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers’ Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.1.4 and 4.2.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Potential effects of run off and drainage | The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.2.4 |
| Effect of the Tunnel on dissolved oxygen content within the river. | The Ministry is following up with Stz’uminus First Nation to obtain further clarification regarding their concern regarding the effect of the Tunnel on dissolved oxygen content within the river. | Ongoing | Clarification regarding concern |
| Impact of potential pollutants and contaminants within the tunnel walls on the river if left in place. | The tunnel decommissioning is anticipated to involve the removal of the four in-river sections of the Tunnel. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Improved ditches will result in less filtering of deleterious materials</p> | <p>Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed in Application</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Stz’uminus First Nation. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed in Application | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Stz’uminus First Nation has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed in Application | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Stz’uminus First Nation is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Stz’uminus First Nation is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|--|---|---------------------------------|--|
| <p>Potential effects to air quality, particularly as it relates to terrestrial wildlife.</p> | <p>The Ministry understands that Cowichan Tribes is concerned with the potential effects of air quality, particularly on terrestrial wildlife species. Projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
|--|---|---------------------------------|--|

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Increase in traffic and consequent increase in associated noise and vibration due to the increases capacity of the new bridge.</p> | <p>The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new Bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment, after mitigation, are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the Highway but do not exceed what is acceptable for residential, educational or institutional facilities. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |
| <p>Choice of building materials in relation to noise and vibration</p> | <p>The Ministry confirms that appropriate building materials will be used to mitigate noise and vibration. Mitigation in accordance with the Ministry’s 2014 Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways will be implemented, as warranted, at select locations to avoid or minimize potential Project-related increase in post-construction noise levels. Atmospheric Noise is addressed in Section 4.10 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.10.4</p> |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

During construction, a measureable effect on access to instream locations for traditional use has been determined.

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During construction, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> <p>“The proposed project has a direct impact on how we are able to use and navigate the areas surrounding the proposed project, and the impact of the project as it limits this ability needs to be considered in the Aboriginal Interests Assessment.”</p> <p>“Future exercise of our Aboriginal rights to fish (and also to harvest) including in-water and upland of the South arm of the Fraser should be considered when assessing project impacts of our interests.”</p> | <p>Potential interference with Stz’uminus First Nation fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Residual & Cumulative Effects

There is a low, short-term probability of disturbance to residential, commercial and industrial land use during construction.

There is a moderate , short-term probability of disturbance to recreational users near the new bridge during construction

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Stz’uminus First Nation has not voiced any specific issues or concerns with respect to Land Use | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.
 No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.
 A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation
 Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.
 Undertake additional archaeological surveys.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the Łæqtinəs/Tl’uqtinus site and potential archaeological values at interchanges | Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Stz’uminus First Nation. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1. | Addressed in Application | Implementation of mitigation measures as outlined in Section 6.1.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports | Stz’uminus First Nation participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Stz’uminus First Nation will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Ethnographical content in reports does not accurately reflect Stz’uminus First Nation’s historical presence within the Project area | The Ministry noted Stz’uminus First Nation’s concern that ethnographical content in Project reports does not accurately reflect Stz’uminus First Nation’s historical presence within the Project area. The Ministry continues to work with Stz’uminus First Nation to address this concern. | Ongoing | Ongoing consultation |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.
 A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---|-------------------------|
| Aboriginal health is not currently being considered in the assessment | Aboriginal health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |
| Current conditions along the foreshore and in the Fraser River are not properly understood and have not been considered in the Human Health Assessment | Current conditions along the foreshore were considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed in Assessment and Application | None |

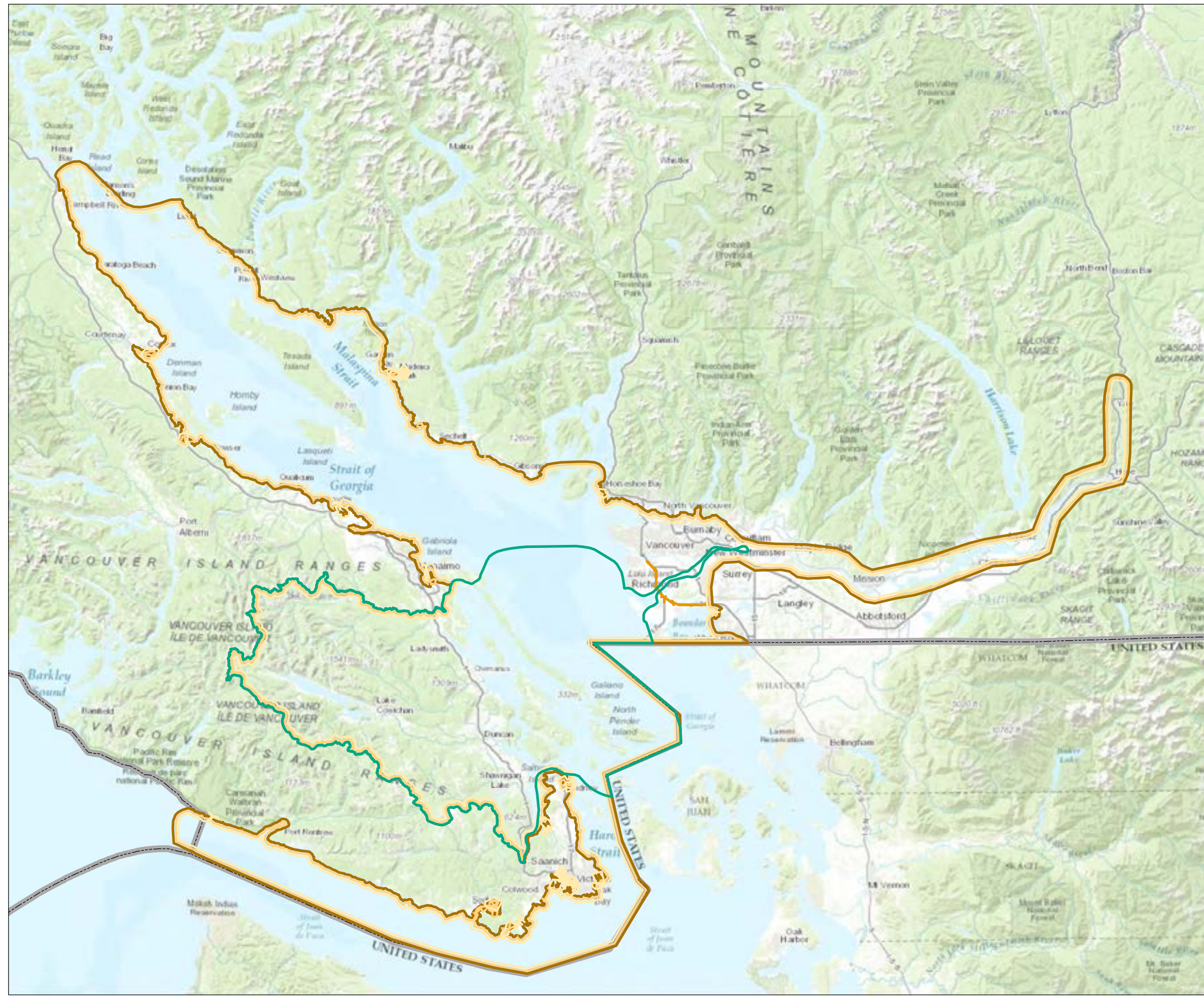
8.0 ACCIDENTS AND MALFUNCTIONS

Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.
 In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|--|
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | As outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan), an Emergency Response and Spill Contingency Plan will be developed. The Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills. | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Contaminants from automobile emission currently captured in Tunnel. New Bridge will send emissions directly into the air and Fraser River and settle on the foreshore | Automobile emissions are currently released from the Tunnel through a series of vents. Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| | <p>construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | | |
| <p>New Bridge could “unleash pent-up demand” and create even more congestion</p> | <p>The Project has been designed to address issues related to current and future traffic safety, congestion and reliability, and to help achieve regional mode share targets by facilitating travel across the Fraser River by transit, HOVs, cycling and walking. During operations, the Project will provide travel time savings for commuters or 25-35 minutes per day, improve safety with a forecast 35 percent reduction in collisions, and support provincial and regional strategies to encourage mode shift to transit and carpooling. As proposed, Project-related improvements, including tolling, will moderate traffic growth while effectively serving forecast demand at the crossing.</p> | <p>Addressed</p> | <p>None</p> |

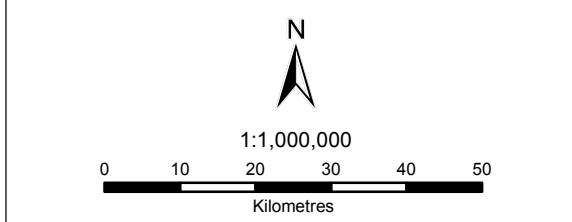
Path: Q:\1217-299\285\077\03\mxd\FirstNations\EA\Fig10-2_285_077_03_FirstNations_HuIQ_160517_FINAL.mxd



Legend

-  Hul'qumi'num Treaty Group (Marine) Asserted Traditional Territory
-  Hul'qumi'num Treaty Group (Core) Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

**HUL'QUMI'NUM TREATY GROUP
ASSERTED TRADITIONAL TERRITORY**

| | |
|-------------|------------|
| Figure 10-2 | 26/05/2016 |
|-------------|------------|



APPENDIX N

Tsawwassen First Nation

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Tsawwassen First Nation (Tsawwassen).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Tsawwassen, refer to the following sections of Part C:

- Consultation with Tsawwassen (**Section 10.1.2.10**);
- Tsawwassen community profile (**Section 10.1.1.10**);
- Description of existing Tsawwassen Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Tsawwassen Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Tsawwassen Aboriginal Interests following application of mitigation (**Section 10.1.3.5**).

A summary of the Aboriginal Interests Assessment for Tsawwassen is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Tsawwassen Overview Table (**Appendix N2**), which provides detailed information regarding:

- Tsawwassen’s issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Tsawwassen’s Aboriginal Interests;
- The Ministry’s response to specific issues and concerns raised by Tsawwassen;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry’s provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Tsawwassen and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, EAO led two Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations. Tsawwassen attended the first of the two Working Group meeting; materials were provided for the Working Group meeting they did not attend.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

Tsawwassen also participated in the completeness review of the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is assumed that Tsawwassen will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Tsawwassen in early 2013 in order to identify the nature and scope of Tsawwassen's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Tsawwassen. A more detailed discussion is provided under the Tsawwassen section in **Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Initial Consultation Phase Activities;
- Pre-Application Phase Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Tsawwassen. The Ministry has been working with Tsawwassen regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Tsawwassen for the preparation and submission of the traditional use study: *George Massey Tunnel Replacement: Project Impact Study: An assessment of potential impacts of the George Massey Tunnel Replacement Project on aspects of the TFN Final Agreement, and other considerations*. The purpose of such studies is to

identify Aboriginal input and traditional knowledge for inclusion in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Tsawwassen during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities – The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study document. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Tsawwassen included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Tsawwassen;
- Funding for Tsawwassen's participation in Project consultation activities and EA process;
- Tsawwassen participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment, draft AIR, and Aboriginal Consultation Plan;
- Meetings with Tsawwassen leadership, staff, consultants, elders and membership; and
- Response and follow up with Tsawwassen regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Tsawwassen included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Tsawwassen;
- Funding for Tsawwassen’s participation in Project consultation activities and EA process;
- Meetings with Tsawwassen leadership, staff, consultants, elders and membership;
- Tsawwassen participation in fieldwork;
- Tsawwassen participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports;
- Review of draft Part C content for the Application; and
- Response and follow up with Tsawwassen regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Tsawwassen’s concerns, identified through consultation undertaken to-date, are presented in **Appendix N2 Tsawwassen First Nation Overview Table**. The Ministry’s response to Tsawwassen’s key concerns regarding potential impacts on Tsawwassen’s Aboriginal Interests are outlined below:

Table 1 **Concerns Identified to Date**

| Concerns Identified to Date | Response |
|--|---|
| Obligations to Tsawwassen as a Treaty Nation must be recognized and consultation must be undertaken as set out in the Tsawwassen Final Agreement. | The Ministry recognizes and respects the obligations to Tsawwassen as a Treaty Nation and will continue to undertake consultation according to the requirements outlined in the Tsawwassen Final Agreement. |
| Potential effects to Tsawwassen Right to Harvest <ul style="list-style-type: none"> • Fish • Marine Mammals • Vegetation • Terrestrial Wildlife | Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected. |
| Aboriginal participation and Project-related opportunities <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Revenue sharing opportunities from tolling | The Ministry is committed to working with Tsawwassen to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness. The Ministry is exploring opportunities for cultural recognition and naming and will work with Tsawwassen on these opportunities. The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways. |

| Concerns Identified to Date | Response |
|--|---|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities • Accommodation of construction windows for fish cycle spikes (i.e. 4 year sockeye and 2 year pink) | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Tsawwassen and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat.</p> <p>Tsawwassen’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> <p>To the extent that is technically feasible and viable, sediment removal will be undertaken between July 16th and February 28th, the least-risk timing window for the protection of juvenile salmon and eulachon.</p> |
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Process and associated timelines • CEAA review | <p>The Ministry acknowledges the importance of Tsawwassen’s involvement in the environmental assessment process and is committed to funding Tsawwassen’s participation in the Initiation Consultation and Application Review phases.</p> <p>Tsawwassen’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects, process and associated timelines are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>The Ministry reviewed the need for a federal review with the federal government. The Project did not meet the Canadian Environmental Assessment Agency (CEAA) requirements for a federal review. Federal agencies, including Environment and Climate Change Canada, are members of the Technical Working Group.</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Social effects of the Project on Tsawwassen’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Tsawwassen’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Tsawwassen and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Tsawwassen or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>While the Ministry acknowledges that Tsawwassen is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> |
| <p>Potential increase in vessel traffic on the Fraser River as a result of the decommissioning of the Tunnel</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> |

| Concerns Identified to Date | Response |
|---|---|
| Potential effects on Fraser River flow rates after Tunnel removal | Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics). |
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will ensure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile – Tsawwassen First Nation

Tsawwassen First Nation is based on the southern aspect of Fraser River delta, on the west side of the peninsula that separates Boundary Bay from the Strait of Georgia. Pursuant to the Tsawwassen First Nation Final Agreement (TFNFA), which came into effect on April 3, 2009, Tsawwassen is a self-governing community led by a chief and council that are elected every three years. The current three-year term for the five-member council expires in April 2019.

Under the TFNFA, Tsawwassen acquired 724 ha of treaty settlement lands, including 290 ha of former reserves and 372 ha of former Provincial Crown Land. These 662 ha of Tsawwassen Lands are located on the upland areas between the ferry terminal at Tsawwassen and the container port at Roberts Bank. Tsawwassen Lands are owned by and under the jurisdiction of Tsawwassen First Nation, and are guided by the Tsawwassen First Nation Land Use Plan. An additional 62 ha of fee simple land near Boundary Bay and on the Fraser River (along Canoe Pass) are owned by the Tsawwassen First Nation, but are under the jurisdiction of the Corporation of Delta. Roughly half (184) of the Tsawwassen First Nation's registered population (365) reside on Tsawwassen Lands. The Project area does not overlap any of the treaty settlement lands of the Tsawwassen First Nation.

In addition to fee simple interests, the TFNFA secures harvesting rights to Tsawwassen members in areas located within Tsawwassen Territory, defined as the area of land that Tsawwassen identified in its Statement of Intent to the British Columbia Treaty Commission. This territory extends from the southern Gulf Islands to the area around Pitt Lake. Rights under the TFNFA are limited by measures necessary for conservation, public health, or public safety.

The Project area lies within Tsawwassen Territory, and is situated in or near several harvesting areas defined in the TFNFA relating to fishing, wildlife and migratory bird harvesting, and plant gathering.

3.1 Tsawwassen Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Tsawwassen's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Tsawwassen in **Section 10.1.3.2 Existing Conditions**.

Tsawwassen has confirmed treaty rights under the TFNFA, which are limited by measures necessary for conservation, public health, and public safety. These treaty rights include:

- Tsawwassen First Nation Fishing Right, including harvesting aquatic plants;

- Tsawwassen First Nation Right to Harvest Wildlife;
- Tsawwassen First Nation Right to Harvest Migratory Birds;
- Tsawwassen First Nation Right to Gather Plants;
- Tsawwassen First Nation Right to Harvest Renewable Resources; and
- Tsawwassen First Nation Right to Practice Tsawwassen First Nation Culture.

3.1.1 Fishing

- The Tsawwassen Fishing Area, which applies to fish and aquatic plants but excludes intertidal bivalves includes the waters of the Main Arm of the Fraser River westerly of the power lines downstream of the Port Mann Bridge, the waters of the North Arm of the Fraser River from the junction of the Main Arm downstream to the Arthur Laing Bridge, the Middle Arm of the Fraser River, the South Arm of the Fraser River, and parts of the waters of the Strait of Georgia and Boundary Bay. Tsawwassen report that they actively fish in the South Arm of the Fraser River and within the Project area.
- Fish, as defined under the TFNFA, includes fish, intertidal bivalves and other shellfish, crustaceans, and marine animals (excluding cetaceans), the parts of these fish, as well as their the eggs, sperm, spawn, larvae, spat, juvenile stages and adult stages.
- The right to harvest fish allows designated members of the Tsawwassen to exercise the right for domestic purposes and to trade or barter those fish among themselves or with other Aboriginal people resident in BC. Domestic allocations for sockeye, chum, pink, chinook, and coho salmon, which are centrally important to Tsawwassen, are calculated using formulas described in the TFNFA.
- In addition to domestic fishing, the Tsawwassen First Nation Harvest Agreement, which is a separate contractual arrangement between the parties to the TFNFA that does not “create, recognize or affirm aboriginal or treaty rights”, is intended to increase commercial fishing capacity for Tsawwassen. The Tsawwassen First Nation Harvest Agreement provides for an annual commercial allocation for salmon.
- Fraser River eulachon, a traditional species, are fished in Canoe Passage in limited quantities for specific domestic purposes. Tsawwassen report that eulachon, once very abundant, in particular in Canoe Passage, is now only available for distribution to Elders.
- Canoe Passage was once a key sturgeon harvesting area, but now sturgeon cannot be kept due to conservation concerns.
- Groundfish (i.e., rockfish, lingcod, halibut, dogfish, and sole) may also be harvested year-round for domestic purposes under the TFNFA, but this harvest has not occurred since the TFNFA came into effect. Tsawwassen report the return of halibut to the Roberts Bank area, and the harvesting of dogfish has occurred in the shallows near the Roberts Bank terminal. Sole, and flounder, present in Canoe Passage, are reported to be small, and some flounder appear to be diseased.

- Since the TFNFA came into effect, four to five licences have been issued for the domestic crab harvest, targeting Dungeness, graceful, and red rock species; domestic harvests of crab are currently not subject to allocation limits and are permitted throughout the year. Tsawwassen report commercial crab harvesting currently occurs in Crab Management Area I, from June through November.
- Shrimp and prawn may be harvested for domestic purposes at any time of year under the TFNFA; however, although a harvest document was issued in 2010, no recorded harvests have been made since the TFNFA came into effect. Tsawwassen members report an interest in harvesting prawn on the eastern side of the Strait of Georgia.
- Intertidal bivalves may be harvested in the Tsawwassen Intertidal Bivalve Fishing Area. There has been no harvest of intertidal bivalves in the designated areas since the TFNFA came into effect. Tsawwassen has expressed interest in developing shellfish aquaculture.
- Tsawwassen report that from Sturgeon Bank south to Point Roberts, clams, cockles, mussels, oysters and abalone were once harvested by their members for food and other purposes such as trade and ceremonial regalia. Boundary Bay was considered an important harvesting area for bivalves, especially clams, cockles, and oysters, while scallops, sea cucumbers were taken from Boundary Bay through to Canoe Passage. Tsawwassen Elders report barnacles, which were harvested by being scraped from rocks, have reduced in size over the years. They also note that abalone, along with a large oyster bed (lying just south of the B.C. Ferries Terminal), began to disappear after development in the Roberts Bank area (i.e. Roberts Bank terminals and B.C. Ferry Terminal). The Elders have also reported that they stopped harvesting shellfish from the area before DFO put in place the existing biotoxin and sanitary closures, which restricts Elders from harvesting what was formerly a mainstay of their diet along the eastern side of the Strait of Georgia.
- Aquatic plants (including attached and detached kelp and seaweeds) may be harvested for domestic purposes in the Tsawwassen Fishing Area at any time of day or year. These plants are specifically defined in the TFNFA as all benthic and detached algae, brown algae, red algae, green algae, golden algae and phytoplankton, and all marine and freshwater flowering plants, ferns and mosses, growing in water or soils that are saturated during most of the growing season (see “Gathering” section, below). Harvesting of these plants has not occurred since the TFNFA came into effect.
- Tsawwassen have previously reported that bulrushes have been harvested for basketry, and also for their medicinal properties. Tsawwassen members have also previously reported that at one time, seaweed grew “all over” and would be, along with sea asparagus, harvested “all along the shoreline” of Tsawwassen’s main community, although there is currently little to none reportedly left in these areas.

- Marine mammals, including porpoise, seals, and sea lions, were once harvested by the Tsawwassen within the mouth and estuary of the Fraser River. These marine animals (with the exception of porpoise, a cetacean) fall within the meaning of fish under the TFNFA. Tsawwassen have indicated that the community does not currently harvest marine mammals and that there is no desire to harvest marine mammals; however, they remain culturally important to the community.

3.1.2 Hunting/Trapping

- The extent of the Tsawwassen Wildlife Harvest Area and Tsawwassen Migratory Bird Harvest Area is the same as the Tsawwassen Territory, which overlaps the Project area. Specific species and harvesting sites (except Burns Bog for wildlife) are not identified in the TFNFA; however, locations near the Project area have been previously identified as preferred wildlife and migratory bird harvesting areas, particularly for deer, beaver, ducks, and geese. These locations include the south side of Lulu Island, the small islands, sloughs, marshes, and tidal flats of the Lower Fraser River, as well as the tidal flats at Boundary Bay.
- Wildlife, as defined under the TFNFA, includes all vertebrate and invertebrate animals, including mammals, birds, reptiles, and amphibians, and the eggs, juvenile stages, and adult stages of these animals. The definition excludes fish (see previous section) and migratory birds. Migratory birds, under the TFNFA, means birds, as defined under federal law enacted further to international conventions, and includes their eggs.
- The Tsawwassen’s rights to harvest wildlife and migratory birds allows designated members to harvest wildlife and migratory bird resources for domestic purposes and to trade or barter wildlife, wildlife parts, and migratory birds among themselves or with other Aboriginal people resident in BC. Harvested wildlife, wildlife parts (including meat and furs), migratory birds, and inedible migratory bird by-products (including down) may also be sold if the sale is permitted by federal, provincial, and Tsawwassen law. Wildlife and migratory bird harvesting rights may be exercised on private land (with the owner’s permission) and, in the case of migratory birds, within National Wildlife Areas (with Canada’s permission). With respect to wildlife harvesting specifically, the TFNFA acknowledges the “limited existing opportunity to harvest Wildlife and the likely future diminution or loss of any meaningful opportunity to harvest Wildlife in the Tsawwassen Wildlife Harvest Area”.
- At present, Tsawwassen is not harvesting any wildlife or migratory bird species for which a conservation risk has been identified. Harvesting of migratory birds is permitted throughout the year.

- Tsawwassen hunters have previously described locations throughout their traditional territory as preferred harvesting areas for wildfowl, including all of what are now Tsawwassen Lands and nearby fields, the shoreline from west of the Roberts Bank causeway up to and including Brunswick Point, and areas in and around Westham Island. Species harvested in the past include mallards, snow geese, and brant along the foreshore, and pintails, teals and wigeons in the back fields. Pheasants were previously taken “all over”, and quail was also eaten. Other species identified as valuable are gadwall, goldeneye, bufflehead, and canvasback ducks; as well as Canada geese, gulls, and songbirds.
- Tsawwassen explain that birds are no longer as abundant as they once were, with some species, such as the pheasant, now scarcely found and others, such as geese, preferring Boundary Bay over Roberts Bank to nest.
- Ducks and geese remain an important winter food and source of feathers, used for ceremonial purposes. Tsawwassen report the number of hunters has diminished and along with it the opportunities for transference of knowledge to youth.
- Tsawwassen explain deer and bear were once hunted from Point Roberts through Tsawwassen to Burns Bog, as well as on the Gulf Islands. Members had traplines for muskrat, otters, beaver, raccoon and rabbits from present-day Tsawwassen Lands to Westham Island. Currently, they pursue large game (e.g., deer and elk), in areas far removed from their Lands. Although they did not report current hunting or trapping of small animals, they did note there are fewer reporting requirements for small game harvesting than for other species, and thus some degree of harvesting is probable.

3.1.3 Gathering

- Plants, as defined under the TFNFA, includes all flora and fungi but does not include aquatic plants (included in the definition for fish) or trees except for their bark, branches and roots.
- Tsawwassen’s right to harvest plants allows members to harvest plants for domestic purposes and includes the right to trade or barter plants among themselves or with other Aboriginal people resident in BC, as well as to exchange regalia or traditional or artistic objects made of plants among themselves or with other Coast Salish people for ceremonial purposes.
- There are four Tsawwassen Plant Gathering Areas designated under the TFNFA, two of which are located considerably north of the Project area. The two areas located near the Project area are:
 - the South Arm Marshes Wildlife Management Area, immediately downstream of the Highway 99 Fraser River crossing; and
 - Provincial Crown Land within the Burns Bog Ecological Conservancy Area, north of the easternmost extent of the Project footprint.

- Specific species harvested in these areas are not identified in the TFNFA; however, plant species and timber resources in the Project area include *quxmin*, salal, bog blueberries, Indian hemp, cattails and rushes, St. John’s wort, western red cedar, Douglas fir, western hemlock, western yew, black cottonwood, red-osier dogwood, and red alder.
- Other plant species identified as important by Tsawwassen Elders or resource users include wild berries (e.g. blackberries, huckleberries, salmonberries, strawberries, snowberries, boysenberries, loganberries, raspberries, black caps, red caps), cherries, crabapples, wild onion, wild mint, rhubarb, Labrador tea, wild rose, thistle, Indian Consumption Plant, yellow or curly dock, devil’s club, ferns, cascara bark, barberry bark, and stinging nettle.
- Traditional timber resources also include cherry, hazelnut, and willow trees; driftwood was also collected from the beach to smoke fish, but no community smokehouses remain.
- Tsawwassen have reported that plants are mainly gathered in and around Tsawwassen Lands (where still available), and plans are currently underway to resume harvesting in designated areas and to support the transfer of traditional plant use knowledge to Tsawwassen youth.

3.1.4 Archaeology and Cultural Heritage Interests

- Tsawwassen’s right to practice their culture, as well as use of the Hən̓q̓əmi̓n̓əm̓ language, is identified in the TFNFA. Several Hən̓q̓əmi̓n̓əm̓ place names for important heritage sites in the vicinity of the Project area are also identified in the TFNFA, including the following:
 - ʔ'eqtinəs (or Tl'ektines), identified in the TFNFA as DgRs-17, which places it slightly upstream of the Project area on the north shore of the South Arm of the Fraser River;
 - čičiləxwqən (Ladner Landing, DgRs-41), downstream of the Project area; and
 - Xwlic'əm (Brunswick Point on Canoe Pass, DgRs-35), also downstream of the Project area.
- Tsawwassen emphasize the importance of the Fraser River to their members for fishing, transportation, recreation, and cultural purposes. Tsawwassen stress the importance of their continued ability to fish, along with and the significance of fishing and associated activities to their community’s culture and economy. Some traditional activities, such as spending time with Elders in the smokehouse, no longer occur, as the last smokehouse was demolished when Highway 17 was expanded.

- Tsawwassen report that disturbance of fish and fish habitat (e.g., sturgeon) as well as water quality are their biggest concerns. Tsawwassen Elders report changes to the foreshore north and south of their Lands (i.e., “our little beach”), to which they attribute access difficulties, decreases in species abundance, and compromised quality of resources, especially shellfish and crab. Accordingly, they say they have also experienced the loss of important and organic means for community gathering and socializing at this important location (i.e., *sćəwə’əən* and *ća yəm*), both internally and with other nations with whom they have traditionally traded. This has also meant the loss of opportunities to pass down traditions related to the use of the beachfront to their youth.
- Tsawwassen explain that participation in fishing, an integral element of Tsawwassen culture, is decreasing, due to diminishing stocks, increasing harvesting restrictions, and higher costs related to having to travel farther to harvest traditional resources.

3.1.5 Other Related Interests

- Tsawwassen identify the lack of a local dock as contributing to higher costs. While public docks are available at the southeastern end of B.C. Ferries Terminal and at Brunswick Point in Canoe Passage, these docks are reportedly very busy, particularly in the summer months.
- Further, Tsawwassen report that physical access to Fraser River fisheries has changed. Chilukthan Slough, which at one time ran between Roberts Bank and the Fraser River, from north of Tsawwassen Lands to the Ladner area, was considered Tsawwassen’s “short cut” to the Fraser River; the slough was filled along ago as a result of farm development, and was described as a “huge” loss by Tsawwassen Elders. Access to the Fraser River by water now involves a longer route around the existing Roberts Bank terminals and B.C. Ferries Terminal.
- For canoe journeys, Tsawwassen members must navigate as close as possible to the terminals to and from the river to avoid shipping lanes, large vessel traffic, and shallow waters.
- Tsawwassen members report that the changes to current flows and sediment build up between the Roberts Bank terminals and causeway to Westham Island are the reason that Canoe Passage, an important fishing area and travel corridor to and from the South Arm of the Fraser River, has become difficult to transit other than at high tide. They report Canoe Passage has become narrower, which means that fewer fishing vessels are able to harvest in the area at any one time.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Tsawwassen's Aboriginal Interests, specifically. For a more detailed description, refer to **Section 10.1.3.3.**

Potential Effects.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Tsawwassen's exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | Construction - Potential temporary direct (minor to moderate) effect on access related to instream construction activities Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|--|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | | ✓ | | ✓ | Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access Operation - Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | Construction - Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.4 Potential Project-Related Effects on Tsawwassen's Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Tsawwassen's Aboriginal Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-related Effect |
|--|---|
| Project Construction | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor to moderate) effect on access related to instream construction activities |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • For instream locations for traditional use, potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access • Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance |
| Project Operation | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses |

4.5 Fishing

The Tsawwassen Fishing Area, which applies to fish and aquatic plants but excludes intertidal bivalves includes the waters of the Main Arm of the Fraser River westerly of the power lines downstream of the Port Mann Bridge, the waters of the North Arm of the Fraser River from the junction of the Main Arm downstream to the Arthur Laing Bridge, the Middle Arm of the Fraser River, the South Arm of the Fraser River, and parts of the waters of the Strait of Georgia and Boundary Bay. Tsawwassen report that they actively fish in the South Arm of the Fraser River and within the Project area.

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Tsawwassen, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Tsawwassen during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Tsawwassen from instream construction activities are expected to be negligible. While it is acknowledged that Tsawwassen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Tsawwassen. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Tsawwassen; therefore, Potential Project-related effects on Tsawwassen fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsawwassen.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Tsawwassen is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Tsawwassen's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

The extent of the Tsawwassen Wildlife Harvest Area and Tsawwassen Migratory Bird Harvest Area is the same as the Tsawwassen Territory, which overlaps the Project area. Specific species and harvesting sites (except Burns Bog for wildlife) are not identified in the TFNFA; however, locations near the Project area have been previously identified as preferred wildlife and migratory bird harvesting areas, particularly for deer, beaver, ducks, and geese. These locations include the south side of Lulu Island, the small islands, sloughs, marshes, and tidal flats of the Lower Fraser River, as well as the tidal flats at Boundary Bay.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Tsawwassen as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Tsawwassen during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Tsawwassen from instream construction activities, are expected to be negligible. While it is acknowledged that Tsawwassen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Tsawwassen resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Tsawwassen. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Tsawwassen; therefore, Potential Project-related effects on Tsawwassen fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsawwassen.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Tsawwassen is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Tsawwassen's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Plants, as defined under the TFNFA, includes all flora and fungi but does not include aquatic plants, which are included in the definition for fish or trees except for their bark, branches and roots. There are four Tsawwassen Plant Gathering Areas designated under the TFNFA, two of which are located considerably north of the Project area. The two areas located near the Project area are:

- the South Arm Marshes Wildlife Management Area, immediately downstream of the Highway 99 Fraser River crossing; and
- Provincial Crown Land within the Burns Bog Ecological Conservancy Area, north of the easternmost extent of the Project footprint.

However, the specific species harvested in these areas are not identified in the TFNFA.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Tsawwassen as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Tsawwassen during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Tsawwassen from instream construction activities, are expected to be negligible. While it is acknowledged that Tsawwassen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Tsawwassen resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Tsawwassen; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsawwassen.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Tsawwassen is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Tsawwassen's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Tsawwassen's right to practice their culture, as well as use of the Hən̓q̓əmiñəm language, is identified in the TFNFA. Several Hən̓q̓əmiñəm place names for important heritage sites in the vicinity of the Project area are also identified in the TFNFA.

The proposed Project has the potential to affect Tsawwassen's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Tsawwassen's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Tsawwassen's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Tsawwassen's archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Tsawwassen has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Tsawwassen's archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Tsawwassen's archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Tsawwassen's archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsawwassen.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Tsawwassen (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Tsawwassen's Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Tsawwassen, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Tsawwassen. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Tsawwassen's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Tsawwassen regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Tsawwassen's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Tsawwassen prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Tsawwassen during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Tsawwassen during consultations include:

- Recognition of Tsawwassen First Nation as a Treaty Nation and consultation must be undertaken as set out in the Tsawwassen First Nation Final Agreement;
- Potential effects to Tsawwassen First Nation's Fishing Right and Rights to Harvest Wildlife, Migratory Birds and Plants as set out in Tsawwassen First Nation Final Agreement;
- Potential effects on ability of Members to participate in commercial fisheries and/or as participants in the general commercial fishery;
- Potential effects on fish, wildlife, birds and plants and their habitats;

- Potential effects on ability to harvest fish, wildlife, birds and plants and on harvesting locations;
- Aboriginal participation and Project-related opportunities and importance of professional development and career planning in relation to career opportunities;
- Changes to river hydrology;
- Social effects of the Project on Tsawwassen 's ability to transfer knowledge, language and participate in socio-cultural practices;
- Use of Fraser River for traditional, recreational and cultural purposes and effects on movements and activities resulting from Tunnel decommissioning;
- Potential economic, cultural and health effects resulting from changes to quality and availability of natural resources for Tsawwassen and Aboriginal Groups' Tsawwassen engages with, now and into the future;
- Protection of archaeological and heritage resources, including intangible heritage sites and participation in archaeological fieldwork and review of archaeological draft reports;
- Construction environmental best management practices;
- Trend in development of the lower Fraser River;
- Adequacy of Environmental Assessment (EA) methodology to address social and cultural effects;
- EA Process for the Project and its associated timelines;
- Absence of a comprehensive study of cumulative effects on the Fraser River;
- Participation of federal government in EA;
- Concerns regarding spills and potential contamination;
- Effects on air quality resulting from increase in traffic volume due to the Project;
- Concerns related to dredging, potential for increased vessel traffic and larger vessels resulting from Tunnel decommissioning;
- Potential effects on flow rates after Tunnel removal; and
- Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge.

Based on information provided by Tsawwassen and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Tsawwassen has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Tsawwassen's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for VCs or ICs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Tsawwassen, except in the following potentially measurable cases:

- Project Construction:
 - Potential temporary direct (minor to moderate) effect on access related to instream construction activities and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses dependent on that access
 - Potential temporary direct (minor to moderate) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project Operation:
 - Potential permanent direct (minor to moderate) effect on quality of experience related to traffic noise and a potential indirect (minor to moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Tsawwassen regarding proposed measures, management plans, and monitoring programs related to VCs and ICs; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Tsawwassen, as a result of the Project, are expected.

Note: Concerns listed in this table include those outlined in the GMT Project Impact Study prepared and submitted by Tsawwassen First Nation.

| ENVIRONMENTAL ASSESSMENT PROCESS | | | |
|---|---|-----------------|--------------------------------|
| <p>An environmental assessment of the Project is required under the B.C. <i>Environmental Assessment Act</i> (B.C. <i>EAA</i>), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. <i>EAA</i> sets out the criteria for reviewable projects.</p> <p>On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. <i>EAA</i>, and that it requires an EAC.</p> <p>The Project as proposed is not subject to review under the <i>Canadian Environmental Assessment Act, 2012</i>, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.</p> <p>EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the <i>Environmental Assessment Act</i>.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Project's EA Process and its associated timelines | Concerns relating to the EA process and its associated timelines were referred to EAO. EAO issued a memo to members of the Working Group on March 18, 2016 in response to questions and concerns related to the EA process and its associated timelines. The Ministry understands that EAO responded to Tsawwassen's queries regarding the EA Process and associated timelines. | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------------|-------------------------|
| <p>Social and cultural effects and the adequacy of EA methodology</p> | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO). Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | <p>Referred to EAO</p> | <p>None</p> |
| <p>Federal government participation in regulatory process. Participation of federal government in Working Group. Request for clarity and certainty with respect to DFO's participation in Project review</p> | <p>The Ministry reviewed the need for a federal review with the federal government. The Project did not meet the Canadian Environmental Assessment Agency (CEAA) requirements for a federal review. Federal agencies, including Environment and Climate Change Canada, are members of the Technical Working Group.</p> | <p>Addressed</p> | <p>None</p> |

| TSAWWASSEN TREATY AND OTHER INTERESTS | | | |
|--|--|---------------------------------|--|
| <p>The Tsawwassen First Nation Final Agreement (TFNFA) secures harvesting rights to the Tsawwassen First Nation in areas located within Tsawwassen Territory, which is defined as the area of land that Tsawwassen First Nation identified in its Statement of Intent to the British Columbia Treaty Commission, and included as a map in Appendix A to the agreement (TFN et al. 2009b). This territory extends from the southern Gulf Islands to the area around Pitt Lake. Rights under the TFNFA are limited by measures necessary for conservation, public health, or public safety (TFN et al. 2009a).</p> <p>The Project area lies within Tsawwassen Territory, and is situated in or near several harvesting areas defined in the TFNFA relating to fishing, wildlife and migratory bird harvesting, and plant gathering (TFN et al. 2009a,b).</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Obligations to Tsawwassen as a Treaty Nation must be recognized and consultation must be undertaken as set out in the Tsawwassen Final Agreement</p> | <p>The Ministry recognizes and respects the obligations to Tsawwassen as a Treaty Nation and will continue to undertake consultation according to the requirements outlined in the Tsawwassen Final Agreement. Potential effects to Tsawwassen treaty rights and other interests are discussed in Part C of the Application.</p> | <p>Ongoing</p> | <p>Ongoing consultation</p> |
| <p>Potential effects to Tsawwassen Fishing Right: Project activities may affect ability of Members to participate in commercial fisheries and/or as participants in the general commercial fishery Direct impacts on fish or fish habitat and impact on water quality could affect fisheries resources Impact on fishing locations Interference or displacement of fishing opportunities within the Project area</p> | <p>The Ministry will work closely with Tsawwassen to ensure negative effects are avoided. Potential interference with Tsawwassen fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Sections 4.4.4 (Fish and Fish Habitat Mitigation Measures) and 5.2.4 (Marine Use Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to Tsawwassen Right to Harvest Wildlife: Spills contaminating habitat, directly killing or poisoning animals. Human presence and activities can lead to safety concerns related to the use of firearms for hunting wildlife resulting in loss of opportunity for TFN Members to exercise treaty rights. Increased wildlife mortality as a result of vehicle collisions and collision with infrastructure. Loss or restriction of harvesting activities over the status quo. Disturbance or displacement of species. Loss or degradation of wildlife habitat.</p> | <p>Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |
| <p>Potential effects to Tsawwassen’s Right to Harvest Migratory Birds: Increased wildlife mortality as a result of vehicle collisions and collision with infrastructure. Loss or restriction of harvesting activities over the status quo. Disturbance or displacement of migratory birds Loss or degradation of bird habitat. Human presence and activities can lead to safety concerns related to the use of firearms for hunting migratory birds resulting in loss of opportunity for members to exercise treaty rights.</p> | <p>Tsawwassen’s rights to harvest terrestrial wildlife within the Project area are addressed in Section 4.8 (Terrestrial Wildlife) of the Application. With the implementation of mitigation measures, residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential effects to Tsawwassen’s Right to Harvest Plants: Changes in river hydrology affecting shorelines, tidal wetlands, mudflats, drainage channel and uplands of the south arm marshes wildlife management area and adjoining areas that may lead to changes impacting members’ ability to gather and use plants. Loss or degradation of plant harvesting areas, including damage by invasive plants. Human activities directly killing biota (collisions, pile driving and dredging). Spills contaminating habitat, directly killing or poisoning plants.</p> | <p>Tsawwassen’s rights to harvest vegetation within the Project area are addressed in Section 4.7 (Vegetation) of the Application. With the implementation of mitigation measures, residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |
| <p>Need for Proponent to understand that Tsawwassen’s Treaty rights are not limited to how the right is currently being exercised. Instead, impacts can include the potential loss of future opportunities for activities that were either not always practiced historically or that may or may not be currently being exercised.</p> | <p>Noted and reflected in Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Aboriginal Groups' access to the Fraser River and the potential to displace Aboriginal fishing vessels</p> | <p>Tsawwassen's access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A measurable direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |
| <p>Social effects of the Project such as knowledge transmission, language loss, dependency and social interaction</p> | <p>Social effects of the Project on Tsawwassen's ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| | <p>Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | | |
| <p>Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided</p> | <p>Potential interference with Tsawwassen fisheries during bridge construction and decommissioning of the Tunnel is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. The Ministry understands the importance of working closely with Tsawwassen to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Implementation measures outlined in Section 5.2.4</p> |
| <p>Significant contracting set aside for Aboriginal businesses to compete</p> | <p>The Ministry is committed to working with Tsawwassen to identify potential opportunities to benefit from the Project and is confident that the Project's procurement process will effectively allow this commitment to be met.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Stronger presence of Tsawwassen and Musqueam in the Project area should be reflected in the way the two Nations participate in the work</p> | <p>Noted.</p> | <p>Noted</p> | <p>Ongoing consultation</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-----------------------------|
| <p>Importance of professional development and career planning in relation to career opportunities</p> | <p>The Ministry will continue discussions with Aboriginal Groups' regarding employment, training and contracting opportunities in relation to the Project.</p> | <p>Addressed</p> | <p>Ongoing consultation</p> |
| <p>Cumulative effects: Consideration of cumulative effects on Aboriginal rights. Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. Absence of a comprehensive study of cumulative effects on the Fraser River</p> | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests. The Ministry's cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is</p> | <p>Addressed</p> | <p>None</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---------------|--|---------------|--------------------------------|
| | <p>outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> <p>While the Ministry acknowledges that Tsawwassen is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |

| ABORIGINAL CONSULTATION | | | |
|---|--|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process. | Tsawwassen received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Importance of ensuring appropriate use of information shared by Aboriginal Groups' as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Tsawwassen may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. Subject to the requirements of applicable laws, the Ministry will respect Tsawwassen requests to keep information confidential. | Addressed | Appropriate use of confidential information |
| Funding for Project Related Study | Tsawwassen received funding for a Project related Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will work with Tsawwassen on this matter. | Ongoing | Discussion with Tsawwassen to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities Adequate training time to take full advantage of potential future Project work activities | The Ministry is committed to working with Tsawwassen to identify potential opportunities to benefit from the Project. The Ministry acknowledges that Tsawwassen want to prepare their membership for employment opportunities and will work with Tsawwassen to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |
| Interest in revenue sharing opportunities from tolling | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | | None |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Development of a mitigation plan to ensure protection to the Lulu-island-Delta water main.

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures)</p> |
| <p>Potential effect of removing the Tunnel on marshes along the river</p> | <p>Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary march, that occur in the vicinity of the Project.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4 (River Hydraulics Mitigation Measures)</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Project activities undertaken in the upland ditch systems will follow Standards and Best Practices for Instream Works.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|---|
| <p>Potential effects of run off and drainage</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (sediment and water quality mitigation measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|---|
| <p>Management of run off from the bridge</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciate change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (sediment and water quality mitigation measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|---|
| <p>High volumes of sediment in Canoe Pass caused by project construction.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4 (Sediment and Water Quality Mitigation Measures)</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term potential of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | <p>Tsawwassen's rights to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures in Section 4.4 (Fish and Fish Habitat), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected.</p> | Addressed in Application | Implementation of mitigation measures in Section 4.4 (Fish and Fish Habitat) |
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon. Effects of the Project on sturgeon, eulachon, and salmon spawning grounds | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon to Tsawwassen. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |
| Effects of lighting on fish | Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|---|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | | <p>Implementation of mitigation measures outlined in 4.3.4 (Underwater Noise Mitigation Measures) and 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Accommodation of construction windows for fish cycle spikes (i.e. 4 year sockeye and 2 year pink)</p> | <p>To the extent that is technically feasible and viable, sediment removal will be undertaken between July 16th and February 28th, the least-risk timing window for the protection of juvenile salmon and eulachon.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4 (Fish and Fish Habitat Mitigation Measures)</p> |
| <p>Requirement for HAAD (Harmful Alteration, Disruption and Destruction) permit</p> | <p>All required permits will be obtained.</p> | <p>Addressed</p> | <p>Obtain required permits</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.6 (Marine Mammals), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected. | Addressed in Application | Implementation of mitigation measures in Section 4.6 (Marine Mammals) |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.
 Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.
 A negligible effect on quality of vegetation resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.
 Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.
 Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.
 Invasive species management plan will included in the Construction Environmental Management Plan

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.7 (Vegetation), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected. | Addressed in Application | Implementation of mitigation measures in Section 4.7 (Vegetation) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|--|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed | Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures) |
| Use of culturally significant plants in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

- A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

- Minimize potential effects through Project design.
- Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.
- There is a low, long-term probability of barn owl mortality.
- No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|--------------------------|---|
| Potential effects to Tsawwassen Right to Harvest | Tsawwassen’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Section 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Tsawwassen as a result of the Project are not expected. | Addressed in Application | Implementation of mitigation measures in Section 4.8 (Terrestrial Wildlife) |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------|-------------------------|
| <p>Potential light and noise effects on wildlife</p> | <p>The Ministry understands that Tsawwassen is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | | |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds and bats</p> | <p>The Ministry understands that Tsawwassen is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | | |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|------------------|-------------------------|
| <p>Effects of change in air quality resulting from increase in traffic volume due to the Project</p> | <p>Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in. Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. The new bridge will allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as the Tunnel portals, where they accumulate today. Effects on air quality during Project construction will be minimized through implementation of recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.</p> | <p>Addressed</p> | <p>None</p> |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience while engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry's 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Noise monitoring program.

Site specific schedules and activities.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|-------------------------------------|---|-----------|--|
| Potential noise effects on wildlife | The Ministry understands that Tsawwassen is concerned with the potential effects of noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application. | Addressed | Implementation of mitigation measures outlined in Section 4.8.4 (Terrestrial Wildlife Mitigation Measures) |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Development and implementation of a specific Tsawwassen First Nation marine use protocol through direct consultation with Tsawwassen First Nation.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-------------|---|
| Potential effects of construction during fishing season on fishing activities | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | Addressed | Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures) |
| Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | Addressed | Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures) |
| Inappropriateness/inadequacy of Marine Users Group for consultation with Tsawwassen | <p>The Ministry is continuing to work with Tsawwassen to better understand how they would like to participate in the development and implementation of mitigation measures in particular, in relation to alternatives to a marine users group.</p> | In progress | Ongoing consultation |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Access Management Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Tsawwassen has not voiced any concerns or issues with Land Use | | | |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--------|---------------------------|--------|-------------------------|
|--------|---------------------------|--------|-------------------------|

| | | | |
|---|--|--|--|
| Tsawwassen has not voiced any concerns or issues with Visual Quality. | | | |
|---|--|--|--|

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a chance find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|--|
| Protection of archaeological and heritage resources, including intangible heritage sites | Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Tsawwassen. All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment. Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1. | Addressed | Implementation of mitigation measures as outlined in Section 6.1.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------|---|
| Participation in archaeological fieldwork and review of archaeological draft reports | Tsawwassen participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Tsawwassen will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

During construction, a measureable effect on access to instream locations for traditional use has been determined.

7.0 HUMAN HEALTH

During construction, a measurable effect on quality of experience tied to access of instream locations for traditional has been determined.

During operation, a negligible effect on access to instream locations for traditional use has been determined.

During operation, a negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.

Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.

Residual & Cumulative Effects

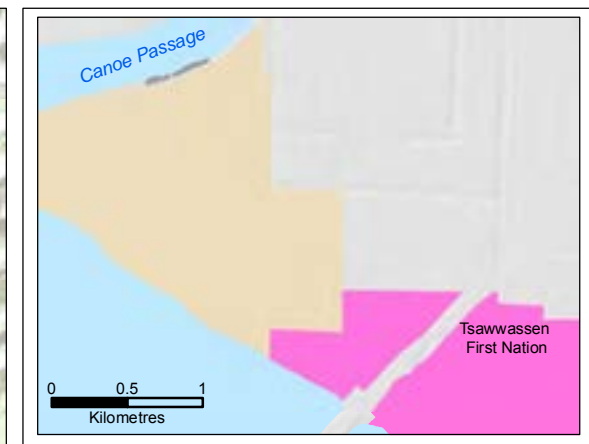
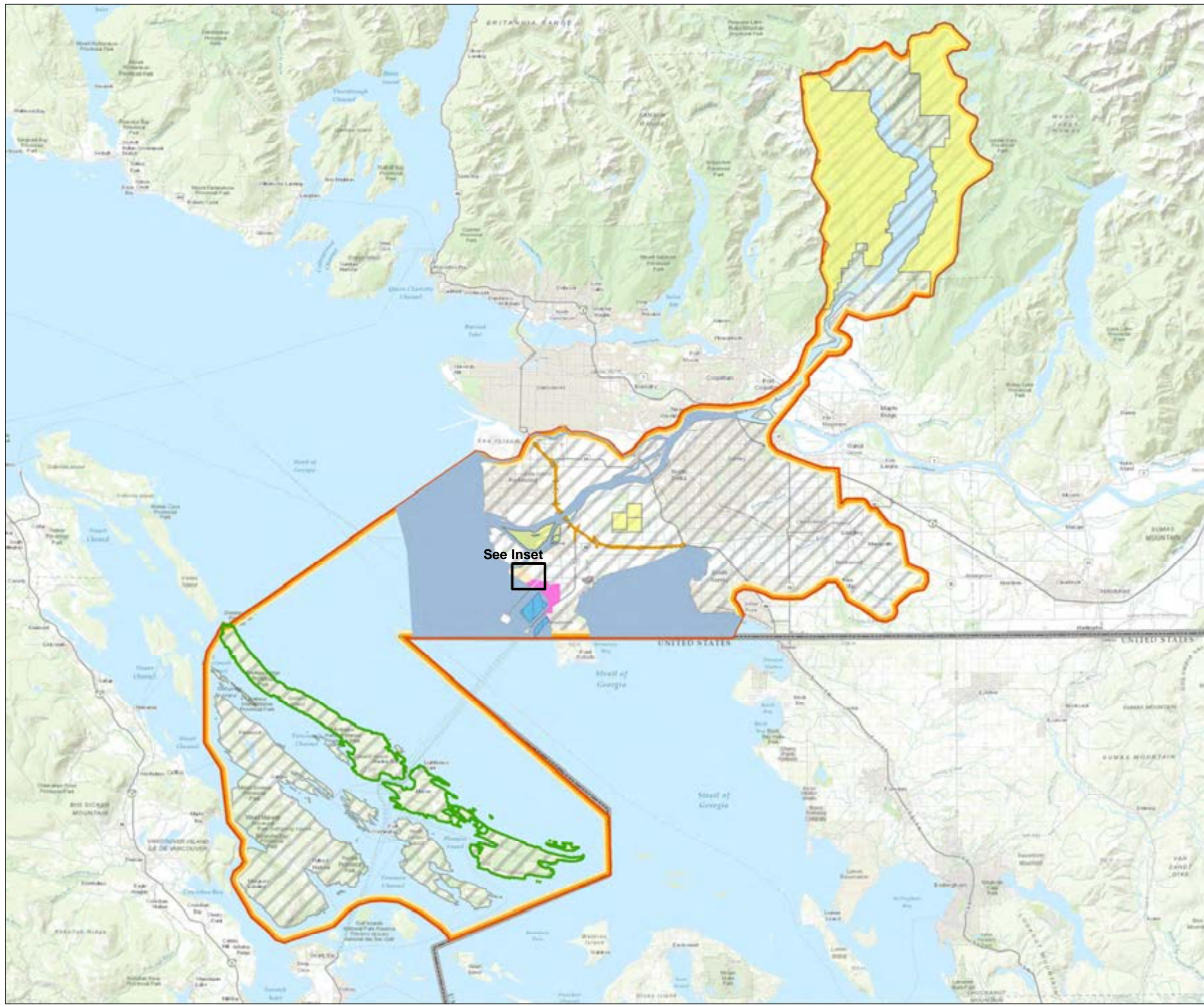
No significant Project-related residual or cumulative effects on human health are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Contamination from harvested species will be passed along to members | Assessments of potential Project-related effects on human health are presented in Section 7.1 of the Application. The Ministry is taking every precaution to ensure that vegetation, fish and fish habitat, and terrestrial wildlife are not contaminated. | Addressed in Application | Implementation of mitigation measures outlined in Sections 4.4.4 (Fish and Fish Habitat Mitigation Measures), 4.7.4 (Vegetation Mitigation Measures), 4.8.4 (Terrestrial Wildlife Mitigation Measures), and 7.1 (Human Health) |

| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|---|--------------------------|--|
| Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur. In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |
| Potential for contamination from fuel and battery acid leaks in soils adjacent to the highway | Any potentially hazardous material identified will be managed in accordance with applicable legislation, including the B.C. Hazardous Waste Regulation, B.C. Reg. 63/88, and the Workers' Compensation Board of B.C. Occupational Health and Safety Regulation, B.C. Reg. 296/97. Spill prevention and management during construction are described in Section 12 of the Application. | Addressed in Application | Adherence to the Construction Environmental Management Plan and applicable legislation |

| OTHER ISSUES | | | |
|---|---|---------------|--------------------------------|
| Consultation with Tsawwassen identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Maintaining access to points connecting to Tsawwassen, specifically access to Highway 17A | As indicated in the Section 16.1 (Draft Reference Concept), the Project will not impact Tsawwassen access. | Addressed | None |
| Length of time tolls are in place | The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |
| Potential increase in vessel traffic on the Fraser River as a result of the decommissioning of the Tunnel | The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. | Addressed | None |

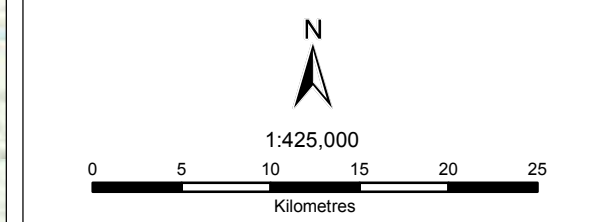
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|-------------------------|
| <p>Use and disposal of dredged and other material in the river as well as general concerns related to dredging of the Fraser River</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed</p> | <p>None</p> |



- Legend**
- Rights of Refusal Lands
 - Other Tsawwassen First Nation Lands
 - Tsawwassen First Nation Fishing Area
 - Tsawwassen First Nation Plant Gathering Area
 - Tsawwassen First Nation Lands
 - Tsawwassen First Nation Water Lots
 - Tsawwassen First Nation Traditional Territory
 - Tsawwassen Intertidal Bivalve Area
 - Tsawwassen Wildlife Harvest and Migratory Bird Harvest Area
 - Project Alignment
 - Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|--|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| TSAWWASSEN FIRST NATION TRADITIONAL TERRITORY | |
| Figure 10-9 | 26/05/2016 |
| | |

APPENDIX O

Tsleil-Waututh Nation

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Tsleil-Waututh Nation (Tsleil-Waututh).

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Tsleil-Waututh, refer to the following sections of Part C:

- Consultation with Tsleil-Waututh (**Section 10.1.2.10**);
- Tsleil-Waututh community profile (**Section 10.1.1.11**);
- Description of existing Tsleil-Waututh Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Tsleil-Waututh's Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Tsleil-Waututh's Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of the Aboriginal Interests Assessment for Tsleil-Waututh is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Tsleil-Waututh Overview Table (**Appendix O2**), which provides detailed information regarding:

- Tsleil-Waututh's issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Tsleil-Waututh's Aboriginal Interests;
- The Ministry's response to specific issues and concerns raised by Tsleil-Waututh;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry's provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Tsleil-Waututh and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, Tsleil-Waututh attended two EAO-led Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Tsleil-Waututh in relation to the draft Application Information Requirements resulted in Aboriginal Groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence with the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Tsleil-Waututh also participated in the completeness review of the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Tsleil-Waututh will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Tsleil-Waututh in early 2014 in order to identify the nature and scope of Tsleil-Waututh's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Tsleil-Waututh. A more detailed discussion is provided under the Tsleil-Waututh section in **Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Tsleil-Waututh. The Ministry has been working with Tsleil-Waututh regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Tsleil-Waututh for the preparation and submission of the traditional use study: *Tsleil-Waututh Knowledge Study for the George Massey Tunnel Project*. The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Tsleil-Waututh during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of the Project Description and Key Areas of Study document. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Tsleil-Waututh included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Tsleil-Waututh;
- Funding for Tsleil-Waututh 's participation in Project consultation activities and EA process;
- Tsleil-Waututh participation in field studies;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment, AIR and Aboriginal Consultation Plan;
- Meetings with Tsleil-Waututh leadership, staff, consultants, elders and membership; and
- Response and follow up with Tsleil-Waututh regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of Section 11 Order, AIR development and collection of baseline information (may include submission of permit applications). The main consultation activities the Ministry undertook with Tsleil-Waututh included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Tsleil-Waututh;
- Funding for Tsleil-Waututh’s participation in Project consultation activities and EA process;
- Meetings with Tsleil-Waututh leadership, staff, consultants, elders and membership;
- Tsleil-Waututh participation in fieldwork;
- Tsleil-Waututh participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements and Aboriginal Consultation Reports;
- Review of components of draft Part C of the Application; and
- Response and follow up with Tsleil-Waututh regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Tsleil-Waututh’s concerns, identified through consultation undertaken to-date, are presented in **Appendix O2 Tsleil-Waututh Nation Overview Table**. The Ministry’s response to Tsleil-Waututh’s key concerns regarding potential impacts on Tsleil-Waututh’s Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|---|--|
| <p>Potential effects to Tsleil-Waututh Right to Harvest</p> <ul style="list-style-type: none"> • Fish • Marine Mammals • Vegetation • Terrestrial Wildlife | <p>Tsleil-Waututh’s rights to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife), residual effects on the exercise of Aboriginal Interests by Tsleil-Waututh as a result of the Project are not expected.</p> |
| <p>Aboriginal participation and Project-related opportunities</p> <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Cultural recognition and naming • Revenue sharing opportunities from tolling | <p>The Ministry is committed to working with Tsleil-Waututh to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness.</p> <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Tsleil-Waututh on these opportunities.</p> <p>The provincial tolling strategy stipulates that revenue from tolling may only be used to defray the costs of designing, constructing, operating and maintaining highways.</p> |

| Concerns Identified to Date | Response |
|--|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Evaluation on impacts to ecological services for all ecosystems within the vicinity of the Project • Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Tsleil-Waututh and is committed to avoiding or mitigating any potential effects.</p> <p>Pacific salmon species selected for Project-related baseline studies include Chinook salmon, Chum salmon, Coho salmon, Pink salmon, and Sockeye salmon. Using existing scientific and literature, baseline conditions will be described for all life history stages of each salmon species, with emphasis on those life history stages that use aquatic habitats within the Project Area. Fish sampling focused on potential rearing values within drainage ditches in Richmond and Delta, for which limited existing inventory information exists, has been incorporated into the baseline studies.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Tsleil-Waututh’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |

| Concerns Identified to Date | Response |
|--|---|
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Adequacy of methodology to address social and cultural effects • Effectiveness of the EAO-led process • Inclusion of Economic Effects Assessment as part of EA • Consideration of cultural assessment methodology | <p>The Ministry acknowledges the importance of Tsleil-Waututh’s involvement in the environmental assessment process.</p> <p>Tsleil-Waututh’s concerns related to Environmental Assessment including the adequacy of methodology to address social and cultural effects, effectiveness of the EAO-led process, inclusion of economics effects assessment, and consideration of cultural assessment methodology are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> |
| <p>Social effects of the Project on Tsleil-Waututh’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Tsleil-Waututh’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |

| Concerns Identified to Date | Response |
|---|--|
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Tsleil-Waututh and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Tsleil-Waututh or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>While the Ministry acknowledges that Tsleil-Waututh is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> |
| <p>Disturbance to benthic and aquatic invertebrates and their habitat</p> | <p>Aquatic habitats, which include habitat for fish and other aquatic species (including benthic and aquatic invertebrates), will be a primary area of focus for the environmental assessment of the Project.</p> <p>Potential disturbance to benthic and aquatic invertebrates is not, on its own, proposed as a key area of study given the nature of the project and the aquatic habitats it overlaps with. Aquatic habitats overlapping with the Project occur within a section of the Fraser River that is dynamic, influenced by large flow variations and downstream transport of sand and organic matter. Therefore, aquatic and benthic invertebrate communities in the Project Area are expected to be resilient to physical disturbance. Given the temporary and short-term changes in flow and water quality expected from Project activities, it is anticipated that the benthic and aquatic invertebrates will recover rapidly from disturbance.</p> |
| <p>Effects on southern resident killer whales within 10 km of Project area</p> | <p>The Project is not anticipated to affect southern resident killer whales (SRKW). Based on the results of underwater noise modelling completed to date, underwater noise generated by Project-related activities is not predicted to extend outside of the Fraser River, and therefore will not affect SRKW. In addition, studies completed to date also indicate that SRKW prey (i.e., chinook salmon) in the Fraser River is not likely to be affected by the Project at a level that could affect the survival or recovery of SRKW.</p> |

| Concerns Identified to Date | Response |
|--|---|
| Interest in considering methods in addition to barriers, for suicide prevention. | <p>The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Tsleil-Waututh.</p> <p>Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application.</p> |
| Consideration of smart technologies in Project design | <p>The Ministry is developing an Intelligent Transportation System Strategy for the Highway 99 corridor as part of the Project scope. Proposed infrastructure includes a fibre optic network connecting the highway to the Regional Transportation Management Centre, cameras providing coverage of the highway, vehicle detection sensors, changeable message signs and additional infrastructure to allow for expansion of the system as new technologies come into use.</p> |

3.0 Community Profile: Tsleil-Waututh Nation

Tsleil-Waututh is governed by a chief and council with two-year terms under an *Indian Act* electoral system. The current term for the six-member council expires in March 2017). The main Tsleil-Waututh community is located in North Vancouver, on the shore of Burrard Inlet, approximately 2 km east of the north end of the Second Narrows Bridge, on Burrard Inlet 3. Two other reserves, Inlailawatash 4 and Inlailawatash 4A, are located on Indian Arm. Of 578 registered members, 287 reside on Tsleil-Waututh reserves. The Project area does not overlap any current or former reserve lands of the Tsleil-Waututh Nation.

Tsleil-Waututh's Consultation Area extends from the vicinity of Mount Garibaldi in the north to the 49th parallel (and beyond) in the south, Gibsons in the west, and Coquitlam Lake in the east. Tsleil-Waututh Nation report that this Consultation Area encompasses all the waters and lands used by Tsleil-Waututh during extensive seasonal rounds of travel and resource harvest, and includes both areas exclusively occupied and governed by Tsleil-Waututh and areas to which Tsleil-Waututh is granted access according to Coast Salish protocols. The Project area lies fully within this Consultation Area.

Tsleil-Waututh established an Economic Development Department in 1992. The Nation owns and operates several businesses, including Takaya Developments Ltd. (real estate development), Takaya Tours (cultural tourism), TWN Wind Power Inc. (small wind turbine distribution), Inlailawatash Forestry Limited Partnership (natural and cultural resources consulting service), Salish Seas Limited (a partnership between Tsleil-Waututh Nation, Sliammon First Nation, and Tsleil-Waututh Indian Band), TWN and Aquilini Group, and SPAL General Constructors, a project management company co-owned with Tsawwassen First Nation. Other important related Tsleil-Waututh organizations and agreements include the First Nations Legacy Society (also involving Katzie First Nation, Kwantlen First Nation, Kwikwetlem First Nation, Tsleil-Waututh Indian Band, and Tsawwassen First Nation) and the MST Land Protocol.

3.1 Tsleil-Waututh Nation Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes that are or may be connected with the exercise of Tsleil-Waututh's Aboriginal Interests. A more detailed discussion, including sources used, is provided under Tsleil-Waututh in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- Tsleil-Waututh has Aboriginal Interests that are known to overlap or lie in the vicinity of the Project corridor, which includes a portion of the South Arm of the Fraser River.
- Tsleil-Waututh has identified past and ongoing effects that have altered and reduced use over time, constraining the current exercise of their Aboriginal Interests. Tsleil-Waututh has identified a desire to regain or increase, based on past patterns and levels of use, the exercise of Aboriginal Interests in relation to locations or resources that may be affected by Project components or activities.
- Tsleil-Waututh have previously stated that all the lands and waters draining into Burrard Inlet and Indian Arm constitute their core territory (a subset of their Consultation Area), and that their use of the South Arm of the Fraser River was dependent on kinship ties with other *Hə́n̓qə́m̓iḥə́m̓*-speakers (i.e., Tsawwassen, Tsleil-Waututh).
- While Tsleil-Waututh continue to access the Fraser River for sockeye, it is not believed the Tsleil-Waututh assert title in or near the Project area.

3.1.2 Fishing

- Marine resources were and remain central to Tsleil-Waututh for subsistence and cultural life. Salmon was a food staple, supported by the harvest of the full range of shellfish, including bivalves and crustaceans, sturgeon, a variety of groundfish (e.g., halibut, cod, sole, flounder, lingcod, rockfish, among others), eulachon, herring, and smelt, as well as aquatic plants, such as seaweeds. Seals, porpoises, and sea lions were also harvested. Tsleil-Waututh have said that access to different species of salmon was important because of their different qualities and requirements for preservation.
- Resources were used immediately, or processed and stored for use in the winter while resident in large villages in and around Burrard Inlet, where the present-day community still lives.
- Tsleil-Waututh report they hold a close cultural and spiritual connection to salmon; however, sockeye salmon do not run in the tributaries of Burrard Inlet. Tsleil-Waututh has previously reported that their ancestors historically accessed sockeye on the South Arm of the Fraser River through kinship ties, moving to the area in July and August, where they would reside at Tsleil-Waututh seasonal villages with other *Hə́n̓qə́m̓iḥə́m̓*-speaking groups (i.e., Tsawwassen). Historically, they would paddle back to Burrard Inlet village sites with thousands of preserved sockeye from the Fraser River to last throughout the year.
- Fraser River sockeye remain a primary traditional food source for Tsleil-Waututh families, and salmon, herring, and crab are among the species that still contribute to the contemporary economy of Coast Salish peoples.

- Sturgeon and eulachon were also harvested while resident on the river, which the Tsleil-Waututh also used as a travel corridor. Tsleil-Waututh report that, historically, billions of eulachon returned to the Fraser River to spawn, providing them with an important early season fishery. Typically they dried eulachon.
- Currently, they occasionally receive Fraser River eulachon through relatives and cultural protocols. Sturgeon, due to its decline, is no longer a component of Tsleil-Waututh diet. It is their goal to participate in the recovery of these species and their habitats for future generations.
- Tsleil-Waututh may fish for FSC purposes under communal licences issued by DFO. There are a number of PFMA subareas to which these licences apply, including subareas 29-13 and 29-14, which overlap the Project corridor.
- Tsleil-Waututh reports that they have an extensive Fraser River sockeye fishery each year, and for the most part, when there are no conservation concerns, Tsleil-Waututh says they fulfil their communal allocation. The largest fishing effort occurs in August. Tsleil-Waututh has also participated in, and continues to reserve the right, to a limited participation fishery for ceremonial purposes outside of the regular Tsleil-Waututh sockeye fishing season.
- Tsleil-Waututh have advised that, in every year since 2008, they have requested a communal licence for Chinook. With the exception of limited participation access in 2009, 2010, and 2014, Tsleil-Waututh Nation has not been granted a DFO communal licence for Chinook. In 2014, Tsleil-Waututh requested communal licences for Fraser River chum. As of 2016, Fraser River chum and pink salmon allocations have been added to Tsleil-Waututh Nation's Comprehensive Fisheries Agreement (CFA).
- In addition to communal licences issued by DFO, Tsleil-Waututh report that they may access food fish through other means, such as through cultural protocols and kinship ties with neighbouring communities, when DFO communal licences are unavailable.
- Tsleil-Waututh advise that they seek to access, protect, and restore traditional foods for future generations, and current and future desired use. For example, Tsleil-Waututh report that they have submitted multiple requests to DFO to access Fraser River eulachon – a species traditionally accessed by Tsleil-Waututh in the Fraser River – but has been denied an allocation.
- Tsleil-Waututh also report having access to PFMA 29 for communal crab licences, and have been working with DFO through an access request process to recognize PFMA 29 for prawn and crab communal fisheries in the Tsleil-Waututh Nation's CFA.
- Fishing is conducted under communal licences on behalf of the community; distributions of fresh fish are made within the community in season and by preserved methods during the winter months.

- In addition to communal FSC access, Tsleil-Waututh Nation’s 2013 CFA with DFO also provides the nation with communal commercial fisheries access through an allocation transfer program.
- Tsleil-Waututh participates in commercial fisheries through Salish Seas Limited Partnership, a business owned jointly with the Tsleil-Waututh Indian Band and Sliammon First Nation.

3.1.3 Hunting/Trapping

- Species hunted historically and continuously by Tsleil-Waututh include ungulates, such as deer and elk, bear, ducks, and other waterfowl.
- Tsleil-Waututh has previously reported that waterfowl were hunted while resident on the South Arm of the Fraser River in July and August. Current waterfowl harvesting by Tsleil-Waututh members in or near the Project area was not identified in sources reviewed.

3.1.4 Gathering

- On southern Lulu Island, around No. 5 Road, Tsleil-Waututh has stated that it harvested berries, and specifically cranberries, while resident on the Fraser River. Tsleil-Waututh has also advised that, in 1870, “Sleholdoo, chief of Slilooet (i.e., Sla-holt, chief of Tsleil-Waututh) was a signatory on a petition to colonial authorities opposing the sale of cranberry patches on the Lower Fraser River.” In addition to demonstrating that Tsleil-Waututh utilized these areas for harvesting cranberries, Tsleil-Waututh consider this to be recognition by other signatory First Nations of Tsleil-Waututh’s “rights of utilization” at this location (TWN 2016). Current gathering activities by Tsleil-Waututh members in or near the Project area were not identified in sources reviewed.

3.1.5 Archaeology and Cultural Heritage Interests

- Tsleil-Waututh have reported that all areas used for traditional purposes, such as fishing, hunting, and gathering, are regarded as sacred. They have explained that the landscape utilized for these purposes was shaped, in the very distant past, by the Transformers—or *Xáls*, *Xexá:ls*, or *Khaals*—who began their journey at the Fraser River delta travelling upstream and creating the world.

3.1.6 Other Related Interests

- Tsleil-Waututh have also explained that waterways within their asserted territory were the principal means of accessing places such as *ł'əqtinəs* (on the north shore of the Fraser River opposite Deas Island); *kwy-yowka* (on the south shore of Lulu Island), and *ʔələqsən* (on the northern end of Westham Island) within the seasonal round of land and resource use.

- Tsleil-Waututh report two historic canoe routes connecting Roberts Bank to Boundary Bay, Canoe Passage, the South Arm of the Fraser River, and Sturgeon Bank, and two fishing villages, one opposite Deas Island in the Fraser River (associated with *λ'əqtinəs*) and the other at Cannery Point, on the southeastern corner of Point Roberts peninsula.
- Tsleil-Waututh has advised that, in 1867, “Slehorte of Slelowet Burrard Inlet Villages” (i.e., Sla-holt, chief of Tsleil-Waututh)...was a signatory of a petition opposing restriction on First Nations travel on the Fraser River.” In addition to demonstrating that Tsleil-Waututh travelled the Fraser River, Tsleil-Waututh consider this to be recognition by other signatory First Nations of Tsleil-Waututh’s “right of unrestricted travel” within this waterway (TWN 2016).

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Tsleil-Waututh’s Aboriginal Interests, specifically. For a more detailed description, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.

- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Tsleil-Waututh’s exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6: Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise. Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise |

| | Construction | | Operation | | Residual Potential Effects |
|------------------------|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects on Tseil Waututh’s Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Tseil Waututh’s Aboriginal Interests of Fishing, Hunting/Trapping, Gathering, Archaeology and Cultural Heritage and Other Related Interests as summarized in Existing Conditions were identified for Project Construction and Operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Project Construction | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |
| Project Operation | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |

4.5 Fishing

Tsleil-Waututh report that marine resources were and remain central for subsistence and cultural life. Salmon was a food staple, and additional species harvested include the full range of shellfish, sturgeon, groundfish, eulachon, herring, and smelt, as well as aquatic plants. Seals, porpoises, and sea lions were also harvested. Tsleil-Waututh has previously reported that their ancestors historically accessed sockeye on the South Arm of the Fraser River through kinship ties, moving to the area in July and August

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Tsleil-Waututh, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Tsleil-Waututh during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Tsleil-Waututh from instream construction activities are expected to be negligible. While it is acknowledged that Tsleil-Waututh has reported a desire for higher levels of use in this portion of the river based on historic use, the

episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Tsleil-Waututh. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Tsleil-Waututh; therefore, Potential Project-related effects on Tsleil-Waututh fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsleil-Waututh.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Tsleil-Waututh is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Tsleil-Waututh's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Tsleil-Waututh report hunting ungulates, such as deer and elk, bear, ducks, and other waterfowl historically and continuously. Waterfowl were hunted while resident on the South Arm of the Fraser River in summer. Current waterfowl harvesting by Tsleil-Waututh members in or near the Project area was not identified in sources reviewed.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Tsleil-Waututh as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Tsleil-Waututh during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Tsleil-Waututh from instream construction activities, are expected to be negligible. While it is acknowledged that Tsleil-Waututh has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Tsleil-Waututh resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Tsleil-Waututh. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Tsleil-Waututh; therefore, Potential Project-related effects on Tsleil-Waututh fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsleil-Waututh.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Tsleil-Waututh is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Tsleil-Waututh's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Tsleil-Waututh report harvesting berries, and specifically cranberries, while resident on the Fraser River historically. Current gathering activities by Tsleil-Waututh members in or near the Project area were not identified in sources reviewed.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Tsleil-Waututh as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Tsleil-Waututh during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Tsleil-Waututh from instream construction activities, are expected to be negligible. While it is acknowledged that Tsleil-Waututh has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Tsleil-Waututh resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Tsleil-Waututh; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsleil-Waututh.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Tsleil-Waututh is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Tsleil-Waututh's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

Tsleil-Waututh have reported that all areas used for traditional purposes, such as fishing, hunting, and gathering, are regarded as sacred. They have explained that the landscape utilized for these purposes was shaped, in the very distant past, by the Transformers—or *Xáls*, *Xexá:ls*, or *Khaals*—who began their journey at the Fraser River delta travelling upstream and creating the world.

The proposed Project has the potential to affect Tsleil-Waututh's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Tsleil-Waututh's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Tsleil-Waututh's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Tsleil-Waututh's archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Tsleil-Waututh has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Tsleil-Waututh's archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Tsleil-Waututh's archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Tsleil-Waututh's archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Tsleil-Waututh.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Tsleil-Waututh (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Tsleil-Waututh's Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Tsleil-Waututh, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Tsleil-Waututh. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Tseil-Waututh's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Tseil-Waututh regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Tseil-Waututh's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Tsleil-Waututh prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Tsleil-Waututh during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Tsleil-Waututh during consultations include:

- Effects to fish and fish habitat, southern resident killer whales and benthic resources;
- Potential light and noise effects on wildlife and fish;
- Potential effects of the bridge structure on species such as waterfowl and migratory birds;
- Wetland assessment (ecological services, productivity and biodiversity), particularly with respect to at-risk amphibians;
- Habitat enhancement;
- Effects on the estuary and island complexes as well as Fraser River plume, particularly in relation to juvenile and returning salmon;
- Access to the Fraser River;
- Economic effects;
- Cultural assessment methodology;
- Capacity funding;
- Confidentiality of information sharing;
- Effectiveness of EAO-led process to address Tsleil-Waututh concerns;
- Social effects of the Project on Tsleil-Waututh Nation's ability to transfer knowledge, language and participate in socio-cultural practices;
- Absence of a comprehensive study of cumulative effects on the Fraser River and consideration of cumulative effects on Aboriginal rights;
- Project-related employment, training, contracting, and economic development opportunities;
- Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River;
- Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations;
- Interest in climate change resiliency;
- Consideration of smart technologies in Project design;
- Interest in considering methods in addition to barriers, for suicide prevention;

- Interest in social determinants of health being assessed in the EA Application and Human Health being a VC;
- Potential effects of construction during fishing season on fishing activities. Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing;
- Change in flow rates after Tunnel removal;
- Impact of Project on Deas and Tilbury Sloughs and Duck, Barber and Woodward Island complexes;
- Traffic;
- Invasive plant management;
- Culturally significant plants;
- Stormwater management; and
- Water quality.

Based on information provided by Tsleil-Waututh and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Tsleil-Waututh has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Tsleil-Waututh's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Tsleil-Waututh Nation, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Tsleil-Waututh regarding proposed measures, management plans, and monitoring programs related to IC and VC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Tsleil-Waututh, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of EA methodology. | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------------|--------------------------------|
| Effectiveness of the EAO-led process to address Tsleil-Waututh Nation's concerns. | Concerns related to the effectiveness of the EAO-led process to address Tsleil-Waututh's concerns are outside the scope of the Project and have been referred to EAO. | Referred to EAO | None |
| Inclusion of Economic Effects Assessment as part of EA. | Concerns related to the inclusion of economic effects assessment as part of the EA have been referred to EAO. | Referred to EAO | None |
| Consideration of cultural assessment methodology. | Concerns related to the consideration of cultural assessment methodology have been referred to EAO. | Referred to EAO | None |

ABORIGINAL INTERESTS

There are potential Project related impacts to Tsleil-Waututh's title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape
- Quality of experience while engaged in or tied to traditional use
- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Tseil-Waututh as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Protection of Tsleil-Waututh Nation’s rights to harvest within the Project area.</p> | <p>Tsleil-Waututh’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures outlined in Table 10.3-1 and Section 10.1.3.4, residual effects on the exercise of Aboriginal Interests by Tsleil-Waututh as a result of the Project are not expected.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation of mitigation measures</p> |
| <p>Tsleil-Waututh Nation’s access to the Fraser River and the potential to displace fishing vessels. Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Tsleil-Waututh Nation’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|---|
| <p>Social effects of the Project such as Tsleil-Waututh Nation’s knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Tsleil-Waututh’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights. • Assessment of cumulative effects in regards to the inclusion of other reasonably foreseeable projects and activities. | <p>The Application will include historical context as outlined relating to changes in use over time by Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by First Nations or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental</p> | | |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------|-------------------------|
| <ul style="list-style-type: none"> Absence of a comprehensive study of cumulative effects on the Fraser River | <p>cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> <p>While the Ministry acknowledges that Teleil- Waututh Nation is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | | |

| ABORIGINAL CONSULTATION | | | |
|---|---|---------------|---|
| <p>Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.</p> <p>Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.</p> <p>In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.</p> <p>Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Capacity funding to facilitate participation in the Project review process | Tsleil-Waututh Nation received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Tsleil-Waututh Nation as it relates to confidentiality and dissemination | The Ministry understands and respects that certain information shared by Tsleil-Waututh Nation may be considered confidential. The Ministry is subject to the provisions of the Freedom of Information and Protection of Privacy Act. However, subject to the requirements of applicable laws, the Ministry will respect Tsleil-Waututh Nation requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Funding for Knowledge Study | The Ministry signed a funding agreement with Tsleil-Waututh Nation which provided funding for a Knowledge Study. | Addressed | None |
| Input into areas for potential habitat enhancement | Request noted. The Ministry will consult with Tsleil-Waututh and other Aboriginal groups. | Noted | Ongoing consultation |
| Importance of working with Tsleil-Waututh in accordance with their stewardship policy | Noted and considered in planning for consultation with Tsleil-Waututh. | Noted | Ongoing consultation |
| Importance in distinction between consultation and information sharing | Importance in distinction between consultation and information sharing was addressed in the Aboriginal Consultation Plan. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|--|
| Opportunities for cultural recognition and naming | The Ministry is exploring opportunities for cultural recognition and naming and will work with Tsleil-Waututh on this matter. | Ongoing | Discussion with Tsleil-Waututh to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities. | The Ministry is committed to working with Tsleil-Waututh to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Tsleil-Waututh to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Aboriginal Groups on the type of information that would be useful. |
| Revenue sharing opportunities from tolling | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Impact of Project on Deas and Tilbury Sloughs and Duck, Barber and Woodward Island complexes</p> | <p>Deas and Tilbury Sloughs and Duck, Barber and Woodward Island complexes are included in Section 4.1 of the Application.</p> <p>Removal of the Tunnel is not expected to have long term effects on Deas and Tilbury Sloughs and Duck, Barber and Woodward Island complexes.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |

4.2 SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------------------------|--|
| <p>Potential effects of run off and drainage - innovative stormwater solutions and bioengineering techniques</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>Water quality and sediment issues: comprehensive understanding of potential ecological impacts and core sampling</p> | <p>Changes in sediment riverbed characteristics that have the potential to affect receptor VCs include changes in sediment composition and organic carbon content, and changes in sediment quality in terms of contaminant concentrations. Similarly, changes in the water column that have the potential to affect receptor VCs include changes in total suspended solids (TSS) and turbidity levels, or changes in ambient water chemistry. Therefore, Project-related study of water and sediment quality was designed to focus on these aspects. A literature review, gap analysis, and field program, as outlined in Table 4.2-1, were undertaken to establish existing conditions, and sediment fate predictions described in Section 4.1 River Hydraulics and River Morphology were used to identify potential Project-related effects of water quality and sediment quality in the Fraser River South Arm, Deas Slough, and Green Slough.</p> | <p>Addressed</p> | <p>None</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

- A negligible effect on the availability of fish resources for traditional use has been determined.
- A negligible effect on quality of fish resources for traditional use has been determined.
- A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

- Avoid effects through Project design.
- Apply best management and environmental management practices.
- Develop Construction Environmental Management and Operational Environmental Management plans.
- Use timing windows for undertaking in-stream works.
- Erosion and sediment control.
- Habitat enhancement and offsetting.

Residual & Cumulative Effects

- There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.
- No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon | The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon and salmon. Potential Project-related effects on fish and fish habitat are presented in Section 4.4 of the Application. | Addressed | Implementation of mitigation measures outlined in 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|---|
| Species of salmon | The Ministry will work with the BC Environmental Assessment Office to ensure that the methodology used to support the assessment of environmental values is consistent with current best practice and guidance materials that support the assessment of projects under the BC Environmental Assessment Act. | | |
| Evaluation on impacts to ecological services for all ecosystems within the vicinity of the Project | Pacific salmon species selected for Project-related baseline studies include Chinook salmon, Chum salmon, Coho salmon, Pink salmon, and Sockeye salmon. Using existing scientific and literature, baseline conditions will be described for all life history stages of each salmon species, with emphasis on those life history stages that use aquatic habitats within the Project Area. Fish sampling focused on potential rearing values within drainage ditches in Richmond and Delta, for which limited existing inventory information exists, has been incorporated into the baseline studies. | Addressed | Implementation of mitigation measures outlined in 4.4.4 |
| Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon | Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project- | Addressed | Implementation of mitigation measures outlined in 4.3.4 and 4.4.4 |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| | <p>related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | | |
| <p>Disturbance to benthic and aquatic invertebrates and their habitat</p> | <p>Aquatic habitats, which include habitat for fish and other aquatic species (including benthic and aquatic invertebrates), will be a primary area of focus for the environmental assessment of the Project.</p> <p>Potential disturbance to benthic and aquatic invertebrates is not, on its own, proposed as a key area of study given the nature of the project and the aquatic habitats it overlaps with. Aquatic habitats overlapping with the Project occur within a section of the Fraser River that is dynamic, influenced by large flow variations and downstream transport of sand and organic matter. Therefore, aquatic and benthic invertebrate communities in the Project Area are expected to be resilient to physical disturbance. Given the temporary and short-term changes in flow and water quality expected from Project activities, it is anticipated that the benthic and aquatic invertebrates will recover rapidly from disturbance.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River. Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of marine mammal resources for traditional use has been determined.
 A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as impact pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.
 Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|-------------------------|
| Effects on southern resident killer whales within 10 km of Project area | The Project is not anticipated to affect southern resident killer whales (SRKW). Based on the results of underwater noise modelling completed to date, underwater noise generated by Project-related activities is not predicted to extend outside of the Fraser River, and therefore will not affect SRKW. In addition, studies completed to date also indicate that SRKW prey (i.e., chinook salmon) in the Fraser River is not likely to be affected by the Project at a level that could affect the survival or recovery of SRKW. | Addressed | None |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Invasive plant species and proposed plans to manage presence during construction | Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan. | Addressed | Implementation of mitigation measures outlined in Section 4.7.4 |
| Culturally significant plants should be used in planting plans | Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans. | Addressed | The Ministry will develop planting plans with consultation from Aboriginal Groups |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|--|
| <p>Potential light and noise effects on wildlife and fish.</p> | <p>The Ministry understands that Tsleil-Waututh is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds.</p> | <p>The Ministry understands that Tsleil-Waututh is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|--|
| <p>Wetland assessment (ecological services, productivity and biodiversity), particularly with respect to at-risk amphibians</p> | <p>At-risk amphibians were not detected within the Project alignment during field studies undertaken in 2014 and 2015. The potential for at-risk amphibians to occur within the Project alignment is low. Applying mitigation, including least-risk timing windows, and adherence to standard practices for undertaking in-stream works and highway maintenance activities, will ensure that Project-related effects on at-risk amphibians are addressed.</p> | <p>Addressed</p> | <p>Implementation of mitigation measures outlined in Table 4.5-6</p> |
| <p>Protection of large mammals including black-tail deer and clarification of WARS on Project area</p> | <p>The Wildlife Accident Reporting System (WARS) contains long-term wildlife-related accident records that provide wildlife data for a range of purposes, including highway planning (Sielecki 2003). Data collected through WARS helps improve understanding of where wildlife mortality is occurring such that measures can be taken to avoid or reduce such mortality. WARS data are primarily collected by highway maintenance crews.</p> <p>Due to previous development in areas directly adjacent to the existing right-of-way, habitat features for deer are absent. As such, large mammals have not been included as a valued component in the environmental assessment for the Project.</p> | <p>Addressed</p> | <p>None</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|----------------------------------|
| Interest in climate change resiliency and a request for review with the Ministry when forms are complete | The Ministry has committed to sharing this information when available | Addressed | Share information when available |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Tsleil-Waututh has not voiced any specific issues or concerns with respect to Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|--------------------------|---|
| Potential effects of construction during fishing season on fishing activities | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | Addressed in Application | Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures) |
| Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing | <p>Potential interference with fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | | Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures) |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operational, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewscales.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

Negligible effect on access to upland locations for traditional use

Negligible effect on quality of experience tied to access of upland areas for traditional use.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|------------------|---|
| <p>Impacts of staging/laydown areas. Request that the Ministry provide construction parameters to avoid impacting areas around Project footprint.</p> | <p>The Application has been developed with the assumption that all temporary and permanent works will be included within the Project alignment. Potential staging areas that will be made available to the contractor encompass areas within the highway right-of-way that have been previously developed and disturbed.</p> <p>Any temporary or permanent works that are to take place will be subject to applicable permitting requirements, including <i>Water Sustainability Act</i> permitting and archaeological investigation if required. Applications for these permits will include detailed descriptions and locations of works to take place.</p> <p>If the contractor chooses to develop staging areas on sites other than those identified, site-specific environmental permitting and approvals will be obtained by the contractor.</p> | <p>Addressed</p> | <p>Contractor will obtain permits and approvals as required</p> |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation: A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Tsleil-Waututh Nation has not voiced any specific issues or concerns with respect to Visual Quality. | | | |

| 6.1 HERITAGE RESOURCES | | | |
|---|---|---------------------------------|---|
| <p>The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.</p> <p><u>Effects</u> A negligible effect on access to upland locations for traditional use has been determined. A negligible effect on quality of experience tied to access of upland locations for traditional has been determined. During construction: No to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape. During operation: A measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.</p> <p><u>Mitigation</u> Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation. Undertake additional archaeological surveys.</p> <p><u>Residual & Cumulative Effects</u> No significant Project-related residual or cumulative effects on heritage resources are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| <p>Protection of archaeological and heritage resources, including intangible heritage sites.</p> | <p>Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Tsleil-Waututh Nation.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|-----------|--|
| Participation in archaeological fieldwork and review of archaeological draft reports | Tsleil-Waututh Nation participated in all archaeological field work to date and was provided the opportunity to review draft archaeological reports. | Addressed | Tsleil-Waututh Nation will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports. |
| Request that First Nations permits be obtained before the commencement of archaeological work | First Nations heritage permits were obtained by the archaeologist in advance of work commencing. | Addressed | Obtain permits as required |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

7.0 HUMAN HEALTH

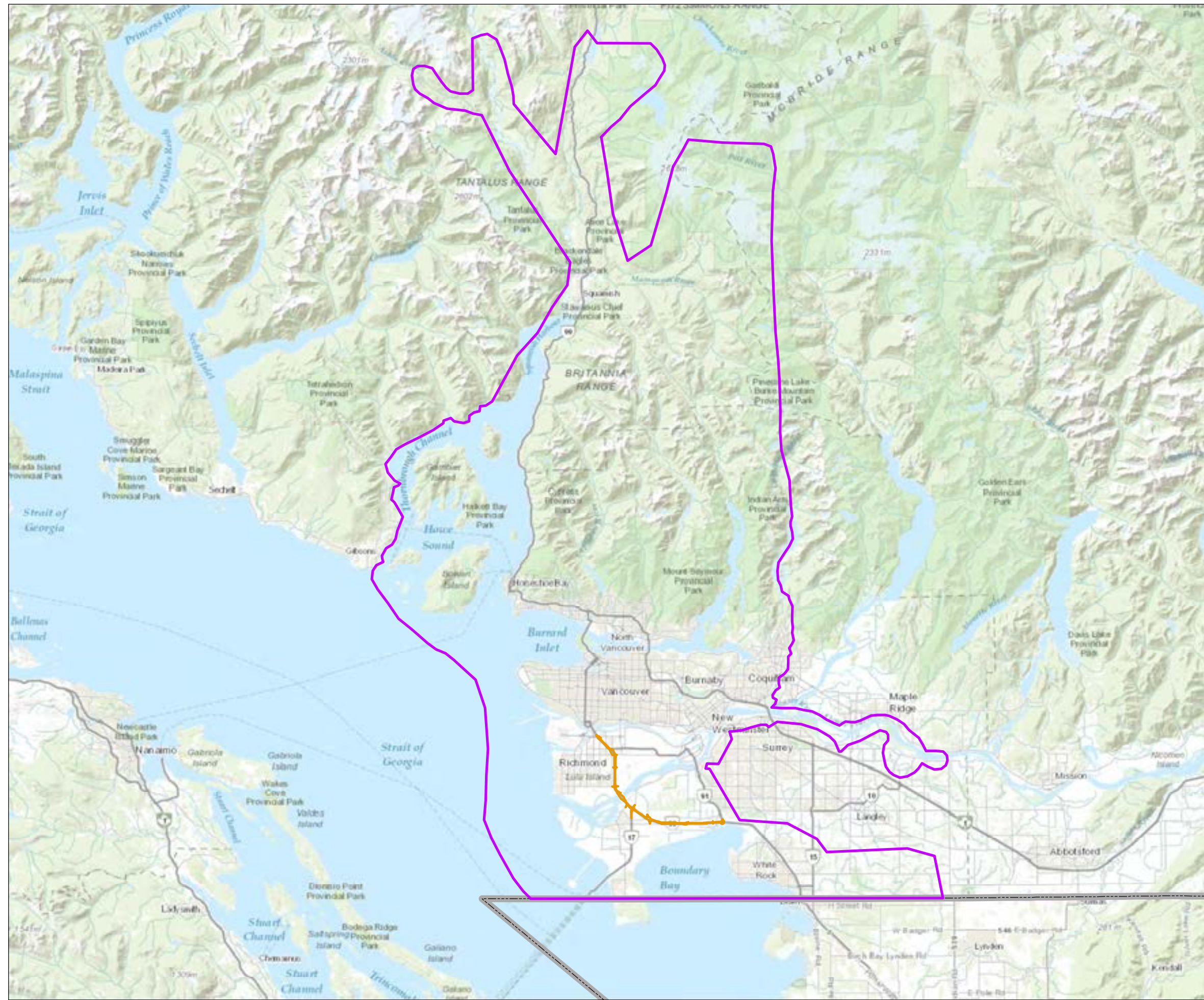
A negligible effect on access to upland locations for traditional use has been determined.
 A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.
Mitigation
 Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.
 Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.
Residual & Cumulative Effects
 No significant Project-related residual or cumulative effects on human health are expected.

| Issue | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|--|
| Interest in considering methods in addition to barriers, for suicide prevention | The Ministry is in the process of developing a policy in which new bridges in the Lower Mainland will require the installation of safety barriers. The Ministry is committed to including safety barriers as part of the design of the new bridge and will continue to discuss additional measures with Tsleil-Waututh. Assessment of potential Project-related effects on human health, including community and social factors, are presented in Section 7.1 of the Application. | Addressed in Application | Development of safety barrier policy for new bridges in the Lower Mainland. Implementation of mitigation measures outlined in Section 7.1 |
| Interest in social determinants of health being assessed in the EA Application and Human Health being a VC | Social determinants of health was considered in the assessment of potential Project-related effects on human health, including community and social factors. Human Health is addressed in Section 7.1 of the Application. | Addressed | None |




| 8.0 ACCIDENTS AND MALFUNCTIONS | | | |
|---|---|---------------|--|
| <p>Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.</p> <p>In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|--|---|---------------|---|
| Consultation with Tsleil-Waututh Nation identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Consideration of smart technologies in Project design | The Ministry is developing an Intelligent Transportation System Strategy for the Highway 99 corridor as part of the Project scope. Proposed infrastructure includes a fibre optic network connecting the highway to the Regional Transportation Management Centre, cameras providing coverage of the highway, vehicle detection sensors, changeable message signs and additional infrastructure to allow for expansion of the system as new technologies come into use. | Addressed | Development of Intelligent Transportation System Strategy |
| Length of time tolls are in place | The Province intends to fund the Project, at least in part, through user tolls. This is consistent with the provincial tolling guidelines. Tolling recognizes that those directly benefitting from the new infrastructure in terms of time savings and reliability should help pay for the Project. This ensures that the needed improvements can proceed now, rather than years in the future when improvements will be even more overdue. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|------------------|-------------------------|
| <p>Use and disposal of dredged and other, material in the river as well as general concerns related to dredging of the Fraser River.</p> | <p>Dredging to deepen the river is not a component of this Project and the Ministry is unaware of any plans by others to dredge the river deeper. The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river. This is outlined in Sections 1.1.7.2 (Construction), 4.1 (River Hydraulics) and 4.2 (Water Quality and Sediment) of the Application.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Consideration of traffic data from other proposed projects or regional studies</p> | <p>As outlined in Section 5.1.9, traffic data from a number of sources was considered.</p> | <p>Addressed</p> | <p>None</p> |

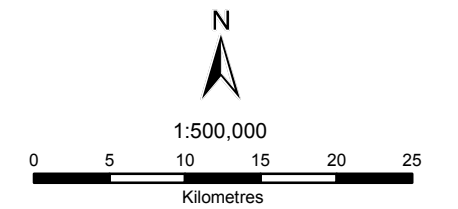


Legend

-  Tsleil-Waututh Nation Consultation Area
-  Project Alignment
-  Canada - U.S. Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

TSLEIL-WAUTUTH NATION

Figure 10-10

18/05/2016

APPENDIX P

Hwlitsum

1.0 Introduction

This appendix provides a summary of the information presented in Part C Aboriginal Consultation (Part C) of the Application for an Environmental Assessment Certificate (the Application) regarding the assessment of effects on Aboriginal Interests. Aboriginal Interests are defined as asserted or determined Aboriginal rights, including title, or treaty rights. This appendix presents the information specific to Hwlitsum.

The organization of the information presented generally follows Part C and includes the following sections:

- Consultation;
- Community Profile;
- Existing Conditions;
- Potential Effects;
- Mitigation;
- Residual Effects; and
- Summary and Conclusion.

For more detailed information on the effects assessment on Aboriginal Interests related to Hwlitsum, refer to the following sections of Part C:

- Consultation with Hwlitsum (**Section 10.1.2.10**);
- Hwlitsum community profile (**Section 10.1.1.2**);
- Description of existing Hwlitsum Aboriginal Interests (**Section 10.1.3.2**);
- Assessment of potential effects of the Project on the exercise of Hwlitsum Aboriginal Interests (**Section 10.1.3.3**);
- Mitigation relating to potential effects on Aboriginal Interests (**Section 10.1.3.4**); and
- Residual effects on Hwlitsum Aboriginal Interests following application mitigation (**Section 10.1.3.5**).

A summary of Aboriginal Interests Assessment for Hwlitsum is also provided in **Section 10.1.3.8**.

The summary presented in this appendix also incorporated information found in the Hwlitsum Overview Table (**Appendix P2**), which provides detailed information regarding:

- Hwlitsum’s issues and concerns identified to date;
- Identification of potential effects on VCs and ICs that relate to the assessment of effects on Hwlitsum’s Aboriginal Interests;
- The Ministry’s response to specific issues and concerns raised by Hwlitsum;
- The status of these issues and concerns; and
- Next steps required to address outstanding issues and concerns.

2.0 Consultation

This section provides information regarding the consultation activities that the EAO and Ministry carried out prior to submission of the Application.

2.1 EAO-led Consultation Activities

2.1.1 Capacity Funding

When a provincial agency is a proponent of a project going through a provincial EA under the British Columbia *Environmental Assessment Act* (BCEAA), that agency provides funding to Aboriginal Groups to support their involvement in pre-Application and Application review phases in place of EAO providing such funding. The Ministry’s provision of capacity funding is discussed in the following section, Proponent-led Consultation Activities.

2.1.2 Participation in Working Group

EAO invited Hwlitsum and all other Aboriginal groups identified in Schedule B of the Section 11 Order to participate as members of a Working Group.

During the Pre-Application stage, Hwlitsum attended two EAO-led Working Group meetings where the Ministry presented information on the Project and the environmental assessment process and received and responded to comments on those presentations.

The first Working Group meeting, held January 2016, focused on the environmental assessment process, Project overview and update, Key Areas of Study, draft Application Information Requirements overview, and preliminary conclusions from study results.

The second working group meeting, held March 2016, focused on the environmental assessment process, list of materials available on the Project website, review of comments received on, and resulting changes to, the draft Application Information Requirements, and a description and rationale of the assessment areas. Working Group comments raised by Hwlitsum in relation to the draft Application Information Requirements resulted in Aboriginal groups being invited to participate in river-otter related fieldwork in April 2016. The objectives of this work were to document river otter presence or potential presence with the Regional Assessment Area, document and describe use of riparian and high use areas and identify potential Project-related effects.

Hwlitsum also participated in the completeness review of the Application that considered whether the Application included information requirements set out in the Application Information Requirements.

It is anticipated that Hwlitsum will continue as an active member of the Working Group through the environmental assessment process.

2.2 Proponent-led Consultation Activities

The Ministry began consultation with Hwlitsum in early 2014 in order to identify the nature and scope of Hwlitsum's Aboriginal Interests and how they might be impacted by the Project. Following is a summary of consultation activities led by the Ministry with Hwlitsum. A more detailed discussion is provided under the Hwlitsum section in **Section 10.1.2.10 Overview of Consultation with each Schedule B Aboriginal Group**. The following sections represent the main activities undertaken in support of Proponent-led consultation and include the following:

- Provision of capacity funding;
- Traditional use, traditional knowledge and other studies;
- Examples of Consultation Activities; and
- Concerns Identified to Date.

2.2.1 Capacity Funding

The Ministry entered into a Participation Funding Agreement, including the Initial Consultation and Pre-Application phases for consultation, with Hwlitsum. The Ministry has been working with Hwlitsum regarding their needs for capacity funding to facilitate their participation in the Application Review Phase. Consultation activities that are anticipated to be undertaken during the Application Review phase that will be supported by capacity funding include participation in technical reviews and analyses, involvement in ongoing consultation activities, and presentation of key information regarding their respective Aboriginal Interests.

2.2.2 Traditional Use, Traditional Knowledge & Other Studies

The Ministry provided additional funding to Hwlitsum for the preparation and submission of the traditional use study *Hwlitsum Traditional Use and Occupancy Study 2015*. The purpose of such studies is to identify Aboriginal input and traditional knowledge for inclusion and consideration in the EA. In addition, studies were funded to enhance the Ministry's understanding of Aboriginal Interests and Aboriginal Group's past, present and desired future use as it pertains to the exercise of Aboriginal Interests within the Project area and the potential adverse effects on identified Aboriginal Interests.

2.2.3 Examples of Consultation Activities

A number of consultation activities were undertaken with Hwlitsum during both the Initial Consultation Phase and the Pre-Application Consultation Phase as follows:

Initial Consultation Phase Activities - The Ministry recognized the importance and value of early engagement with Schedule B Aboriginal Groups and undertook an Initial Consultation Phase prior to the Pre-Application Phase. The Initial Consultation Phase concluded in December 16, 2015 with submission of Project Description. The focus of the Initial Consultation Phase was collection of baseline information and sharing of draft EA-related documents (i.e. Project Description and Key Areas of Study, draft Application Information Requirements (AIR)). The main consultation activities the Ministry undertook with Hwlitsum included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Hwlitsum;
- Funding for Hwlitsum's participation in Project consultation activities and EA process;
- Site visit;
- Review of draft EA documents such as the Project Description and Key Areas of Study, Heritage Resources Overview Assessment/Archaeological Overview Assessment, Heritage Resources Assessment and Aboriginal Consultation Plan;
- Meetings with Hwlitsum leadership, staff, consultants, and elders; and
- Response and follow up with Hwlitsum regarding the identification and resolution of issues.

Pre-Application Consultation Phase Activities - The Pre-Application Consultation Phase began with the filing of the Project Description and Key Areas of Study on December 16, 2015 and concluded with the submission of the Application. This phase included the issuance of Section 11 Order, AIR development and collection of baseline information. The main consultation activities the Ministry undertook with Hwlitsum included:

- Sharing of Project-related information including focused presentation on topics on interest and/or concern to Hwlitsum;
- Funding for Hwlitsum’s participation in Project consultation activities and EA process;
- Meetings with Hwlitsum leadership, staff, consultants, elders and membership;
- Hwlitsum participation in the EA Working Group;
- Review of draft EA documents such as the Application Information Requirements, Aboriginal Consultation Plan, and Aboriginal Consultation Reports; and
- Response and follow up with Hwlitsum regarding the identification and resolution of issues.

2.2.4 Concerns Identified to Date

As outlined above, Hwlitsum’s concerns, identified through consultation undertaken to-date, are presented in **Appendix P2 Hwlitsum Overview Table**. The Ministry’s response to Hwlitsum’s key concerns regarding potential impacts on Hwlitsum’s Aboriginal Interests are outlined below:

Table 1 Concerns Identified to Date

| Concerns Identified to Date | Response |
|---|--|
| <p>Protection of Hwlitsum’s rights to harvest within the Project area.</p> | <p>Hwlitsum’s rights to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected.</p> |
| <p>Aboriginal participation and Project-related opportunities</p> <ul style="list-style-type: none"> • Potential employment, training, contracting and economic development opportunities • Community preparedness • Cultural recognition and naming • Revenue from tolling | <p>The Ministry is committed to working with Hwlitsum to identify potential employment, training, contracting and economic development opportunities and to identify ways to support community preparedness.</p> <p>The Ministry is exploring opportunities for cultural recognition and naming and will work with Hwlitsum on these opportunities.</p> <p>Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application.</p> |
| <p>Environmental Assessment (EA):</p> <ul style="list-style-type: none"> • Hwlitsum’s assignment on Schedule B as a sub-group of Penelakut • Adequacy of methodology to address social and cultural effects • Process and associated timelines • CEAA review | <p>The Ministry acknowledges the importance of Hwlitsum’s involvement in the environmental assessment process.</p> <p>Hwlitsum’s concerns related to Environmental Assessment including the their assignment on Schedule B, adequacy of methodology to address social and cultural effects, and process and associated timeline are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>The Ministry reviewed the need for a federal review with the federal government. The Project does not meet the Canadian Environmental Assessment Agency (CEAA) requirements for a federal review. Federal agencies, including Environment and Climate Change Canada, are members of the Technical Working Group</p> |

| Concerns Identified to Date | Response |
|---|--|
| <p>Effects to fish and fish habitat</p> <ul style="list-style-type: none"> • Importance of fish and fish habitat including species of cultural and economic importance such as eulachon, sturgeon and salmon • Potential effects of pile driving, blasting and underwater noise generated by Tunnel decommissioning and other construction activities | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, salmon to Hwlitsum and is committed to avoiding or mitigating any potential effects.</p> <p>The Ministry designed a clear span bridge over the Fraser River South Arm and Deas Slough to avoid or minimize Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Hwlitsum’s Fisheries Department continues to be very helpful in the review of Green Slough concepts.</p> <p>As outlined in Section 4.3 (Underwater Noise), sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources will be effectively mitigated by scheduling activities during period of low tide, when work can be completed under shallow water conditions or in the dry.</p> |
| <p>Social effects of the Project on Hwlitsum’s ability to transfer knowledge, language and participate in socio-cultural practices</p> | <p>Social effects of the Project on Hwlitsum’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C of the Application. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3 and Section 10.3 of Part C of the Application.</p> |

| Concerns Identified to Date | Response |
|---|---|
| <p>Potential effects of construction during fishing season on fishing activities. Effects of construction and decommissioning-related barging activities on Hwlitsum fishing.</p> | <p>Hwlitsum’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible direct effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined. Mitigation measures are outlined in Section 5.2.4 (Marine Use Mitigation Measures) of the Application.</p> |
| <p>Cumulative effects:</p> <ul style="list-style-type: none"> • Consideration of cumulative effects on Aboriginal rights • Absence of comprehensive study on cumulative effects on the Fraser River | <p>The Application includes historical context relating to changes in use over time by Hwlitsum and other Aboriginal Groups (i.e., cumulative effects on this use to date), where this information has been provided to the Ministry by Hwlitsum or was otherwise available from publicly available sources. However, there is no EAO requirement to assess incremental cumulative effects on the exercise of Aboriginal Interests separately of the cumulative effects assessments on VCs that are directly linked to the exercise of those Aboriginal Interests.</p> <p>While the Ministry acknowledges that Hwlitsum is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> |
| <p>Potential effects on Fraser River flow rates after Tunnel removal</p> | <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Flow rates are discussed in Section 4.1 (River Hydraulics).</p> |

| Concerns Identified to Date | Response |
|---|---|
| Potential effects of run off and drainage | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will ensure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected.</p> <p>Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> |

3.0 Community Profile – Hwlitsum

Members of the Hwlitsum community, who consider themselves descendants of the Lamalchi and close relatives of the Penelakut Tribe (i.e., from Kuper Island), reside in the area of Canoe Pass, and carry the Halkomelem name for this location (e.g., *Hwlhitsu'm*, *Xwulit'sum*). While Hwlitsum community members, who number over 300, are individually registered Indians under the *Indian Act*, they are not collectively recognized as a “band” under the *Indian Act* and do not have any reserves. The group is represented by a chief.

Hwlitsum report that early ethnographic sources often employ the term “Cowichan” to refer to a set of linked communities that include the Hwlitsum. Hwlitsum consider the “Island” dialect of Halkomelem as their ancestral language and have described themselves as related to but independent of the Cowichan Nation community.

In 2008, Hwlitsum’s Statement of Intent was accepted into the British Columbia Treaty Commission process. The Ministry understands that Canada and BC advised Hwlitsum at that time that they had decided to not continue negotiations to Stage 2 of that process.

3.1 Hwlitsum Aboriginal Interests: Existing Conditions

This section provides a high level of summary of past, present, and desired future use of the proposed Project area and surroundings for traditional purposes are or may be connected with the exercise of Hwlitsum’s Aboriginal Interests. A more detailed discussion, including sources used, is provided under Hwlitsum in **Section 10.1.3.2 Existing Conditions**.

3.1.1 General

- The Project is located within Hwlitsum territory, upstream of Hwlitsum’s current and traditional year-round residence at Canoe Pass and downstream of *Tl'uqtinus*, along the Fraser River in the vicinity of the north end of the George Massey Tunnel.
- Hwlitsum report that *Tl'uqtinus* was a home base occupied and used exclusively by the Cowichan Nation, of which the Hwlitsum consider themselves to be descendants. Hwlitsum have stressed, however, that they are independent of the Cowichan Nation community and consult on their own behalf.

3.1.2 Fishing

- Hwlitsum followed a seasonal round of resource use and regional settlement that involved spending summers on the Lower Mainland (March to November). Hwlitsum began living year-round at Canoe Pass, reported as the centre of Hwlitsum fishing, after 1863.
- While part of their salmon fishing season was also spent at *Tl'uqtinus*, all species of salmon, cutthroat, Dolly Varden, dogfish, flounder, steelhead, smelt oysters, crab, sturgeon, eulachon, and trout are or have been obtained by Hwlitsum at Canoe Pass or at nearby locations.
- Salmon, steelhead, trout, and sturgeon were also taken further up the Fraser River and its tributaries.
- Areas within the wider Fraser River estuary were also reportedly utilized by Hwlitsum for fishing salmon, sturgeon, groundfish, and other marine resources.
- Hwlitsum harvest crab and bivalve species such as clams, cockles, mussels, oysters, and abalone in the Gulf Islands.
- Shrimp are generally harvested throughout the Strait of Georgia (between the Gulf Islands and the Lower Mainland), as well as immediately west of the existing Roberts Bank terminals, with targeted shrimp harvesting at Sturgeon Bank.
- Other marine invertebrates taken include red and green sea urchin, octopus, squid and sea cucumber, all harvested on the western side of the Strait of Georgia

3.1.3 Hunting/Trapping

- Hwlitsum have hunted at “Canoe Pass and all along the Fraser River as far up as Hope and Yale”.
- Species harvested by Hwlitsum in the vicinity of the South Arm of the Fraser River have included seal, otter, muskrat (Westham Island), black duck, mallard, widgeon, geese (snow, Canada), brant, pintail, pigeon, pheasant (Ladner Reach), and red fox; at Burns Bog, deer, and black bear have been taken.
- Many of these species continue to be harvested by Hwlitsum members.

3.1.4 Gathering

- Hwlitsum have said they gathered up to 20 plant species from areas throughout their traditional round for food, medicinal, and other purposes.
- Plants said to be currently utilized in the area of Canoe Pass include cattails, rhubarb, crab apple, and plums. Ferns and alder (for firewood and smoking salmon) have been reported as collected at Burns Bog, with cottonwood having been gathered in the area of *Tl'uqtinus*. Hwlitsum also report harvesting marine plants, such as kelp, seaweed, and rockweed, from the Gulf Islands.

3.1.5 Archaeology and Cultural Heritage Interests

- No information on Hwlitsum’s interests with respect to archaeology were identified in the study prepared for this Project, *Hwlitsum Traditional Use and Occupancy Study 2015*, or in publicly available sources.
- Hwlitsum report that changes in resources and their use have disrupted community life and gatherings and that without fishing, hunting, and gathering, they will be unable to continue to pass on the teachings of generations of their ancestors.

3.1.6 Other Related Interests

- Hwlitsum have said that accessibility and availability of healthy local species for harvest within their traditional territory is important for food security as well as ritual and spiritual practices.

4.0 Potential Effects

This section provides a summary of the methodology used to identify potential adverse effects of the proposed Project on the exercise of Aboriginal Interests by Aboriginal Groups during Project construction and operation, followed by a summary of potential effects on Hwlitsum’s Aboriginal Interests, specifically. For a more detailed description of the methodology and a summary of the results, refer to **Section 10.1.3.3. Potential Effects**.

4.1 Methodology for Identification of Potential Effects

The first step in the effects assessment on Aboriginal interests was the identification of potential adverse effects on traditional use activities and related interests as a result of Project construction or operation. To evaluate these potential adverse effects, the findings of the following Valued Component (VC) chapters in Part B of the Application were considered, including identified mitigation measures, residual effects, cumulative effects and follow up strategies:

- **Section 4.4 Fish and Fish Habitat**
- **Section 4.6 Marine Mammals**
- **Section 4.7 Vegetation**
- **Section 4.8 Terrestrial Wildlife**
- **Section 5.2 Marine Use**
- **Section 5.3 Land Use**
- **Section 5.5 Visual Quality**
- **Section 6.1 Heritage Resources**
- **Section 7.1 Human Health**

The findings of the following Intermediate Component (IC) chapters were also considered in the assessment:

- **Section 4.1 River Hydraulics and River Morphology**
- **Section 4.2 Sediment and Water Quality**
- **Section 4.9 Air Quality**
- **Section 4.10 Atmospheric Noise**

The assessment of potential adverse effects of the Project on the exercise of Aboriginal Interests, including measures to address those effects, are presented in **Section 10.1.3.3** through **Section 10.1.3.5**, and largely applies the same methods used in Part B of the Application for the IC and VC assessments, as outlined in **Section 3.0 Assessment Methodology**.

In addition to information from the VC and IC assessments that support the assessment of potential effects on Aboriginal Interests, information from a Health Impact Assessment (HIA) undertaken to support Project planning, including mitigation recommendations, has been integrated into the assessment of potential effects on Aboriginal Interests. The HIA for the Project can be found at <https://engage.gov.bc.ca/masseytunnel>. A summary of the key findings is provided in **Section 7.2 Health Impact Assessment**.

4.2 Selection of Indicators

Four parameters were chosen as indicators to understand and evaluate potential Project-related effects on the exercise of Aboriginal Interests. The rationale for their selection is presented in the following table.

Table 2 Indicators for the Aboriginal Interests Assessment

| Indicator | Rationale for Selection |
|---|---|
| Access to preferred locations for the exercise of Aboriginal Interests | Project components or activities could result in changes in access to or patterns of travel between traditional use locations on land or water |
| Availability of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in distribution or movement, relative abundance, or habitat area or composition of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of preferred resources for the exercise of Aboriginal Interests | Project components or activities could result in changes in the real or perceived quality of traditional use resources (as informed by IC or VC assessments pertaining to these resources) in traditional use areas (as informed by information provided by Aboriginal Groups or available in public sources specific to the exercise of their Aboriginal Interests) |
| Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests | Project components or activities could result in: (1) direct sensory disturbance to traditional users (e.g., from noise, vibration); and/or (2) indirect changes to cultural practices, customs or traditions – i.e., cultural heritage or the expression and transfer of cultural values or ways of knowing (e.g., language, laws/governance, stories, spiritual beliefs) – tied to the cultural landscape or to the traditional use of specific traditional use locations or resources within that landscape. |

Potential adverse effects on the indicators noted above were analyzed in terms of the type and level of effect that Project components and activities may be expected to have on the exercise of Aboriginal Interests.

For the purposes of this assessment, no effect was understood to mean that no interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests would be expected. Where it was determined that an interaction, and potential effect, could occur, the following definitions were used to guide the characterization of the effect as negligible or measurable:

- Negligible – An interaction between Project components or activities and preferred locations or preferred resources for the exercise of Aboriginal Interests may occur, but modifications to the use of preferred options would not be expected.
- Measurable – Modifications to the exercise of Aboriginal Interests at preferred locations or in relation to preferred resources may be needed, and may be considered to be:
 - Minor (minimal or temporary modifications may be required to use preferred options),
 - Moderate (more frequent or longer term modifications may be required to use preferred options), or
 - Serious (permanent or indefinite modifications may be required potentially resulting in the loss of preferred options).

4.3 Identified Potential Effects

As noted above, the first step in evaluating potential adverse effects on Aboriginal Interests was a consideration of the findings for relevant Part B VCs and ICs, including identified mitigation measures, residual effects, cumulative effects and follow up strategies. The residual effects with the potential to result in an adverse effect on Aboriginal Interests are then carried forward in the assessment. Using the four indicators noted in the previous section, the potential Project-related effects and level of effect predicted in relation to Hwlitsum's exercise of Aboriginal Interests remaining after Part B mitigation are as follows:

Table 3 Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

Table 4 Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 5 Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| Water used for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |

Table 6 Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests

| | Construction | | Operation | | Residual Potential Effects |
|---|--------------|------------|------------|------------|----------------------------|
| | Negligible | Measurable | Negligible | Measurable | |
| River locations for traditional use as a result of changes to physical characteristics of these locations | ✓ | | ✓ | | |
| Instream locations for traditional use | ✓ | | ✓ | | |
| Upland locations for traditional use | ✓ | | ✓ | | |

| | Construction | | Operation | | Residual Potential Effects |
|--|--------------|------------|------------|------------|---|
| | Negligible | Measurable | Negligible | Measurable | |
| Water for cultural purposes | ✓ | | ✓ | | |
| Fish resources for traditional use | ✓ | | ✓ | | |
| Marine mammal resources for traditional use | ✓ | | ✓ | | |
| Terrestrial wildlife resources for traditional use | ✓ | | ✓ | | |
| Vegetation resources for traditional use | ✓ | | ✓ | | |
| Air quality | ✓ | | ✓ | | |
| Noise | ✓ | ✓ | ✓ | ✓ | <p>Construction - Potential temporary direct (minor) effect on quality of experience related to construction-related noise.</p> <p>Operation - Potential permanent direct (minor) effect on quality of experience related to traffic noise</p> |
| Ground-borne vibration | ✓ | | ✓ | | |
| Cultural landscape | | ✓ | | ✓ | <p>Construction - Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance</p> <p>Operation - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.</p> |

4.4 Potential Project-Related Effects Hwlitsum’s Aboriginal Interests

Using the methodology presented in **Section 10.1.3.3 Potential Effects**, Table 7 provides the potential incremental Project-related effects, following mitigation of Project-related effects on Part B VCs and ICs as described in Part B, related to Hwlitsum’s Aboriginal Interests as summarized in Existing Conditions were identified for construction and operation. A discussion of potential Project-related effects on fishing, hunting/trapping, gathering and archaeology and cultural heritage follows the table.

Table 7 Summary of Potential Project-Related Effects

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Project Construction | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential temporary direct (minor) effect on quality of experience related to construction-related noise • Potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |

| Indicator | Potential Project-Related Effect | Potentially-Affected Aboriginal Interests |
|--|---|--|
| Project Operation | | |
| Changes in Access to Preferred Locations for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Availability of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Preferred Resources for the Exercise of Aboriginal Interests | <ul style="list-style-type: none"> • None identified | <ul style="list-style-type: none"> • n/a |
| Changes in Quality of Experience in Exercising, or tied to the Exercise, of Aboriginal Interests | <ul style="list-style-type: none"> • Potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses • Potential permanent direct (minor) effect on quality of experience related to traffic noise • Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses | <ul style="list-style-type: none"> • Fishing • Hunting/Trapping • Gathering • Archaeology & Cultural Heritage • Other Related Interests |

4.5 Fishing

Hwlitsum harvest crab and bivalve species such as clams, cockles, mussels, oysters, and abalone in the Gulf Islands. Shrimp are generally harvested throughout the Strait of Georgia (between the Gulf Islands and the Lower Mainland), as well as immediately west of the existing Roberts Bank terminals, with targeted shrimp harvesting at Sturgeon Bank. Other marine invertebrates taken include red and green sea urchin, octopus, squid and sea cucumber, all harvested on the western side of the Strait of Georgia

The proposed Project has the potential to affect fishing practices through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred fishing locations by Hwlitsum, as a result of changes in river hydraulics or morphology, are expected to be negligible before mitigation. Potential changes in access to instream locations for fishing by Hwlitsum during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to fishing locations by Hwlitsum from instream construction activities are expected to be negligible. While it is acknowledged that Hwlitsum has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Mitigation measures identified in the fish and fish habitat assessment to address Project-related effects on fish are expected to be effective at addressing potential effects on the availability of fishing resources preferred by Hwlitsum. Further, as residual effects on fish identified in the fish and fish habitat assessment are not anticipated to affect population integrity, potential residual effects as a result of Project construction activities, would not be expected to measurably affect the availability of preferred fish resources.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of fishing resources preferred by Hwlitsum; therefore, Potential Project-related effects on Hwlitsum fishing would be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when fishing are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** are expected to largely address a potential Project-related effect to the quality of experience while fishing. At preferred fishing locations that overlap or are in proximity to known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Hwlitsum.

Section 5.5 Visual Quality predicts that residual effects to visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Hwlitsum is fishing. As this landscape has been previously modified, the potential Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Hwlitsum's Aboriginal Interests related to fishing are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.6 Hunting/Trapping

Hwlitsum have hunted at "Canoe Pass and all along the Fraser River as far up as Hope and Yale". Species harvested by Hwlitsum in the vicinity of the South Arm of the Fraser River have included seal, otter, muskrat (Westham Island), black duck, mallard, widgeon, geese (snow, Canada), brant, pintail, pigeon, pheasant (Ladner Reach), and red fox; at Burns Bog, deer, and black bear have been taken. Many of these species continue to be harvested by Hwlitsum members.

The proposed Project has the potential to affect hunting and trapping through changes in access to preferred locations, changes in availability of preferred locations, changes in quality of preferred resources and changes in quality of experience when fishing.

Potential changes in access to preferred hunting and trapping locations by Hwlitsum as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for hunting and trapping by Hwlitsum during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to hunting and trapping locations by Hwlitsum from instream construction activities, are expected to negligible. While it is acknowledged that Hwlitsum has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for hunting and trapping by Hwlitsum resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with hunting and trapping locations.

Mitigation measures identified in the marine mammal and terrestrial wildlife assessments are expected to be effective at addressing potential effects on the availability of hunting and trapping resources preferred by Hwlitsum. Therefore, Project-related effects on hunting and trapping related to potential changes in the availability of resources would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for hunting and trapping by Hwlitsum; therefore, Potential Project-related effects on Hwlitsum fishing would be expected to be negligible.

Project operation is not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when hunting and trapping are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** to address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while hunting and trapping. At preferred hunting and trapping locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Hwlitsum.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Hwlitsum is hunting and trapping. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Hwlitsum's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.7 Gathering

Hwlitsum have reported that they gathered up to 20 plant species from areas throughout their traditional round for food, medicinal, and other purposes. Plants said to be currently utilized in the area of Canoe Pass include cattails, rhubarb, crab apple, and plums. Ferns and alder (for

firewood and smoking salmon) have been reported as collected at Burns Bog, with cottonwood having been gathered in the area of *Tl'uqtinus*. Hwlitsum also report harvesting marine plants, such as kelp, seaweed, and rockweed, from the Gulf Islands.

The proposed Project has the potential to affect gathering through changes in access to preferred locations, changes in availability of preferred resources, changes in quality of preferred resources and changes in quality of experience when gathering.

Potential changes in access to preferred gathering locations by Hwlitsum as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations for gathering by Hwlitsum during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to gathering locations by Hwlitsum from instream construction activities, are expected to be negligible. While it is acknowledged that Hwlitsum has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations for gathering by Hwlitsum resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and is not expected to overlap with gathering locations.

Mitigation measures identified in the vegetation assessment to address Project-related effects on terrestrial vegetation are expected to be effective at addressing potential effects on the availability of resources for the exercise of Aboriginal Interests related to gathering. Therefore, Project-related effects on gathering related to potential changes in the availability of vegetation would be expected to be negligible after the implementation of mitigation identified in Part B of the Application.

Mitigation measures identified in the assessments in **Section 4.2 Sediment and Water Quality** and **Section 4.9 Air Quality** are expected to be effective at addressing potential effects on the quality of preferred resources for gathering by Hwlitsum; therefore, Potential Project-related effects on gathering related to potential changes in the quality of resources would therefore be expected to be negligible.

Project operation activities are not expected to lead to perceptible changes in ground-borne vibration levels or result in residual adverse changes in air quality; therefore, Project-related air quality or vibration effects on the quality of experience when gathering are either not expected or would be expected to be negligible.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** address changes in noise levels during construction and operation, would also be expected to address the potential Project-related effect to the quality of experience while gathering. At preferred gathering locations that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Hwlitsum.

Section 5.5 Visual Quality predicts that residual effects on visual quality may be experienced only within 1 km of the new bridge; however, the addition of a new feature to this landscape may affect the quality of experience when Hwlitsum is gathering. As this landscape has been previously modified, potential Project-related effects on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal.

Additional mitigation to address potential incremental Project-related effects on Hwlitsum's Aboriginal Interests related to gathering are proposed in **Section 10.1.3.4** and summarized below under Mitigation.

4.8 Archaeology and Cultural Heritage Interests

The proposed Project has the potential to affect Hwlitsum's Aboriginal Interests related to archaeology and cultural heritage through changes in access to preferred locations and changes in quality of experience.

Potential changes in access to locations related to Hwlitsum's archaeological and cultural heritage interests as a result of changes in river hydraulics or morphology are expected to be negligible before mitigation. Potential changes in access to instream locations related to Hwlitsum's interests related to archaeology and cultural heritage during Project operation are also expected to be negligible as the bridge is designed to be clear span.

Potential changes in access to locations related to Hwlitsum's archaeological and cultural heritage interests from instream construction activities are expected to be negligible. While it is acknowledged that Hwlitsum has reported a desire for higher levels of use in this portion of the river based on historic use, the episodic and short-term access effects that are anticipated as a result of instream Project-related construction activities are not expected to measurably affect their current or desired future use.

Potential changes in access to upland locations related to Hwlitsum’s archaeological and cultural heritage interests resulting from Project footprint effects during operation are expected to be negligible, as the majority of lands required for physical works is within the existing Highway 99 right of way and not expected to overlap with locations related to Hwlitsum’s archaeological and cultural heritage interests.

With regard to noise, mitigation measures proposed in **Section 4.10 Atmospheric Noise** would also be expected to address the potential Project-related effect to the quality of experience while undertaking activities related to cultural heritage. At locations related to Hwlitsum’s archaeological and cultural heritage interests that overlap, or are in proximity to, known noise-sensitive locations for which Project operation-related effects may not be fully mitigable or reversible, changes in noise levels as a result of Project operation could have an effect on the quality of experience at those locations for Hwlitsum.

As reported in **Section 6.1 Heritage Resources**, no archaeological or historical sites were identified within the Project area during fieldwork; however, there may be other locations with intangible cultural value or meaning to Hwlitsum (e.g., spiritual or storied sites, named places) potentially affected by the Project. In addition, physical alterations to the landscape may affect archaeological or historical sites, and how this landscape is experienced culturally.

As a result, mitigation measures proposed in Part B are not expected to address a potential incremental and permanent Project-related effect tied to Hwlitsum’s Aboriginal Interests related to archaeology and cultural heritage that may be associated with the introduction of a new prominent feature to the cultural landscape. As this landscape has been previously modified by anthropogenic changes, the potential incremental Project-related effect on the quality of experience tied to the exercise of Aboriginal Interests is expected to be minimal, but permanently disruptive for Hwlitsum, who have identified a historical connection to, and continued or desired use of, sites or places that help define the cultural landscape in the Project area.

Additional mitigation to address this potential incremental effect that is not otherwise addressed in the Application is proposed in **Section 10.1.3.4** and summarized below under Mitigation.

5.0 Mitigation

This section provides a summary of mitigation measures identified to address potential Project-related effects on the exercise of Aboriginal Interests by Hwlitsum. For a more detailed discussion, refer to **Section 10.1.3.4 Mitigation**.

Mitigation measures identified for the relevant VCs and ICs in Part B of the Application were reviewed to assess their effectiveness at addressing potential Project-related effects on the exercise of Aboriginal Interests related to those VCs. Examples of mitigation that are proposed in the Application to address potential effects on VCs and ICs, with the potential to result in an effect on Aboriginal Interests, include:

- Avoiding fisheries sensitive timing windows during key Project activities.
- Developing a Marine Access Management Plan to ensure marine use activities, including those supporting Aboriginal Interests, can continue during Project construction.
- Scheduling activities with the potential to generate underwater noise to avoid potential effects on marine mammals.
- Development and implementation of a Terrestrial Vegetation and Wildlife Management Plan with measures to minimize disturbance and loss of vegetation, prevent soil compaction, and minimize clearing in order to minimize effects on vegetation.

These measures are expected to be largely effective at avoiding, reducing, or otherwise managing potential Project-related effects on the exercise of Aboriginal Interests during Project construction and operation.

Recognizing some measurable effects on Hwlitsum's Aboriginal Interests could remain following the application of mitigation to address potential effects on the relevant VCs and ICs in Part B, the following additional measures have been identified to address such effects:

- Ongoing consultation with Hwlitsum regarding proposed measures, management plans, and monitoring programs related to intermediate components and valued components assessments; and
- Development of a Cultural Heritage Management Plan.

6.0 Residual Effects

With the implementation of mitigation measures identified in **Section 10.1.3.4** and summarized above, residual adverse effects of the proposed Project on the exercise of Aboriginal Interests are expected to be negligible (i.e., not measurable or detectable), and are not further assessed.

7.0 Summary and Conclusion

Part C of the Application builds on consultation undertaken to date to understand Hwlitsum's Aboriginal Interests and provides for an assessment of potential Project-related effects of the Project on Aboriginal Interests.

The Ministry began consultations with Hwlitsum prior to the submission of the Project Description, which is the end of the Initial Consultation Phase. Both EAO and the Ministry consulted with Hwlitsum during the Pre-Application Phase, which concluded with the submission of the Application. The main concerns expressed by Hwlitsum during consultations include:

- Adequacy of Environmental Assessment (EA) methodology to address social and cultural effects;
- Federal government participation in regulatory process and participation of federal government in Working Group;
- Hwlitsum's assignment on Schedule B as a sub-group of Penelakut;
- Potential impacts to Hwlitsum's Aboriginal Interests, including fishing, hunting and gathering;
- Cumulative effects;
- Effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon;
- Capacity funding for Traditional Use Study and to facilitate participation in the Project review process;
- Aboriginal participation and Project-related opportunities;
- Cumulative effects on Aboriginal Interests;
- Protection of archaeological and heritage resources and opportunities for cultural recognition and naming;
- Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations;
- Change in flow rates after Tunnel removal;
- Potential effects of the bridge structure, lighting, and noise on terrestrial wildlife, marine mammals, waterfowl, and migratory birds;
- Inclusion of culturally significant plants in planting plans and opportunity for Lyackson in the identification of plants, and planting work. Need for management of invasive plant species; and
- Potential effects of run off and drainage along the highway corridor, including heavy metal transport from traffic to water and land, management of runoff from the bridge.

Based on information provided by Hwlitsum and other publicly-available sources, the Ministry developed a summary of past, present and desired future use of the proposed Project area and its surroundings for the purposes of fishing, hunting/trapping, gathering, archaeology and cultural heritage interests and other related interests. This summary indicates that Hwlitsum has, does and intends to continue to use the Fraser River for cultural purposes.

Relying first on the results of the effects assessments for related VCs and ICs in Part B, the assessment of potential effects of Hwlitsum's Aboriginal Interests considered four indicators:

1. Access to preferred locations for the exercise of Aboriginal Interests;
2. Availability of preferred resources for the exercise of Aboriginal Interests;
3. Quality of preferred resources for the exercise of Aboriginal Interests; and
4. Quality of experience in exercising, or tied to the exercise of, Aboriginal Interests.

As reviewed in **Section 10.1.3.3** and **Section 10.1.3.4**, the mitigation measures, management plans, and monitoring programs identified in Part B of the Application for ICs or VCs linked to the exercise of Aboriginal Interests are expected to be largely effective at addressing the incremental Project-related effects noted above on the exercise of Aboriginal Interests by Hwlitsum, except in the following potentially measurable cases:

- Project construction:
 - Potential temporary direct (minor) effect on quality of experience related to construction-related noise and a potential temporary indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance
- Project operation:
 - Potential permanent direct (minor) effect on quality of experience related to traffic noise and a potential indirect (minor) effect on quality of experience (i.e., cultural heritage) tied to traditional uses that may be avoided due to direct sensory disturbance while engaged in those uses
 - Potential permanent indirect (moderate) effect on quality of experience (i.e., cultural heritage) tied to traditional uses due to visual disturbance to the cultural landscape that informs and supports those uses.

The following additional measures have been identified to address the above-noted effects:

- Ongoing consultation with Hwlitsum regarding proposed measures, management plans, and monitoring programs related to IC and VC assessments; and
- Development of a Cultural Heritage Management Plan.

With the implementation of mitigation proposed to address potential effects on VCs and ICs, as well as additional mitigation proposed to address potential residual effects on Aboriginal Interests, no effects on the exercise of Aboriginal Interests by Hwlitsum, as a result of the Project, are expected.

ENVIRONMENTAL ASSESSMENT PROCESS

An environmental assessment of the Project is required under the B.C. *Environmental Assessment Act* (B.C. *EAA*), S.B.C. 2002, c. 43, and permits to construct and operate can only be received once the environmental assessment process is complete and an Environmental Assessment Certificate (EAC) has been issued. If the Project is approved, an EAC will be awarded to and held by the Ministry. The Reviewable Projects Regulation B.C. Reg. 370/2002 under the B.C. *EAA* sets out the criteria for reviewable projects.

On December 16, 2015, the B.C. Environmental Assessment Office (EAO) issued a Section 10(1)(c) Order confirming that the Project is a reviewable project pursuant to the B.C. *EAA*, and that it requires an EAC.

The Project as proposed is not subject to review under the *Canadian Environmental Assessment Act, 2012*, S.C. 2012, c. 19, s. 52, since it does not meet the definition of a physical activity under the Schedule of Physical Activities in the Regulations Designating Physical Activities SOR/2012-147.

EAO is a neutral agency that manages the review of proposed major projects in British Columbia, as required by the *Environmental Assessment Act*.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------------|-------------------------|
| Social and cultural effects and the adequacy of Environment Assessment (EA) methodology. | <p>Concerns related to the adequacy of Environmental Assessment are outside the scope of the Project and have been referred to the Environmental Assessment Office (EAO).</p> <p>Social and cultural effects of the project are considered in Part C of the Environmental Assessment Application (Application). Where Aboriginal Groups values and perspectives have been provided to the Proponent regarding environmental, economic, social, heritage or health valued components (VCs), they have been incorporated, where applicable into the Part B assessment of those VCs.</p> | Referred to EAO | None |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|--------------------------|-------------------------|
| Strength of Claim assessment and related depth of consultation. | Concerns related to the strength of claim assessment have been referred to EAO and MARR. | Referred to EAO and MARR | None |
| Federal government participation in regulatory process and participation of federal government in Working Group. | Ministry reviewed the need for a federal review with the federal government. The Project did not meet the Canadian Environmental Assessment Agency (CEAA) requirements for a federal review. Federal agencies, including Environment and Climate Change Canada, are members of the Technical Working Group. | Addressed | None |
| Hwlitsum’s assignment on Schedule B as a sub-group of Penelakut | Concerns related to Hwlitsum’s assignment on Schedule B have been referred to the Environmental Assessment Office (EAO). | Referred to EAO | None |
| Request to be referred to as Hwlitsum First Nation | Hwlitsum’s request to be referred to as Hwlitsum First Nation is acknowledged; however, the name is reproduced verbatim from the Section 11 Order. Hwlitsum’s point that they have been recognized as a First Nation by government entities, including the BC Treaty Commission, has been added to Aboriginal Consultation Report #2 and to this Issues Summary Table. | Addressed | None |

ABORIGINAL INTERESTS

There are potential Project related impacts to Hwlitsum’s title, Rights and culture. Potential effects and the level of effect predicted include:

1. Access to preferred locations for the exercise of Aboriginal Interests (access to river locations for traditional use as a result of changes to physical characteristics of these locations).
2. Availability of preferred resources for the exercise of Aboriginal Interests (availability of fish, marine mammal, vegetation and terrestrial wildlife resources for Traditional Use).
3. Quality of preferred resources for the exercise of Aboriginal Interests (quality of water used for cultural purposes, quality of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use).
4. Quality of experience of exercising, or tied to the exercise, of Aboriginal Interests (quality of experience tied to the traditional use of river locations as a result of changes to the physical characteristics of the location; quality of experience tied to access of instream and upland areas locations for traditional use; quality of experience tied to use of water for traditional purposes; quality of experience tied to the traditional use of fish, marine mammal, vegetation and terrestrial wildlife resources for traditional use; and quality of experience while engaged in or tied to traditional use as a result of changes in air quality, noise, ground-borne vibration and to the cultural landscape).

Measureable Effects

Access for traditional use

- Cultural landscape

Quality of experience while engaged in or tied to traditional use

- cultural landscape

No, Negligible or Moderate Effects

Quality of experience while engaged in or tied to traditional use

- Noise

Negligible Effects

Access for traditional use

- Instream locations
- River locations
- Upland locations

ABORIGINAL INTERESTS

Quality for Traditional Use

- Water
- Fish resources
- Marine mammal resources
- Vegetation resources

Quality of experience while engaged in or tied to traditional use

- Fish resources
- Instream locations
- Marine mammal resources
- River locations
- Terrestrial wildlife resources
- Upland locations
- Water
- Vegetation resources

Availability for Traditional Use

- fish resources
- Marine mammal resources
- Terrestrial wildlife resources
- Vegetation resources

No to Negligible Effects

Quality of experience while engaged in or tied to traditional use

- changes to the cultural landscape

No or Negligible Effects

Quality of experience while engaged in or tied to traditional use

- Air quality
- Ground-borne vibration

ABORIGINAL INTERESTS

High, Short-term Probability of Effect

- Disturbance to residential, commercial and industrial land uses
- Disturbance to recreational uses near the new bridge

Moderate, Long-term Probability of Effect

- Disturbance to visual quality

Low, Short-term Probability of Effect

- Barn swallow habitat loss (construction period)
- Physical injury or mortality to fish through crushing or entrainment (construction period)

Low, Long-term Probability of Effect

- Barn owl mortality

No Significant Residual or Cumulative Effects

- Air quality
- Fish and fish habitat
- Heritage resources
- Marine access
- Marine mammals
- River hydraulics and river morphology
- Sediment and water quality
- Terrestrial Wildlife
- Vegetation

The Ministry has developed mitigation measures to address these Potential effects. Residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Hwlitsum “is greatly concerned that the Project will negatively impact our ability to fish, hunt and gather as we have done since time immemorial. These practices are central and integral to our Hwlitsum and Coast Salish identity and without them, we are unable to continue to pass on the teachings of generations of our ancestors.”</p> | <p>Hwlitsum’s ability to harvest within the Project area are addressed in Part C of the Application.</p> <p>With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections 4.4.4 (Fish and Fish Habitat Mitigation Measures), 4.6.4 (Marine Mammals Mitigation Measures), 4.7.4 (Vegetation Mitigation Measures), and 4.8.4 (Terrestrial Wildlife Mitigation Measures)</p> |
| <p>Hwlitsum’s access to the Fraser River and the potential to displace fishing vessels.</p> <p>Potential interference with Aboriginal fisheries during decommissioning of the Tunnel and the importance of working closely with communities to ensure negative effects are avoided.</p> | <p>Hwlitsum’s access to the Fraser River and the potential to displace fishing vessels (access to river locations for traditional use as a result of changes to physical characteristics of these locations) is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined. A negligible effect on access to instream locations for traditional use and a negligible effect to upland locations for traditional use has been determined.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation measures outlined in Section 5.2.4 (Marine Use Mitigation Measures)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Social effects of the Project on knowledge transmission, language loss, dependency and social interaction.</p> | <p>Social effects of the Project on Hwlitsum’s ability to transfer knowledge, language and participate in socio-cultural practices are discussed in Part C. Specifically, potential effects on cultural heritage (such as the ability to transfer knowledge, language, and participate in socio-cultural practices that support the maintenance of this heritage within and between generations) are considered through both direct and indirect effect pathways on the exercise of Aboriginal Interests as a result of Project components or activities. This analysis, which was dependent on cultural heritage information provided by Aboriginal groups or otherwise available through public sources, occurs predominantly within Section 10.1.3.3 Potential Effects of Part C of the Application, with results also provided on a nation-by-nation basis in Section 10.1.3.8 and Section 10.3 of Part C of the Application.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in all Sections of the Application</p> |
| <p>Protection of Hwlitsum’s rights to harvest within the Project area. Importance of ensuring fish and fish habitat is protected for future generations of Hwlitsum.</p> | <p>Hwlitsum’s rights to harvest within the Project area are addressed in Part C of the Application. With the implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife, residual effects on the exercise of Aboriginal Interests by Hwlitsum as a result of the Project are not expected.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures in Sections 4.4 (Fish and Fish Habitat), 4.6 (Marine Mammals), 4.7 (Vegetation), and 4.8 (Terrestrial Wildlife)</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|------------------|-------------------------|
| <p>Consideration of cumulative effects on aboriginal rights, including measurement against a pre-industrial baseline.</p> | <p>The Ministry’s cumulative effects assessment looked at potential incremental environmental effects of construction and operation of the Project in conjunction with other present and reasonably foreseeable projects that could interact with the potential effects of this Project. The process and methodology used to conduct the cumulative effects assessment, including the identification of potential cumulative effects, identification of additional mitigation measures, and evaluation of any (residual) cumulative effects is outlined in Part B of the Application. Other Projects that are considered in the assessment of Project-related cumulative effects are also listed.</p> | <p>Addressed</p> | <p>None</p> |
| <p>Absence of a comprehensive study of cumulative effects on the Fraser River.</p> | <p>While the Ministry acknowledges that Hwlitsum is interested in a comprehensive study of cumulative effects on the Fraser River, this is outside the scope of the Project.</p> | <p>Addressed</p> | <p>None</p> |

ABORIGINAL CONSULTATION

Aboriginal Interests, defined as asserted or determined Aboriginal rights, including title, and treaty rights, are known to overlap or lie in the vicinity of the Project corridor. Potential adverse effects on the exercise of Aboriginal Interests as a result of Project construction and operation have been identified.

Mitigation measures to address potential Project-related effects on intermediate components (ICs) and valued components (VCs) associated with the exercise of Aboriginal Interests are expected to be effective. With the application of mitigation, potential effects on the exercise of Aboriginal Interests are predicted to be negligible except in specific cases during Project construction and operation. To address potential effects during Project construction and operation, the development of an Archaeological and Heritage Resources Management Plan is proposed.

In addition to mitigation measures proposed to address potential effects on ICs and VCs, ongoing engagement between the Ministry and Schedule B Aboriginal Groups will be undertaken. Such engagement will take place during Application Review and, if the Project is approved, following the issuance of an Environmental Assessment Certificate (EAC). Engagement will involve consultation on management plans and monitoring programs, related to the exercise of Aboriginal Interests.

Ongoing engagement is also proposed to address other matters of environmental, economic, social, heritage, and health concern raised by Aboriginal Groups during the pre-Application period. With this ongoing engagement, residual effects on the exercise of Aboriginal Interests or other matters of concern as a result of the Project are not expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|-----------|---|
| Capacity funding to facilitate participation in the Project review process. | Hwlitsum received funding for the Pre-Application Phase. The Ministry will provide further funding for the Application Review Phase. | Addressed | Consultation regarding funding for the Application Review Phase |
| Appropriate use of information shared by Hwlitsum as it relates to confidentiality and dissemination. | The Ministry understands and respects that certain information shared by Hwlitsum may be considered confidential. The Ministry is subject to the provisions of the <i>Freedom of Information and Protection of Privacy Act</i> . However, subject to the requirements of applicable laws, the Ministry will respect Hwlitsum requests to keep information confidential. | Addressed | Appropriate use of confidential information |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|-----------|-------------------------|
| Importance of having opportunities for the community to learn about the Project. | The Ministry met with the Hwlitsum community and will continue to work with Hwlitsum in accordance with the Aboriginal Consultation Plan. | Ongoing | Ongoing consultation |
| Traditional Use Study: <ul style="list-style-type: none"> • Funding for Traditional Use Study (TUS). • Amount of funding provided for TUS. | The Ministry signed a funding agreement with Hwlitsum which provided funding for a Traditional Use Study. | Addressed | None |

ABORIGINAL PARTICIPATION AND PROJECT-RELATED OPPORTUNITIES

The Ministry is actively exploring opportunities to provide benefits, economic and non-economic, to Aboriginal Groups that are directly affected by the Project. Opportunities include employment, training, and contracting as well as participation in environmental enhancement and other components of the Project.

Prior to the Pre-Application Phase of the Project, the Ministry worked with Schedule B Aboriginal Groups to determine appropriate tools to support consultation. Consultation activities were based on the specific needs and preferences of these Aboriginal Groups and the Consultation Plan included individualized plans that were co-developed and reviewed.

The Project's Aboriginal Consultation Plan has been developed in consultation with Schedule B Aboriginal Groups, in order to meet the Aboriginal consultation requirements as delegated by EAO and to maintain and, where possible, enhance positive working relationships between the Ministry and the respective Aboriginal Groups.

The objectives and requirements of the Aboriginal Consultation Plan are to:

- Provide relevant Project-related information in a timely and effective manner that supports an understanding of the nature of the Project and its potential adverse effects on Aboriginal Interests
- Plan and implement mutually acceptable consultation activities that support effective participation of Aboriginal communities in the EA as well as related regulatory and permitting processes
- Establish and maintain dialogue throughout the EA as a means of providing opportunities to respond to outstanding concerns
- Provide opportunities for Aboriginal Groups to share views of the Project with the Ministry and EAO within reasonable timeframes
- Provide opportunities for Aboriginal Groups to identify potential adverse effects of the proposed Project on Aboriginal Interests, including cumulative effects and, to the extent appropriate, develop ways to mitigate or otherwise accommodate potential adverse effects
- Involve Aboriginal Groups, where possible, in relevant studies including, but not limited to, archaeological fieldwork.
- Incorporate community and traditional knowledge in Project components

Document and report to EAO on the Ministry's Aboriginal consultation program at times specified by EAO.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|-----------|---|
| Opportunities for cultural recognition and naming. | The Ministry is exploring opportunities for cultural recognition and naming and will work with Hwlitsum on this matter. | Ongoing | Discussions with Hwlitsum to explore opportunities related to cultural recognition and naming, art and interpretive signage |
| Project-related employment, training, contracting, and economic development opportunities. | The Ministry is committed to working with Hwlitsum to identify potential opportunities to benefit from the Project. Ministry acknowledges that Aboriginal Groups want to prepare their membership for employment opportunities and will work with Hwlitsum to identify ways to support community preparedness. | Ongoing | The Ministry will share information as it becomes available to support community preparedness and welcomes input from Hwlitsum on the type of information that would be useful. |
| Revenue sharing opportunities from tolling. | Revenue from tolling is only used to defray the costs of designing, constructing, operating and maintaining highways. A discussion on tolls is included in Sections 1.0 and 5.1 of the Application. | Addressed | None |

4.1 RIVER HYDRAULICS

The proposed bridge will have a clear-span, which eliminates potential changes to river hydraulics or river morphology resulting from the new structure. The Fraser River South Arm is dynamic with scour in the order of several metres during freshet and migrating sand dunes with heights of up to four metres. Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor. Tunnel removal is expected to result in temporary bed lowering between the Tunnel and Lulu Island-Delta water main; however, no permanent effect on the Lulu Island-Delta watermain is expected.

Effects

A negligible effect to access to river locations for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of river locations has been determined.

Mitigation

Monitor the riverbed within 100 metres upstream and downstream of the watermain.

Stockpile appropriately-sized rock near the Project site, for priority scour protection repairs at the water main crossing.

Establish on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal, to ensure that scour protection repairs can be designed and implemented on short notice

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|---------------------------------|--|
| <p>Change in flow rates after Tunnel removal.</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects to river hydraulics and river morphology within the Fraser River South Arm.</p> <p>Removal of the Tunnel is not expected to result in any changes in water level or flow splits between the main channel and nearby channels. Suspended sediment load in the Fraser River is naturally high and the temporary increase in suspended sediments anticipated during Tunnel removal is expected to be relatively minor.</p> <p>River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.1.4</p> |
| <p>Lack of inclusion of Deas Slough and the stagnant waters east by the rowing club in the river hydraulics and morphology study.</p> | <p>Deas Slough and the stagnant waters east by the rowing club were included in the River Hydraulics and River Morphology study. River Hydraulics and River Morphology are addressed in Section 4.1.</p> | <p>Addressed</p> | <p>None</p> |

SEDIMENT AND WATER QUALITY

The proposed bridge will have a clear-span, which reduces potential effects to sediment and water quality within the Fraser River South Arm. During Tunnel decommissioning, a minor, temporary increase in turbidity, as compared with baseline conditions, is anticipated. No appreciable change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated.

Effects

A negligible effect on quality of water used for cultural purposes has been determined.

A negligible effect on quality of experience tied to use of water for cultural purposes has been determined.

Mitigation

Avoid effects through Project design.

Incorporate a stormwater collection and distribution system (stormwater detention ponds and biofiltration swales) into bridge design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment.

Develop Construction Environmental Management and Operational Environmental Management plans.

Control suspended sediment during Tunnel decommissioning. Employment of construction methods that minimize levels of Project-induced turbidity. Use spoil barges equipped with sediment containment system (filter cloth, concrete lock blocks, straw bales) to transport removed material off-site.

Control suspended sediment during Project construction in and adjacent to Deas and Green Sloughs. Use of sediment control measures such as turbidity curtains and de-watered cofferdams.

Monitor water quality during construction.

Use timing windows for undertaking in-stream works.

Residual & Cumulative Effects

No Project-related residual or cumulative effects on river hydraulics and river morphology or sediment and water quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|--|
| <p>Potential effects of run off from bridge and tunnel decommissioning</p> | <p>The proposed bridge will have a clear-span, which reduces potential effects on sediment and water quality within the Fraser River South Arm associated with Project construction and operation. During Tunnel decommissioning, a minor, temporary increase in turbidity is anticipated. No appreciative change in water quality, related to the re-suspension or re-distribution of sediments during Tunnel decommissioning, is anticipated. Elements of the Project design, including the use of bio-filtration ponds, will provide a benefit by improving the level of treatment of surface runoff from Highway 99. Applying mitigation, including timing windows for undertaking in-stream works, will insure that Project-related effects on water quality are effectively mitigated. No Project-related residual or cumulative effects on sediment and water quality are expected. Sediment and Water Quality is addressed in Section 4.2 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.2.4</p> |

4.4 FISH AND FISH HABITAT

The proposed bridge will have a clear span over the Fraser River South Arm and Deas Slough, avoiding or minimizing Project-related effects on fish and fish habitat. The small area of fish habitat affected by the Project will be offset or improved by proposed habitat enhancements, including restoring Green Slough to its historic alignment, to achieve net environmental benefits for fish and fish habitat. Given the disturbed nature of much of the Project alignment, re-vegetation and restoration of areas within the Project alignment, including under the new bridge and adjacent to relocated ditches, represents an opportunity to provide a net improvement to ecological conditions. The productive capacity of local ecosystems will be enhanced by improvements to local water quality; removal of non-native species; and replanting with species that provide habitat value for fish and wildlife.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

Mitigation

Avoid effects through Project design.

Apply best management and environmental management practices.

Develop Construction Environmental Management and Operational Environmental Management plans.

Use timing windows for undertaking in-stream works.

Erosion and sediment control.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of physical injury or mortality to fish through crushing or entrainment during the construction period.

No significant Project-related residual or cumulative effects on fish and fish habitat are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects to fish and fish habitat, including species of cultural and economic importance such as eulachon, sturgeon, and salmon.</p> <p>Hwlitsum consider the creation and preservation of habitat for fish and wildlife as a key concern and priority.</p> <p>Hwlitsum have a strong connection to the Project area and to the river and are concerned with any additional impacts on fish and fish habitat.</p> <p>Elders are concerned with habitat loss partly due to “the mismanagement of fisheries by DFO” and expressed concerns related to future generations and practice of traditional activities.</p> <p>“What I say about the loss of these fish, including eulachons, is it is death by a 1000 cuts”</p> | <p>The Ministry understands the significance of culturally and economically important fish such as eulachon, sturgeon, and salmon to Hwlitsum and is committed to avoiding or mitigation any potential effects. Fish and Fish Habitat are discussed in Section 4.4</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.4.4</p> |

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential effects of underwater noise generated by Tunnel decommissioning and other construction activities on migrating salmon.</p> | <p>Sources of construction-related underwater noise such as driving piles along the edges of Deas Slough will be temporary in nature. Propagation of underwater noise from these sources can be mitigated effectively by scheduling such activities during periods of low tide, when work can be completed under shall water conditions or in the dry, thereby minimizing potential effects. No Project-related residual or cumulative effects on underwater noise conditions are expected. Underwater Noise and Fish and Fish Habitat are addressed in Sections 4.3 and 4.4 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in 4.3.4 and 4.4.4</p> |

4.6 MARINE MAMMALS

Marine mammals, specifically harbor seals and sea lions, are known to use marine areas within the Project alignment. Other species of conversation interest, including southern resident killer whales, do not occur in the Fraser River.

Underwater noise during construction is the key area of focus for potential Project-related effects on marine mammals. Underwater noise in the Fraser River South Arm from existing sources currently exceeds thresholds for disturbance to marine mammals approximately 20% of the time. The distance from source within which seals could hear underwater noise generated by construction activities is estimated at no more than 7.5 km.

Effects

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

Mitigation

Apply standard industry and best management practices to activities such as pile driving that have the potential to generate underwater noise to ensure sound thresholds for the protection of marine mammals are adhered to.

Marine Mammal Management Plan to be incorporated into the Construction Environmental Management Plan

Monitor underwater noise.

Cumulative Effects

No significant Project-related residual or cumulative effects on marine mammals are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Marine Mammals. | | | |

4.7 VEGETATION

The Highway 99 corridor is a highly developed area and vegetation along the Project alignment reflects the influence of past development.

Project components and activities will be primarily located within the existing Highway 99 right-of-way, where the vegetation consists mainly of grassy, mowed verges. Through Project planning, the Ministry has taken steps to avoid or minimize Project-related effects on at-risk ecosystems, primarily cattail marsh and estuary marsh that occur in the vicinity of the Project. No at-risk vegetation species were observed during field surveys and their presence is unlikely, given the disturbed nature of habitats present.

Effects

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to best management and environmental, terrestrial vegetation and wildlife management practices. Apply best practices such as flagging of at-risk ecosystems to avoid encroachment during construction.

Offset and enhance habitat. Create comparable habitat within the Project alignment to offset unavoidable potential Project-related effect, limited to a small reduction in area of the cattail marsh that overlaps with Project components. Replant disturbed areas with native species.

Invasive species management.

Cumulative Effects

No significant Project-related residual or cumulative effects on vegetation are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Invasive plant species and proposed plans to manage presence during construction.</p> | <p>Mitigation and management of invasive species are presented in Section 4.7 of the Application. The Ministry will develop and implement an Invasive Species Management Plan as part of the Construction Environmental Management Plan.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.7.4 (Vegetation Mitigation Measures)</p> |
| <p>Inclusion of culturally significant plants in planting plans and opportunity for Hwlitsum in the identification of plants, and planting work.</p> | <p>Planting plans will be developed during later stages of Project planning and design. Opportunities for inclusion of culturally significant plants in in planting plans will be considered at that time. The Ministry will consult Aboriginal Groups on the development of these plans.</p> | <p>Addressed</p> | <p>The Ministry will develop planting plans with consultation from Aboriginal Groups</p> |

4.8 TERRESTRIAL WILDLIFE

The Highway 99 corridor is a highly developed area and terrestrial wildlife has generally adapted to this current condition. Terrestrial wildlife along Highway 99 consists primarily of raptors, riverine birds, and small mammals. Barn owl foraging habitat has been identified along vegetated sections of Highway 99 and barn/cliff swallow nesting has been noted under the Deas Slough Bridge. No Pacific water shrew occurrence, and limited habitat potential, was identified within or adjacent to the Project alignment.

Effects

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

Mitigation

Minimize potential effects through Project design.

Adhere to terrestrial vegetation and wildlife management best practices such as spatial and temporal avoidance, pre-construction surveys and nest survey protocols, wildlife salvage and translocation, flagging and management of sensitive areas, and timing window restrictions.

Habitat enhancement and offsetting.

Residual & Cumulative Effects

There is a low, short-term probability of barn swallow habitat loss during the construction period. The new bridge will provide new nesting opportunities for barn swallows.

There is a low, long-term probability of barn owl mortality.

No significant Project-related residual or cumulative effects on terrestrial wildlife are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Potential light and noise effects on wildlife</p> | <p>The Ministry understands that Hwlitsum is concerned with the potential effects of light and noise on species such as waterfowl, bats and migratory birds. Construction best practices, including flagging of sensitive wildlife habitat and adhering to least-risk timing windows will ensure construction-related effects on wildlife and wildlife habitat are effectively addressed. Project-related effects on wildlife and wildlife habitat. Potential Project-related effects on terrestrial wildlife are presented in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |
| <p>Potential effects of the bridge structure on species such as waterfowl and migratory birds. Concern with the effects of the Project on species hunted by Hwlitsum such as on ducks and geese</p> | <p>The Ministry understands that Hwlitsum is concerned with the potential effects of the new bridge structure on species such as mammals, waterfowl, bats, eagles and migratory birds including ducks and geese. Installation of flight deflectors such as hedgerows at appropriate locations along the highlight will mitigate potential Project-related increase in traffic collision risk. Terrestrial Wildlife in addressed in Section 4.8 of the Application.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures outlined in Section 4.8.4</p> |

4.9 AIR QUALITY

Ambient air quality in the vicinity of the Highway 99 corridor has improved in recent years and will continue to improve with or without the Project. These projected future improvements are partly linked to reductions in emissions from vehicles as new emission control technologies are phased in.

Project-related reduction in idling due to congestion, and consequent reduction in emissions, is expected to result in further improvement in air quality. Anticipated Project-related improvements by 2031 include a 35% reduction in particulate matter emissions, as compared with a 14% reduction without the Project; a 47% reduction in volatile organic compound emissions, as compared with a 40% reduction without the Project; and no exceedances of the current most stringent air quality objectives for specific air contaminants, as compared with two predicted exceedances without the Project.

The new bridge will also allow for better dispersion of vehicle emissions and avoid accumulation of emission-related air contaminants at specific locations such as at the Tunnel portals, where they accumulate today.

Greenhouse gas emissions from traffic along the Highway 99 corridor are expected to decrease, with or without the Project, as newer engine technologies provide substantial reductions in overall CO₂e emission levels. Project-related reduction in idling due to congestion is anticipated to result in a further 5% to 6% reduction in GHG emissions.

Effects

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

Mitigation

Minimize effects through Project design.

Implement recognized mitigation measures and best management practices that have proven to be effective on other transportation projects.

Development of an Air Quality and Dust Control Management Plan for inclusion of the Construction Environmental Management Plan.

Measure and monitor vehicle emissions and road dust during Project operation.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Air Quality. | | | |

4.10 ATMOSPHERIC NOISE

The Project is located in an area where ambient noise levels are generally high, dominated by noise from traffic on Highway 99 and connecting roadways. Once the new bridge and upgraded highway become operational, ambient noise levels at the majority of residential receptors along the Project alignment are expected to be lower than current noise levels. Noise levels at parks adjacent to the Project, including Deas Island Regional Park, will increase by varying degrees dependent on the distance from the highway but do not exceed what is acceptable for residential, educational or institutional facilities.

Effects

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

Mitigation

Minimize effects through Project design.

Adhere to construction best practices and the Ministry’s 2014 *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways*.

Develop and implement a Noise Management Plan.

Residual & Cumulative Effects

With the application of mitigation, no significant Project-related residual or cumulative effects on air quality are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Atmospheric Noise. | | | |

5.2 MARINE USE

The Fraser River South Arm supports a variety of marine uses, including deep sea and domestic shipping, materials handling, log storage, and sorting and booming, as well as commercial, recreational and Aboriginal fishing activities. In addition, recreational boating, supported by marinas and a rowing club located in Deas Slough, take place within the vicinity of the Project.

A clear span crossing of the Fraser River is proposed to avoid impacts to marine use and the existing three span Deas Slough Bridge will be replaced with a clear span to improve navigation in and out of the slough.

Project-related effects on marine use may include temporary constraints on access and use of sections of the Fraser River South Arm and Deas Slough during construction.

Effects

A negligible effect on access to instream locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Develop and implement a Marine Access Management Plan to ensure that important marine use activities can be reconciled with temporary constraints associated with Project construction.

Establish communications protocols to advise in-stream construction activities.

Ensure appropriate lighting and marking for safe navigation.

Establish navigation protection zones during construction to avoid or minimize impact on marine use.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|---|---------------------------------|---|
| <p>Potential effects of construction during fishing season on fishing activities.</p> <p>Impacts of Tunnel decommissioning on Aboriginal fisheries, specifically as it relates to timing.</p> | <p>Potential interference with Hwlitsum fisheries during bridge construction is addressed in Part C of the Application (in Section 10.1.3.2 and 10.1.3.8.7). A negligible effect to access to river locations for traditional use as a result of changes to the physical characteristics of these locations has been determined.</p> <p>The Ministry understands the importance of working closely with Aboriginal Groups to ensure negative effects are avoided.</p> | <p>Addressed in Application</p> | <p>Ongoing consultation and implementation of mitigation measures outlined in Section 5.2.4</p> |
| <p>Facilitation of increased shipping in the river. “Our concern being a salmon culture is there would be a build-up of ships which makes it impossible for us to fish and puts us in hazardous situations”.</p> | <p>The Project will not appreciably increase the size, or volume, of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Other factors, including the Metro Vancouver water main to the west of the Tunnel, other utility crossings, and the width of the river itself, limit the size of vessels that can navigate the river.</p> | <p>Addressed in Application</p> | <p>None</p> |

5.3 LAND USE

The majority of the Project alignment is located on provincial Crown land, including submerged land on the Fraser River bed, within the existing Highway 99 right-of-way. Land uses in areas adjacent to the highway include agriculture, industrial, institutional, mixed commercial and residential, parkland, and the Vancouver Landfill in Delta.

The Project is consistent with local and regional land use plans, and will support long-term economic growth and encourage denser, land-intensive, high-quality forms of development consistent with such plans. The Project is not anticipated to affect regional growth trends or current trends for industrial land use and development. The Project aligns with adjacent land uses that have evolved along the highway 99 corridor.

Once the new bridge becomes operations, recreational experience in its vicinity is expected to change due to improvements in local air quality, shoreline restoration of Deas Island, and re-vegetation of areas currently supporting highway infrastructure; improved connectivity across the Deas Island Regional Park resulting from removal of the Tunnel portals; and shading adjacent to the bridge, overhead noise, and changes in local viewsapes.

The Project will not result in changes to existing land use beyond small amounts of land, outside of the existing right-of-way, that area required for the Project.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

Mitigation

Minimize effects through Project design.

Address temporary effects on existing land use during construction and incorporate land use considerations into a Traffic Management Plan.

Incorporate land use considerations into a Marine Construction Plan.

Reconnect recreational trails.

Residual & Cumulative Effects

There is a high, short-term probability of disturbance to residential, commercial and industrial land uses.

There is a high, short-term probability of disturbance to recreational uses near the new bridge.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|--|--|---------------|--------------------------------|
| Interest in the inclusion of a single multi-use pathway. | The Project will include multi-use pathways on both sides of the new bridge, which will provide new and enhanced opportunities for cycling and pedestrians, as well as enhanced connections to community trails and cycling routes for interchange and overpass reconstructions. | Addressed | None |

5.5 VISUAL QUALITY

The new bridge will add noticeable visual features to the landscape and will change visual conditions adjacent to the Project alignment. Replacement of interchanges also has the potential to change visual conditions of these locations. At distances greater than one kilometer, the bridge deck will merge with the natural landscape and the main visual features will be the bridge towers. Changes in visual quality at interchanges will be minor as visual quality in such areas is currently influenced by existing transportation infrastructure.

Effects

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Minimize effects through Project design.

Use of vegetated buffers to minimize visual effects to residential developments within close proximity to the bridge in Delta.

Residual & Cumulative Effects

There is a moderate, long-term probability of disturbance to visual quality.

No significant Project-related residual or cumulative effects on marine access are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---------------------------|--------|-------------------------|
| Hwlitsum has not voiced any specific issues or concerns with respect to Visual Quality. | | | |

6.1 HERITAGE RESOURCES

The Project is located in an area where substantial historical development has occurred and the majority of the Project alignment is characterized as having low archaeological potential. No archaeological or historical sites were found within the Project alignment during the field inventory of the Project area.

Effects

A negligible effect on access to upland locations for traditional use has been determined.

A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.

During construction, no to negligible effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

During operation, a measurable effect on quality of experience while engaged in or tied to traditional use as a result of changes to the cultural landscape.

Mitigation

Develop and implement a Heritage Resources Management Plan, which will include a change find procedure, to avoid impacts to previously unknown heritage resources that may be encountered during Project construction and operation.

Undertake additional archaeological surveys.

Residual & Cumulative Effects

No significant Project-related residual or cumulative effects on heritage resources are expected.

| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|--|---------------------------------|--|
| <p>Protection of archaeological and heritage resources, including intangible heritage sites and specific concern for any effects on the ǻǻqtinǻs/Tl'uqtinus site and potential archaeological values at interchanges.</p> | <p>The Ministry acknowledges that protection of archaeological sites as well as intangible heritage sites are of utmost importance to Hwlitsum.</p> <p>All Aboriginal Groups have been provided with a comprehensive list of these sites, the Archaeological Overview Assessment, the Archaeological Impact, and Heritage Resources Overview Assessment.</p> <p>Appropriate measures will be taken to ensure the protection of archaeological and heritage resources as outlined in Section 6.1.</p> | <p>Addressed in Application</p> | <p>Implementation of mitigation measures as outlined in Section 6.1.4</p> |
| <p>Participation in archaeological fieldwork and review of archaeological draft reports.</p> | <p>Hwlitsum will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports</p> | <p>Addressed</p> | <p>Hwlitsum will be invited to participate in any additional archaeological fieldwork required for the Project and will have an opportunity to review related reports.</p> |

7.0 HUMAN HEALTH

Predicted Project-related improvements in local and regional air quality, primarily due to reductions in congestion-related idling, are anticipated to have a positive effect on human health. The Project is anticipated to improve health equity by providing disadvantaged groups with better access to reliable transportation options. The Project will result in additional health benefits related to greenhouse gas emissions reductions, increased active and public transportation, improved traffic safety, improvement connectivity and access, improved emergency response, and economic development opportunities.

Future Project-related consultation with Aboriginal groups represents an important opportunity to address health interests specific to Aboriginal communities that have been identified in the health impact assessment.

Planned future engagement with a broad range of stakeholders will help to optimize Project benefits associated with improvements to active transportation options such as cycling, addressing safety and security considerations, and emergency response.

Effects

A negligible effect on the availability of fish resources for traditional use has been determined.

A negligible effect on quality of fish resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of fish resources has been determined.

A negligible effect on the availability of marine mammal resources for traditional use has been determined.

A negligible effect on quality of marine mammal resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of marine mammal resources has been determined.

A negligible effect on the availability of vegetation resources for traditional use has been determined.

A negligible effect on quality of vegetation resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of vegetation resources has been determined.

A negligible effect on the availability of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of terrestrial wildlife resources for traditional use has been determined.

A negligible effect on quality of experience tied to the traditional use of terrestrial wildlife resources has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in air quality has been determined.

No, negligible or measureable effect on quality of experience with engaged in or tied to traditional use as a result in noise has been determined.

No or negligible effect on quality of experience with engaged in or tied to traditional use as a result in ground-borne vibration has been determined.

| 7.0 HUMAN HEALTH | | | |
|---|----------------------------------|---------------|--------------------------------|
| <p>A negligible effect on access to instream locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of instream locations for traditional has been determined.</p> <p>A negligible effect on access to upland locations for traditional use has been determined.</p> <p>A negligible effect on quality of experience tied to access of upland locations for traditional has been determined.</p> <p><u>Mitigation</u></p> <p>Implement proven mitigation measures, effectively used during construction of projects such as the South Fraser Perimeter Road and Port Mann / Highway 1 Improvement, to ensure that temporary increases in ambient noise levels and air emissions during construction do not result in health effects.</p> <p>Implementation of mitigation measures outlined in Fish and Fish Habitat, Marine Mammals, Vegetation, Terrestrial Wildlife, Air Quality, Atmospheric Noise, Marine Use and Land Use.</p> <p><u>Residual & Cumulative Effects</u></p> <p>No significant Project-related residual or cumulative effects on human health are expected.</p> | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Hwlitsum has not voiced any specific issues or concerns with respect to Human Health. | | | |

8.0 ACCIDENTS AND MALFUNCTIONS

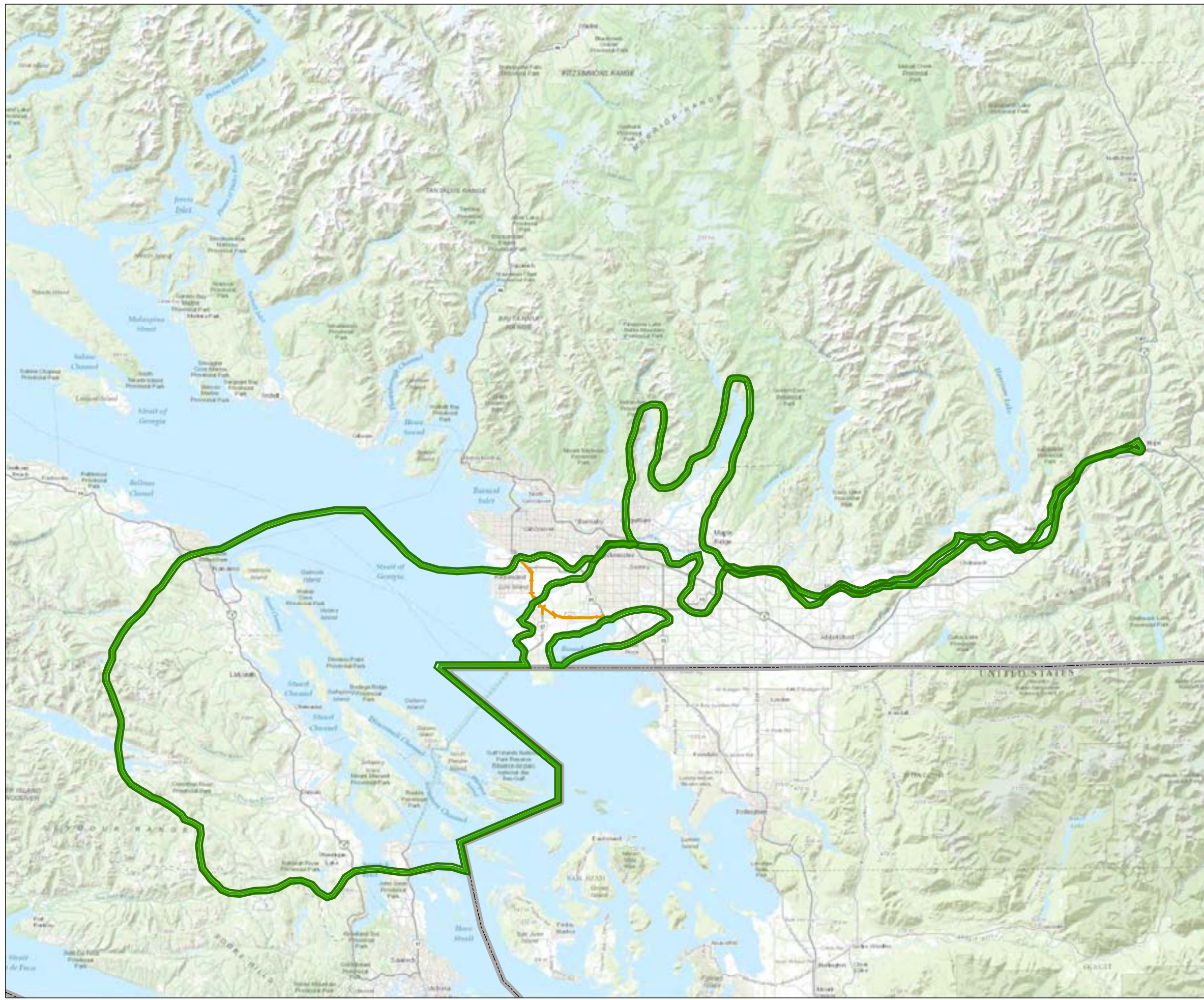
Adherence to the practices and procedures contained in the Construction Environmental Management Plan will minimize the potential for accidents and malfunctions to occur.

In general, replacement of the Tunnel with a new crossing and the proposed highway improvements are expected to lower the risk of accidents and malfunctions during highway operations and maintenance.




| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
|---|---|--------------------------|--|
| Spills of hydrocarbons from refueling or leaks in construction equipment/vessels, including human waste. Spills from accidents during construction and operations | An Emergency Response and Spill Contingency Plan will outline how construction personnel will prevent, prepare for, respond to, and clean up spills | Addressed in Application | Implementation of mitigation measures outlined in Section 12.1.5 (Emergency Response and Spill Contingency Plan) |

| OTHER ISSUES | | | |
|---|--|---------------|--|
| Consultation with Hwlitsum identified issues outside of the environmental assessment process, Aboriginal Interests, Aboriginal Consultation, Aboriginal Participation and Project-Related Opportunities, and sections of the Application. | | | |
| Issues | Proponent Response/Action | Status | Next Steps by Proponent |
| Potential for falling snow and ice | The design of the new bridge is similar to the Alex Fraser Bridge, with cable stays on the outside of the span. There are no cables crossing the deck. Snow and ice control measures will be reflected in the bridge design. | Addressed | Inclusion of snow and ice control measures in bridge design. |

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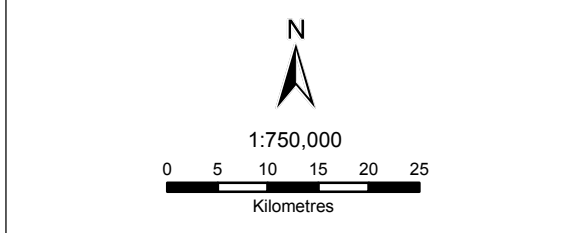


Legend

-  Hwlitsum Asserted Traditional Territory
-  Project Alignment
-  Canada - U.S. Border

SOURCES




Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

HWLITSUM ASSERTED TRADITIONAL TERRITORY

| | |
|-------------|------------|
| Figure 10-3 | 26/05/2016 |
|-------------|------------|

Part D – Public Consultation

11.0 Public Consultation

Planning and engagement for the Project has been underway since 2012. During this time, the Ministry has been working to raise awareness of the Project, receive feedback from stakeholders and interested parties, and respond to Project related enquires.

The main purpose of the Project’s public consultation program is to ensure that members of the general public (the public), and local governments, residents, property owners, other rights holders and interest groups (collectively described as stakeholders) have an opportunity to become informed and provide meaningful input throughout Project development, before, during and after the EA process. This includes ensuring that the consultation fulfills EAO’s requirements for the purpose of the provincial EA.

This section of the Application describes the public consultation activities that have been undertaken before entering the EA process and during the pre-Application phase through to Application submission. This section also describes the activities that are being undertaken during the review phase of this Application. Information regarding consultation with Aboriginal Groups can be found in **Section 10.0 Aboriginal Consultation** of the Application.

11.1 Background Information

This section identifies the stakeholders who have been identified as being potentially affected by the proposed Project.

11.1.1 Stakeholder Identification

The Project’s public consultation program has been designed to reach a wide variety of stakeholders and the public. Since 2012, the Ministry has been working to identify, meet with and keep informed a broad list of stakeholders who may be interested in or affected by the Project. These include:

Regulatory Agencies:

- Provincial
 - Agricultural Land Commission
 - B.C Environmental Assessment Office
 - B.C. Ministry of Agriculture

- B.C Ministry of Environment
- B.C Ministry of Forests, Lands, and Natural Resource Operations
- B.C Ministry of Transportation and Infrastructure
- Federal
 - Canadian Environmental Assessment Agency
 - Environment and Climate Change Canada
 - Fisheries and Oceans Canada
 - Transport Canada
 - Port of Vancouver

Provincial and Federal Elected Officials:

- Federal Members of Parliament (MP)
 - Honourable Marc Garneau, Minister of Transport, MP Notre-Dame-de-Grâce–Westmount
 - Honourable Carla Qualtrough, Minister of Sport and Persons with Disabilities, MP Delta
 - Joe Peschisolido, MP Steveston - Richmond East
- Provincial Members of the Legislative Assembly (MLA)
 - Honourable Linda Reid, Speaker of the Legislative Assembly and MLA Richmond East
 - John Yap, MLA Richmond - Steveston
 - Honourable Teresa Wat, Minister of International Trade and Minister Responsible for the Asia Pacific Strategy and Multiculturalism, MLA Richmond Centre
 - Honourable Peter Fassbender, Minister of Community, Sport and Cultural Development, and Minister Responsible for TransLink, MLA Surrey Fleetwood
 - Honourable Stephanie Cadieux, Minister of Children and Family Development, MLA Surrey Cloverdale
 - Marvin Hunt, MLA Surrey Panorama
 - Honourable Amrik Virk, Minister of Technology, Innovation and Citizens' Services, MLA Surrey Tynehead
 - Gordon Hogg, MLA Surrey White Rock
 - Scott Hamilton, MLA Delta – North
 - Vicki Huntington, MLA Delta –South

Local Elected Officials and Governments:

- Local and Regional Government Staff, Council and Organizations
 - Corporation of Delta, staff and Council
 - City of Richmond, staff and Council
 - City of Surrey, staff
 - City of Vancouver, staff
 - City of White Rock, staff
 - Fraser Health Authority, staff
 - Metro Vancouver, staff
 - TransLink, staff
 - Vancouver Coastal Health, staff

Other interested Groups and Organizations:

- Agricultural organizations
 - Delta Farmers' Institute
 - Richmond Farmers' Institute
 - Individual farmers whose properties are adjacent to the Project area
- Businesses and business organizations that rely on Highway 99 for goods and service movements and access for their customer base, such as:
 - BC Chamber of Commerce
 - Delta Chamber of Commerce
 - Richmond Chamber of Commerce
 - Greater Vancouver Board of Trade
 - Ladner Business Association
 - Tsawwassen Business Association
 - BC Trucking Association
 - Vancouver Airport Authority (YVR)
 - Boundary Bay Airport
 - Western Stevedoring/Coast 2000
 - London Drugs
 - FedEx

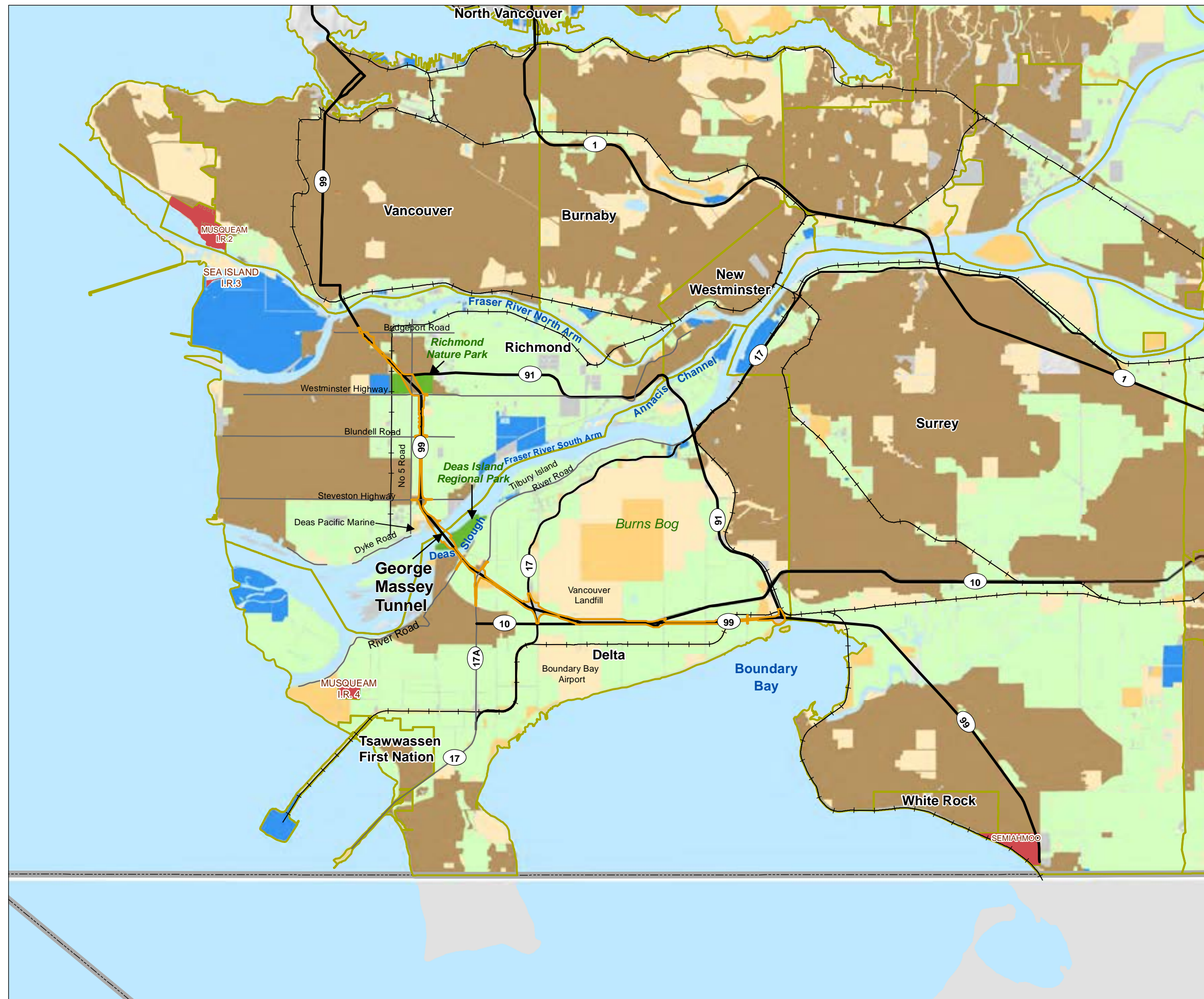
- Commercial and recreational marine users, including:
 - Amix Marine Services Ltd.
 - BC Ferries
 - BC Marine Terminal Operators Association
 - BC Seafood Alliance
 - Bridgeview Marine
 - Britannia Heritage Shipyard Park
 - Canadian Coast Guard
 - Captain's Cove Marina
 - Catherwood Towing
 - Coast Pilot
 - Council of Marine Carriers
 - Crosby Marine Film Services
 - C-Tow
 - Deas Harbour Marina
 - Emergency Management BC
 - Fish Safe BC
 - Forrest Marine
 - Fraser River Pile & Dredge Inc.
 - Fraser River Pilots
 - Fraser Surrey Docks Ltd.
 - Global Container Terminals Canada
 - Harken Towing Co. Ltd.
 - Hodder Tug Co. Ltd.
 - Island Tug & Barge Marine (ITB)
 - Island View Marina
 - Lafarge Canada
 - Ledcor Marine
 - Ledcor Resources & Transportation
 - Lehigh Cement
 - Local Rotary Clubs

- Maersk Canada
- Mercury Launch & Tug Ltd.
- North Arm Transportation Ltd.
- Pacific Custom Log Sorting
- Pacific Pilotage Authority
- Pacific Towing Services
- Riverhouse Marina
- Safe Harbour Marine
- Samsun Tug Boats Inc.
- Seaspans Ferries
- Seaspans Marine Corporation
- Shelter Island Marina
- SMIT Harbour Towing Vancouver Inc
- SMIT Marine Canada Inc
- Steveston Water Taxi
- The Marine Service Network
- Valley Towing Ltd
- Vancouver Mobile Marine
- Vancouver Pile Driving Ltd
- West Coast Fuel & Transport Ltd
- Western Canada Marine Response Corporation (WCMRC)
- Local emergency responders, including:
 - BC Ambulance
 - Delta Fire
 - Delta Police
 - RCMP - Deas Highway Patrol
 - RCMP – Lower Mainland District
 - RCMP – Richmond
 - Richmond Fire

- Community and resident groups in Delta, Richmond, Surrey and southwest Vancouver
Cycling organizations representing recreational and commuter cyclists, including:
 - Cycling BC
 - BC Cycling Coalition
 - Borderline Cycling Club
 - Cross Canada Cycle Tour Society
 - Richmond Cycling Committee
 - Tour de Delta
 - Cycling HUB Delta
 - Cycling HUB Greater Vancouver
 - Cycling HUB Richmond
 - Cycling HUB (formerly Vancouver Area Cycling Coalition)
 - Cycling HUB Safe Route Tsawwassen
 - Cycling HUB Surrey
 - Cycling HUB Surrey/North Delta/White Rock
 - Richmond Community Cycling Committee
- Environmental and naturalist organizations, including:
 - Burns Bog Conservation Society
 - Ducks Unlimited
 - Reifel Bird Sanctuary
 - Nature Vancouver
 - Garden City Conservation Society
 - Delta Naturalist Society
 - Earthwise Society
- Land-based recreation organizations, including:
 - Deas Island Regional Park users and trail users on both sides of the Fraser River
 - Delta Community
 - Delta Deas Rowing Club
 - Deas Island Yacht Club
 - Delta Marine Rescue Society
 - Delta Outriggers

- Delta Racing Canoe
- Ladner Business Association
- Model Airplane Club
- Steveston Community Society
- UBC Boathouse
- Property owners adjacent to Highway 99 within the Project boundaries
- Other members of the public

Figure 11.1-1 shows the locations of municipal boundaries, private land and crown land.



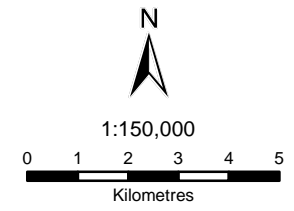
Legend

- Crown Federal
- Municipal
- Provincial
- Private
- Unknown
- Residential
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Waterbody
- Canada - U.S. Border
- Highway
- Railway Corridors
- Arterial/Collector Road

¹ Tsawwassen First Nations Lands are excluded from the RAA

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| LAND OWNERSHIP | |
| Figure 11.1 | 22/06/2016 |
| | |

11.1.2 Stakeholder Profiles

Based on engagement with key stakeholders over the past three years since the Project was announced, the Ministry has compiled summary information pertaining to the interests of primary stakeholders including local governments and regulatory agencies, as summarized in **Table 11.1-1** below.

Table 11.1-1 Project Stakeholder Background Information

| Stakeholder | Questions and Interests | Background |
|---|---|---|
| Agricultural Land Commission | <ul style="list-style-type: none"> • Interest in potential agricultural effects and benefits including <ul style="list-style-type: none"> ▫ Reliability of getting goods to market ▫ Cross highway connectivity ▫ Drainage and irrigation ▫ Applicable mitigation measures • Interest in land impacts to existing farms and the potential for a net positive gain in available agricultural land • Recommended meeting with farming groups and individual farmers | <ul style="list-style-type: none"> • An independent administrative tribunal dedicated to preserving agricultural land and encouraging farming in British Columbia. The purpose of the Agricultural Land Commission as set out in Section 6 of the <i>Agricultural Land Commission Act</i> is a) to preserve agricultural land; b) to encourage farming in collaboration with other communities of interest; and c) to encourage local governments, Aboriginal Groups, the government and its agents to enable and accommodate farm use of agricultural land and uses compatible with agriculture in their plans, bylaws, and policies. |
| Canadian Environmental Assessment Agency | <ul style="list-style-type: none"> • Limited interest in the Project given that it does not trigger a federal review under the <i>Canadian Environmental Assessment Act, 2012</i> | <ul style="list-style-type: none"> • A federal body accountable to the Minister of Environment and Climate Change. The Agency provides environmental assessments that contribute to informed decision making, in support of sustainable development. The Agency is the responsible authority for most federal environmental assessments. |

| Stakeholder | Questions and Interests | Background |
|------------------------------------|--|--|
| <p>Corporation of Delta</p> | <ul style="list-style-type: none"> • Council supports the Project • Council supports extending River Road underneath the new bridge (improvement under Delta’s jurisdiction) • Staff have discussed potential environmental and recreational improvements • Staff have asked questions about Project scope details • Staff reviewed the proposed list of EA key areas of study in advance of, and as part of, the EA pre-Application | <ul style="list-style-type: none"> • The Corporation of Delta is one of two municipalities through which the Project runs. Delta encompasses 180 square kilometres bordered by the Fraser River on the north, the United States border and Boundary Bay on the south, the City of Surrey on the east and the Strait of Georgia on the west. With the support of a strong farming and agricultural foundation, Delta has grown into three thriving communities: Ladner, Tsawwassen, and North Delta. The municipality also has one of the fastest growing industrial areas in Greater Vancouver. |
| <p>City of Richmond</p> | <ul style="list-style-type: none"> • Council has expressed a preference for a new tunnel or upgrades to the existing Tunnel. • Council supports the following objectives for the Project: <ul style="list-style-type: none"> ▫ Zero or net positive effects on agricultural land ▫ New lanes dedicated for specific use and the new bridge supports alternative transportation modes ▫ Improved travel times and reliability and reduction of GHGs ▫ Connections for pedestrians and cyclists at either end of the bridge ▫ Aesthetically pleasing architectural design for the new bridge ▫ Facilitate sustainable transportation including future rapid transit | <ul style="list-style-type: none"> • The City of Richmond is one of two municipalities through which the Project runs. Richmond is a unique island city comprised of a series of islands (Sea Island, most of Lulu Island, and fifteen smaller islands) nested in the mouth of the Fraser River. Neighboring communities are Vancouver and Burnaby to the north, New Westminster to the east, and Delta to the south. The Strait of Georgia forms its western border. Richmond has been experiencing growth and change, transforming from a rural, local community to an international city with a balance of urban, sub-urban family, and rural areas. |

| Stakeholder | Questions and Interests | Background |
|------------------------------|--|---|
| | <ul style="list-style-type: none"> • Council requested staff to analyze and report back on the Project’s potential implications for Richmond • Staff have requested information about traffic patterns particularly with regard to Oak St. Bridge, Knight St Bridge, Blundell Road Overpass and Steveston Highway Interchange. • Staff reviewed the proposed list of EA key areas of study in advance of, and as part of, the EA pre-Application • Staff advised that the City has environmentally sensitive designated areas in the Project area, including in the Fraser River, that should be protected • Questions about the potential effects of the Vancouver Airport Fuel Facility pipeline currently in development within the Project area | |
| <p>City of Surrey</p> | <ul style="list-style-type: none"> • Recognize the need for the Project and request consideration of additional scope including replacing older Highway 99 interchanges within the City of Surrey | <ul style="list-style-type: none"> • The City of Surrey is a municipality immediately adjacent to the southern/eastern terminus of the Project. Surrey is the 2nd largest city in BC, with over 6000 acres of parkland and green space. |

| Stakeholder | Questions and Interests | Background |
|---|--|--|
| <p>City of Vancouver</p> | <ul style="list-style-type: none"> • Request consideration of short-term improvements at SFPR/Highway 99 to facilitate northbound Highway 99 access to the Vancouver Landfill • Indicated the City likely will defer to Metro Vancouver staff with respect to the Environmental Review | <ul style="list-style-type: none"> • The City of Vancouver is a municipality immediately adjacent to the northern terminus of the Project. Vancouver is located on the western half of the Burrard Peninsula, bound to the north by English Bay and the Burrard Inlet and to the south by the Fraser River. The City of Burnaby lies to the east and the Strait of Georgia to the west. |
| <p>City of White Rock</p> | <ul style="list-style-type: none"> • Recognize the need for the Project and request to be kept informed as planning continues • Request consideration of improvements for local access from Highway 99 to White Rock when border traffic causes congestion | <ul style="list-style-type: none"> • The City of White Rock is a municipality adjacent to the southern terminus of the Project. White Rock is located in the southwest corner of the Lower Mainland, 45 kilometres from Vancouver and only five minutes to the Canada/US border. |
| <p>Environment and Climate Change Canada</p> | <ul style="list-style-type: none"> • Interest from an air quality and wildlife perspective | <ul style="list-style-type: none"> • Environment and Climate Change Canada is a federal ministry mandated to protect the environment, conserve the country's natural heritage, and provide weather and meteorological information. |
| <p>Fisheries and Oceans Canada</p> | <ul style="list-style-type: none"> • DFO has indicated they will likely have more involvement during Tunnel decommissioning activities. | <ul style="list-style-type: none"> • Fisheries and Oceans Canada is a federal agency responsible for managing Canada's fisheries and safeguarding its waters. The department supports strong economic growth in our marine and fisheries sectors by supporting exports and advancing safe maritime trade. |

| Stakeholder | Questions and Interests | Background |
|---|---|--|
| Metro Vancouver. | <ul style="list-style-type: none"> • Interest in: <ul style="list-style-type: none"> ▫ Use and connectivity of Deas Island Regional Park ▫ Potential Project related effects on Metro Vancouver utilities ▫ Potential Project related effects on air quality ▫ Potential Project related changes in traffic and growth patterns • Staff reviewed and commented on the proposed list of EA key areas of study in advance of, and as part of, the EA pre-Application | <ul style="list-style-type: none"> • Metro Vancouver is a partnership of 21 municipalities, one Electoral Area and one Treaty First Nation that collaboratively plans for and delivers regional-scale services. Its core services are drinking water, wastewater treatment and solid waste management. Metro Vancouver also regulates air quality, plans for urban growth, manages a regional parks system and provides affordable housing. The regional district is governed by a Board of Directors of elected officials from each local authority. |
| B.C. Ministry of Environment | <ul style="list-style-type: none"> • Interest in potential Project effects on air quality, wildlife, and contaminated sites | <ul style="list-style-type: none"> • The Ministry of Environment is responsible for the protection, management and conservation of B.C.'s water, land, air and living resources. Its expertise in science, research and analysis are central to supporting all its responsibilities. |
| B.C. Ministry of Forest, Lands and Natural Resource Operations | <ul style="list-style-type: none"> • Discussed heritage resources as it pertains to the Project • Discussed FLNR's approach to permitting for the construction phase • Interest in potential Project related effects on dikes | <ul style="list-style-type: none"> • The Ministry of Forests, Lands and Natural Resource Operations is the Province's land manager, responsible for stewardship of Provincial Crown land, cultural and natural resources. The Ministry ensures the sustainable management of forest, mineral and land-based resources, supports activities that lead to benefits for all British Columbians both economically and environmentally, and facilitates public access to a wide range of activities such as hunting, fishing and recreation. |

| Stakeholder | Questions and Interests | Background |
|---|---|---|
| <p>TransLink</p> | <ul style="list-style-type: none"> • Staff worked with the Project team to ensure that traffic modelling undertaken by both agencies is consistent • Staff's analysis suggests that improvements would help address current and future congestion • At Metro Vancouver's request, staff coordinated an independent assessment of the potential effects of an eight-lane bridge on the regional transportation network • Staff requested additional scope for transit improvements, which was incorporated into the Project design | <ul style="list-style-type: none"> • TransLink is Metro Vancouver's regional transportation authority, responsible for regional transit, cycling and commuting options as well as Intelligent Transportation System programs. TransLink is responsible for the planning, financing and managing of all public transit in addition to major regional roads and bridges. |
| <p>Vancouver Fraser Port Authority</p> | <ul style="list-style-type: none"> • Supports the Project as an improvement for port-related container truck movements • Concerns about new bridge height; want to ensure that marine navigation is protected • Recommended convening meeting with marine users • Input on air quality aspects of the environmental assessment • Interest in current and future port-related transportation needs in the Fraser Richmond Lands area | <ul style="list-style-type: none"> • The Vancouver Fraser Port Authority is responsible for the stewardship of federal port lands in and around Vancouver. It was established by the Government of Canada pursuant to the <i>Canada Marine Act</i> and is accountable to the federal Minister of Transport. Their mandate is to facilitate Canada's trade objectives, ensuring goods are moved safely, while protecting the environment and considering local communities. |

| Stakeholder | Questions and Interests | Background |
|--|---|---|
| <p>Delta Farmers' Institute and Richmond Farmers' Institute</p> | <ul style="list-style-type: none"> • Support the Project as a means to improve speed and reliability of getting goods to market, improving cross-highway travel and improving drainage and irrigation for properties along Highway 99 • Support for the Project as an opportunity to incorporate median barriers on Highway 99 to help with flood control • Interest in ensuring no net loss of farm land • Concerns about potential salt wedge migration and its effect on irrigation if future river dredging were to occur | <ul style="list-style-type: none"> • The purpose of the Delta Farmer's Institute is to a) promote and enhance the agricultural industry in the community of Delta; b) to engage with the Ministry of Agriculture (Federal and Provincial) and the Municipality of Delta; c) to improve relationships between the agricultural industry and the agricultural community in Delta, the Ministry of Agriculture and the Municipality of Delta; and d) to work in unison and agreement to address the issues, concerns and policies of the agricultural industry and community in the Municipality of Delta. • The Richmond Farmers Institute is an independent association of Richmond-based farmers that provide networking and advocacy support for local farmers to address key issues and concerns. The Richmond Farmers Institute nominates five of its members for the Richmond Agriculture Advisory Committee. |
| <p>First Responders</p> | <ul style="list-style-type: none"> • Support the Project as a means to improve safety and to improve access and response time, as well as safety of first responders, in the event of an incident • Numerous suggestions for specific Project scope elements to improve enforcement and emergency response on Highway 99 | <ul style="list-style-type: none"> • First responders are emergency service personnel; police, fire and ambulance who respond to emergencies and incidents. |
| <p>Marine Users</p> | <ul style="list-style-type: none"> • Interest in marine access and potential restrictions during construction | <ul style="list-style-type: none"> • Marine users include user groups that participate in marine activities (e.g., fishing, shipping, kayaking). |

| Stakeholder | Questions and Interests | Background |
|------------------------------|---|--|
| <p>General Public</p> | <ul style="list-style-type: none"> • General support for the Project overall and interest in more detail about specific elements including interchange designs, traffic forecasts, and the environmental assessment • Strong support for capacity improvements to address congestion • Strong support for proposed transit, cycling and pedestrian measures • Support for the proposed interchange improvements • Most participants who commented about tolls supported tolling as a funding mechanism; however, many participants suggested that tolling should be applied in the context of a regional tolling policy • Concerns about potential increased traffic congestion at the Oak Street Bridge and, to a lesser extent, other Fraser River North Arm crossings • Interest in greenhouse gas emissions • Interest in Tunnel decommissioning and potential for increased activity within the Fraser River South Arm | <ul style="list-style-type: none"> • General public includes residents and businesses from municipalities adjacent to Highway 99 who use or cross the Highway for general travel needs; community groups, recreational groups, environmental groups, transit users, etc. with interest in how the Project will affect their use of the corridor, their community economy or livability, or the natural environment. |

11.2 Summary of Past and Planned Consultation Activities

The consultation activities undertaken, or proposed to be undertaken, by the Ministry are described below.

11.2.1 Public Consultation Plan

A Public Consultation Plan was prepared and posted to EAO's website on January 6, 2016 (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39675.html). This plan describes the consultation activities that had occurred up to issue of the section 10 Order on December 16, 2015, as well as proposed consultation to be undertaken by the Ministry throughout the pre-Application and Application review phases of the EA.

The Public Consultation Plan is based on best practices and input received through consultation up until finalization of the plan, and is intended to meet pre-Application and Application review phase consultation requirements under the Public Consultation Policy Regulation (BC Reg. 363/2002) and the B.C. *Environmental Assessment Act* (B.C. *EAA*), as well as to satisfy the requirements for public consultation established by EAO in its letter to the Ministry of January 7, 2016 (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39676.html), and under EAO's section 11 Order, issued on March 7, 2016 (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39946.html) under the B.C. *EAA* that such a Plan be developed and approved by EAO. The Ministry has made no changes or updates to the Public Consultation Plan for the Project since it was approved by EAO.

The key objective of the public consultation program is to provide stakeholders with an opportunity to become informed and provide meaningful input toward the development of the Project, before, during, and after the Application process.

Objectives of the Public consultation program as outlined in the Consultation Plan are to:

Inform people about the Project and the opportunities to provide input – This includes but is not limited to building awareness of the Project through undertaking consultation, having a Project Office where people can ask questions and provide feedback, maintaining a Project website with current and background information, inviting and responding to enquiries, attending presentations and community meetings on request and convening meetings of stakeholders as appropriate.

Ensure that public input is considered in refining and finalizing Project Designs – This includes encouraging dialogue and information exchange, gathering input to understand areas of interest and concern, and considering and appropriately responding to the input provided. It also includes seeking input from the public on ways to mitigate or otherwise accommodate potential Project effects.

Ensure that all interested parties have the opportunity to make informed decisions about the Project – This includes providing timely and relevant information about the Project. For the purposes of the EA, the Ministry will ensure that the public has access to information about the environmental, economic, heritage, health and social conditions in the Project area, the potential Project effects, and proposed mitigation measures.

Meet EAO’s public consultation requirements for the EA – This includes tracking public input, and communicating to the public how public comments will be addressed in the EA. The Ministry’s Project website will provide information about the EA throughout the EA review process and will direct interested members of the public to EAO’s website to provide comments on the Project’s EA. In accordance with EAO’s requirements, the Ministry has maintained a tracking table in which the Ministry has responded to each individual public comment provided during the public comment period in the pre-Application phase of the EA process and will do the same for the Application Review phase. The Project has prepared a Consultation Report in accordance with EAO’s section 11 Order.

11.2.2 Public Consultation to Date

Since announcement of the Project in September 2012, the Ministry has been conducting technical analyses, raising awareness about the Project, engaging interested parties in dialogue, and responding to Project-related enquiries. As part of Project planning, the Ministry consulted widely, gaining insight from municipalities, Aboriginal Groups, Metro Vancouver, TransLink, the agricultural community, first responders, recreational groups, local businesses, local residents, cyclists, marine users, other stakeholders, and the public over a period of more than two years.

This section describes the consultation undertaken by the Ministry since fall 2012 up to the Pre-Application phase consultation. **Section 11.2.3** describes consultation undertaken as part of the pre-Application phase of the EA.

11.2.2.1 Ministry led Consultation Phases

The Ministry undertook three phases of Project consultation. Each phase included open houses complete with display boards, discussion guides and feedback forms, which provided participants with an opportunity to speak with Project staff. All consultation materials were made available online at masseytunnel.ca during and after each consultation event, and all events were advertised in local and regional newspapers, on the Project website, through the Project e-database (see “Project Office” section, below), and through media releases that resulted in broadcast and print news coverage. Following each consultation event or series of events, a Consultation Summary Report was prepared, documenting the input received.

Phase 1 Consultation: Understanding the Need (November/December 2012) sought input to gain a better understanding of current travel needs and community considerations for developing replacement options. This input was used to help develop a draft project scope and potential replacement scenarios. Results can be viewed in the Phase 1 Consultation Summary Report (<http://engage.gov.bc.ca/masseytunnel/files/2012/11/George-Massey-Tunnel-Phase-1-Consultation-Summary-Report3.pdf>).

Phase 2 Consultation: Exploring the Options (March/April 2013) sought input on five potential replacement scenarios which were developed in consideration of Phase 1 input. During this phase, participants indicated a preference for a new bridge along the existing Highway 99 corridor. Participants also expressed interest in transit, cyclist and pedestrian improvements as part of the Project, and interim improvements at the Tunnel while development for a new crossing continues. Results can be viewed in the Phase 2 Consultation Summary Report (<http://engage.gov.bc.ca/masseytunnel/files/2013/09/Phase-2-report-FINAL.pdf>).

Phase 3 Consultation: Project Definition (December 2015/January 2016) sought input on the Project Definition Report (<http://engage.gov.bc.ca/masseytunnel/files/2015/12/GMT-Project-Definition-Report-Dec-2015.pdf>) including the proposed Project scope, Project success measures, funding options, and traffic management during construction. This input assisted in finalizing the Application and also will be used to finalize the Project scope and cost estimate. Results can be viewed in the Phase 3 Consultation Summary Report (<http://engage.gov.bc.ca/masseytunnel/files/2016/04/Phase-3-Consultation-Summary-Report-March-2016.pdf>).

11.2.2.2 Project Office, Website and Telephone Information Line

A Project website (www.masseytunnel.ca) was established in November 2012 to provide information about the Project, including: historical information and reports; current Project status; Project-generated reports and information including consultation materials; answers to frequently asked questions; how to contact the Ministry; and how to subscribe to the Project e-database (see below). The Project work with the Ministry's social media team to incorporate Project updates into the Ministry's @TRANBC Twitter feed.

A Project-related electronic database (e-database) was established in November 2012, enabling people to sign up to receive e-mails about the Project. People can subscribe by completing the web-based form at www.masseytunnel.ca, emailing masseytunnel@gov.bc.ca, or phoning the Project Office (1-855-MASSEY). The database has more than 1,800 subscribers. Also established in November 2012, the Project information telephone line and e-mail address enable one-to-one correspondence and response to enquiries. Where possible, the Ministry responds to information requests within 48 hours.

A Project Office in Richmond was opened in January 2014. The Project Office has full-time community relations staff who provide Project information to the public as well as manage the website, the information telephone line, and the e-database. The office includes information display boards, access to the Project website, and fly-through animation of the Project corridor. To date (up to 15 May, 2016), more than 4,000 people have visited the Project office.

11.2.2.3 Stakeholder Outreach

The Ministry has engaged in a variety of additional outreach activities with the stakeholders identified in Section 11.1.1:

- **Presentations on request** to business and community groups. To date, the Ministry has made more than 100 presentations to organizations including:
 - Community and recreational clubs and organizations
 - Boards of Trade and Chambers of Commerce
 - Business clubs and associations
 - Professional organizations
 - Metro Vancouver planning, transportation, and engineering symposia

- **Meetings with key stakeholder groups** to gather input in support of developing conceptual designs for the new crossing. Since 2012, the Ministry has consulted extensively with:
 - Municipal, provincial and federal elected officials
 - Municipal, provincial and federal government staff
 - Provincial and federal agency staff
 - Aboriginal Groups
 - Stakeholder groups including agricultural organizations, business organizations, commercial and recreational marine users, community and resident groups, recreational groups, and first responders

The Ministry has participated in more than 85 meetings with City of Richmond staff and more than 85 meetings with Corporation of Delta staff, with whom the Ministry's Project team meets bi-weekly, and more than 30 meetings with Metro Vancouver staff.

11.2.2.4 Advertising and Media Relations

The Ministry maintains an ongoing and open dialogue with the media. Since November 2012, numerous stories have been published on the Project, including interviews with the Minister of Transportation and Infrastructure, the Executive Project Director, and other Project spokespersons. Highlights include:

- More than 750 directly related articles have been published in local and regional newspapers, primarily the Vancouver Sun, the Province, the Delta Optimist, South Delta Leader, Richmond News, and the Globe and Mail.
- Notification for each of the three phases of Project consultation to date (outside of the EA process) has been advertised in local and regional newspapers, which includes eight news releases, four information bulletins, and one public notice.

11.2.2.5 EA Public Consultation Phases

The B.C. EA process provides an integrated process for identifying, mitigating, and evaluating the potential for effects on environmental, economic, social, heritage, and health values that may occur during the life of a reviewable project. EAO led public comment periods, one held in the pre-Application phase, and another to be held in the Application review phase, and ongoing stakeholder consultation, seek to ensure that the interests and concerns of the public, Aboriginal Groups, stakeholders, and government agencies are considered. The following sections discuss EA related Public Consultation.

11.2.3 Pre-Application Phase Public Consultation

11.2.3.1 Public Comment Period

As part of the Pre-Application phase of the EA, the EAO held a public comment period from January 15, 2016 to February 15, 2016 that sought input on the Project Description and Key Areas of Study document for the Project

(http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39646.html).

Based on issues identified by the public, Aboriginal Groups, regulators, and local and regional governments during consultation to date, and the Ministry's experience on comparable projects in the Lower Mainland, the following key areas of study have been identified to support the assessment of potential environmental, economic, social, heritage, and health effects of the Project:

- River hydraulics and morphology
- Sediment quality and water quality
- Underwater noise
- Fish and fish habitat
- Marine mammals
- Vegetation
- Amphibians
- Terrestrial wildlife
- Traffic*
- Land and Water Use, *including marine use, land use and agricultural use*
- Visual quality
- Air quality
- Atmospheric noise
- Human health
- Heritage resources

*Traffic is not listed as a key area of study in the Project Description and Key Areas of Study document. As a result of interest from the public, Project related changes in traffic during construction and operation have been assessed as part of the EA (see **Section 5.1**) and support the assessment of atmospheric noise, air quality, human health, land use, and terrestrial wildlife.

Availability of the Project Description and Key Areas of Study

The Project Description and Key Areas of Study document and information regarding the environmental assessment process were available at:

- EAO's website,
- The Project website (www.masseytunnel.ca)

- All Municipal Libraries in the City of Richmond
- All Municipal Libraries in the Corporation of Delta
- The Project Office in Richmond
- Public comment period open houses

Public Notification

To inform interested individuals and the public, and to comply with EAO advertising requirements, the Ministry undertook the following notification program:

Advertising in regional and local papers, including:

- Vancouver Sun
- The Province
- The Richmond News
- The Delta Optimist
- The Leader
- The Now
- Peace Arch News
- Ming Pao
- Sing Tao
- Indo Canadian Times

Online information updates including:

- EAO's website at www.eao.gov.bc.ca
- The Project website (www.masseytunnel.ca)
- Ministry's Twitter feed @TRANBC

Email notices to people who registered to receive Project updates through the Ministry's Project website.

Two media releases, which generated extensive print, online and broadcast news coverage.

11.2.3.2 Open Houses

Two open houses, led by EAO, were held in support of the 31-day public comment period:

Table 11.2-1 Open House Overview

| Community | Date/Time | Venue |
|-----------|---|--|
| Richmond | Tuesday, January 26, 2016 2:00 p.m. – 8:00 p.m. | Sandman Signature Hotel Vancouver Airport Round Room 10251 St. Edwards Drive, Richmond, BC |
| Delta | Wednesday, January 27, 2016 2:00 p.m. – 8:00 p.m. | Delta Town & Country Inn Ballroom 6005 Highway 17A, Delta, BC |

More than 750 people attended the open houses. Project and EAO staff and the Ministry’s technical experts were present to answer questions on the Project. Copies of the Project Description and Key Areas of Study document were available, and display boards summarizing the Project, and the key areas of study identified for the Project, were presented. The display boards used at the Open Houses are included as an Appendix to the Phase 3 Consultation Summary Report and the Public Consultation Report prepared for EAO. A summary of feedback from the Open Houses and other sources of input is presented in **Table 11.2-3** in **Section 11.3.2.5** below.

11.2.3.3 Comments Submitted to the BC Environmental Assessment Office

Comments from the public were submitted to BC EAO over the length of the public comment period from January 15, 2016 to February 15, 2016 and posted to EAO’s electronic Project Information Centre (ePIC) within seven days of the comment being received by EAO (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39730.html).

Approximately 450 public submissions were sent to EAO. Comments received and responses provided are available on the EAO’s website.

(http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39730.html).

A summary of comments from these submissions, as well as other sources of input, is presented in **Table 11.2-3**.

11.2.3.4 Stakeholder Consultation

Consultation with stakeholders to discuss the Project, and obtain feedback on the Project scope and the scope of environmental review has been ongoing throughout the pre-Application phase. In addition to engaging in a variety of outreach activities with stakeholders, the Ministry maintained its Project Office, website, and Information Line as described in **Section 3.2. Table 11.2-2** provides a summary of stakeholder outreach activities (scheduled meetings and presentations) undertaken by the Ministry during the pre-Application phase, from the release of the issuance of the section 10 Order on December 16, 2015 through to May 15, 2016.

Table 11.2-2 Summary of Project Public and Stakeholder Engagement Activities

| Dates | Agency/Organization | Type | Description |
|---------------|----------------------------------|---------------------------------------|---|
| 2015-12-16 | Media | Presentation and Q&A | Project Definition Report Technical Briefing |
| 2015-12-16/17 | Project Stakeholders | Notification Call and Follow-up email | Notification of release Project Definition Report and start of Pre-Application Phase for EA with issuance of section 10 Order |
| 2015-12-18 | Greater Vancouver Board of Trade | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-05 | City of Richmond | Meeting | Project Update on Project Definition Report and EA Process |
| 2016-01-07/08 | Project Stakeholders | Notification Call and Follow-up email | Notification of start of public comment period for Pre-Application Phase or EA and upcoming Open Houses. |
| 2016-01-12 | Richmond Chamber of Commerce | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-12 | Local Cycling Community | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-13 | BC Trucking Association | Presentation and Q&A | Project Update- Phase 3 Consultation |

| Dates | Agency/Organization | Type | Description |
|------------|---|-----------------------|---|
| 2016-01-13 | City of Richmond Active Transportation Committee (regular meeting of Committee) | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-14 | City of Richmond | Meeting | Project Meeting |
| 2016-01-18 | Steveston 20/20 Group | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-18 | Rotary Club of Steveston | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-18 | City of Richmond General Purposes Committee (*regular meeting of Committee) | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-20 | Steveston-Richmond East MP Joe Peschisolido | Meeting | Project Update |
| 2016-01-20 | Corporation of Delta | Project Meeting | Project Meeting |
| 2016-01-21 | EAO technical Working Group | Working Group Meeting | Project update and EA process. |
| 2016-01-22 | Honourable Linda Reid, MLA Richmond East | Meeting | Project Update |
| 2016-01-25 | Richmond Farmers Institute, Honourable Linda Reid, MLA Richmond East | Presentation and Q&A | Project Update- Phase 3 Consultation |
| 2016-01-26 | Richmond Open House | Open House | Public open house. Phase 3 Consultation for the Project Definition Report and Pre-Application public comment period for Project Description and Key Areas of Study. |
| 2016-01-27 | Delta Open House | Open House | Public open house. Phase 3 Consultation for the Project Definition Report and Pre-Application public comment period for Project Description and Key Areas of Study. |

| Dates | Agency/Organization | Type | Description |
|------------|---|---|--|
| 2016-01-27 | Riverhouse Residents Strata (<i>regular strata meeting</i>) | Presentation | Project Update |
| 2016-01-29 | Corporation of Delta | Presentation at Delta Mayor's Breakfast | Project Meeting |
| 2016-02-01 | Metro Vancouver | Meeting (conference call) | Project Meeting |
| 2016-02-01 | City of Richmond | Meeting | Project Meeting |
| 2016-02-05 | Land Use stakeholders meeting hosted by Metro Vancouver (included representatives from local municipalities, agencies, and consultants) | Meeting | Regional land use and growth management |
| 2016-02-10 | Vancouver Airport Authority | Meeting | Project Update |
| 2016-02-11 | TransLink | Meeting | Project Meeting |
| 2016-02-11 | Corporation of Delta | Meeting | Project Meeting |
| 2016-02-12 | Honourable Carla Qualtrough, MP Delta-Richmond East | Meeting | Project Update |
| 2016-02-12 | Local Emergency Responders | Meeting | Project Update |
| 2016-02-15 | City of Richmond City of Vancouver | Meeting | Traffic |
| 2016-02-17 | City of Richmond | Meeting | Project Meeting |
| 2016-02-18 | Ministry of Agriculture | Meeting | Project Update, EA and ALC Applications Update |
| 2016-02-18 | Ladner Business Association | Presentation and Q&A | Project Update |
| 2016-02-18 | Delta Chamber of Commerce | Meeting | Project Overview and Update |
| 2016-02-18 | Corporation of Delta | Meeting | Project Meeting |
| 2016-02-18 | Agricultural Land Commission | Meeting | Project Update, EA and ALC Applications Update |

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| Dates | Agency/Organization | Type | Description |
|------------|--|---------------------------------------|--|
| 2016-02-22 | Boundary Bay Airport | Meeting | Project Update |
| 2016-02-25 | City of Richmond | Meeting | EA process and comment review |
| 2016-02-26 | HUB Cycling representatives | Meeting | Cycling design |
| 2016-02-29 | City of Richmond | Meeting | Project Meeting |
| 2016-03-02 | Delta Chamber of Commerce | Presentation and Q&A | Project Update |
| 2016-03-03 | Fraser Health Metro Vancouver TransLink Vancouver Coastal health | Meeting | Project Update, Air Quality and traffic workshop |
| 2016-03-03 | Corporation of Delta | Meeting | EA process and comment review |
| 2016-03-08 | Corporation of Delta Delta Agricultural Advisory Committee Ministry of Agriculture | Meeting | Project Update |
| 2016-03-09 | Metro Vancouver and TransLink | Meeting | Project Update, Traffic workshop |
| 2016-03-10 | EAO technical Working Group | Working Group Meeting | EA process and comment review |
| 2016-03-14 | City of Richmond | Meeting | Project Meeting |
| 2016-03-17 | Corporation of Delta | Meeting | Project Meeting |
| 2016-03-17 | City of Richmond | Meeting | Project Meeting |
| 2016-03-29 | Richmond Farmers Institute Richmond Agricultural Advisory Committee and BC Cranberry Growers Association | Meeting | Project Update, EA and ALC Application Update |
| 2016-03-30 | Richmond Chamber of Commerce | Chamber Luncheon Presentation and Q&A | Phase 3 Consultation Summary Report |
| 2016-03-30 | Metro Vancouver Parks | Meeting | Project Update, EA process and comment review |

| Dates | Agency/Organization | Type | Description |
|------------|--|----------------------|---|
| 2016-03-31 | BC Hydro | Meeting | BC Hydro Distribution Coordination Meeting |
| 2016-04-03 | Agricultural Land Commission | Meeting | ALC Application |
| 2016-04-04 | City of Richmond | Meeting | Project Meeting |
| 2016-04-04 | Canadian Society for Civil Engineers | Presentation and Q&A | Project Update |
| 2016-04-06 | Corporation of Delta | Meeting | Project Meeting |
| 2016-04-07 | Cycling Community - South Delta HUB | Meeting | Cycling designs |
| 2016-04-07 | Corporation of Delta | Meeting | Cycling designs |
| 2016-04-08 | Ministry of Agriculture | Meeting | Project Update, EA and ALC Applications Update |
| 2016-04-11 | Metro Vancouver | Meeting | Project Update, Utilities discussion |
| 2016-04-11 | City of Richmond | Meeting | Project Meeting |
| 2016-04-14 | Corporation of Delta | Meeting | Project Meeting |
| 2016-04-14 | BC Ferries | Meeting | Project Update |
| 2016-04-18 | Agricultural Land Commission Richmond Farmers Institute | Meeting | ALC Application |
| 2016-04-18 | Agricultural Land Commission Delta Farmers' Institute | Meeting | ALC Application |
| 2016-04-20 | Cycling Working Group | Meeting | Project Update and Cycling Working Group kick off |
| 2016-04-21 | Corporation of Delta | Meeting | Project Meeting |
| 2016-04-21 | City of Richmond Environmental Assessment Office | Meeting | Project Update, EA Process and comment review |
| 2016-04-25 | City of Richmond | Meeting | Project Meeting |
| 2016-04-26 | TransLink | Meeting | Project Meeting |
| 2016-04-26 | Local emergency responders | Meeting | Project Update, Health Impact Assessment input |

| Dates | Agency/Organization | Type | Description |
|------------|--|----------------------|---|
| 2016-04-28 | Corporation of Delta | Meeting | Project Meeting |
| 2016-05-02 | Environmental Assessment Office Metro Vancouver | Meeting | Project Update, EA process and comment review |
| 2016-05-02 | Beta Sigma Phi Kinsmen | Presentation and Q&A | Project Update |
| 2016-05-05 | Richmond Farmers Institute | Meeting | Agricultural Update |
| 2016-05-11 | City of Richmond | Meeting | Project Meeting |
| 2016-05-12 | Corporation of Delta | Meeting | Project Meeting |

11.2.3.5 Summary of Public Feedback and Proponent Responses

This section summarizes the public feedback received at the open houses, comments submitted to EAO, and feedback received through the Ministry’s stakeholder outreach during the Pre-Application period (up to May 15 2016). **Table 11.2-3** below lists the key themes of feedback received, the Ministry’s general response to the comment or concern, and how that comment or concern has been or is being addressed in the Application. A complete list of comments formally received regarding the Project Description and Key Areas of study document is available on the EAO’s website (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_project_home_430.html).

Table 11.2-3 Key Areas of Interest for Public and Stakeholders

| Theme | Response | Action/Status | Applicable Mitigation |
|---|--|---|-----------------------|
| <p>Analysis of other options:</p> <ul style="list-style-type: none"> • How was the new bridge option selected? • Why were other options not selected? • What consultation was done? • Preference for other options | <p>The Ministry evaluated five potential options for replacing the Tunnel. Each scenario was evaluated based on transportation efficiency, safety, agriculture, environment, economic considerations, and social and community considerations.</p> <p>As identified in the Ministry’s Phase 2 Exploring the Options Consultation Discussion Guide (http://engage.gov.bc.ca/masseytunnel/files/2012/11/GMT-Phase-2-Discussion-Guide.pdf), the public and stakeholders were consulted on the five potential options. Respondents expressed a clear choice for moving forward with capacity improvements along the existing corridor, with preference for a new bridge. Twice as many people preferred a completely new bridge as compared with a new bridge/upgraded tunnel scenario and many people specifically commented that any option including the existing Tunnel would not meet the Project goals.</p> <p>Substantial technical analysis was also undertaken, confirming that a new bridge is also the best technical solution. The analysis is summarized in the Evaluation of Crossing Scenarios report and is available on the Project website (http://engage.gov.bc.ca/masseytunnel/files/2015/06/GMT-2014-March_Evaluation-of-Crossing-Scenarios.pdf).</p> <p>A new bridge built to modern day standards is the most logical and cost-effective solution. As compared with upgrading the Tunnel, the new bridge will reduce crashes, improve emergency response time, provide a safer facility in the event of an earthquake, provide new options for cyclists and pedestrians, improve transit and HOV travel, allow flexibility for future rapid transit, and provide an enhanced traveler experience.</p> <p>As compared with a new tunnel, the new bridge will minimize private property impacts and environmental effects as well as provide more environmental and agricultural benefits. A new bridge also provides best flexibility to provide transit, cycling, and pedestrian improvements on Highway 99, including provision for future rapid transit.</p> <p>A discussion on Alternatives for the Project, including how technical analysis and extensive public consultation led to the determination of the new bridge as the preferred alternative, will be included in the Application.</p> | <p>Section 1.4 of the Application discusses the alternatives for the Project and how the alternatives were assessed.</p> | <p>N/A</p> |

| Theme | Response | Action/Status | Applicable Mitigation |
|---|---|---|-----------------------|
| <p>Consultation with the public:</p> <ul style="list-style-type: none"> • Past consultation results • Process transparency | <p>The Ministry adopted a phased public consultation program to support Project planning and development. This included:</p> <ul style="list-style-type: none"> • Phase 1: Understanding the Need (November to December 2012) Focused on understanding the need and potential constraints to develop the project scope and design requirements. • Phase 2: Exploring the Options (March to April 2013) – Based on Phase 1 consultation results and preliminary technical work, Phase 2 sought input on the draft project scope and goals, five potential replacement scenarios, and the criteria to evaluate these options. • Phase 3: Project Definition Report (December 16, 2015 to January 28, 2016) Sought feedback on the Project scope and business case, including goals, design features, benefit and cost analysis, draft performance evaluation/success measures, and tolling. <p>More than 1,000 people and dozens of community groups and associations participated in each of these consultations. Summary reports for each Phase are available on the Project website.</p> <p>The Ministry also consulted widely to gain insight from municipalities, Aboriginal Groups, Metro Vancouver, TransLink, the agricultural community, first responders, recreational groups, local businesses, local residents, cyclists, marine users, and other stakeholders.</p> <p>Based on this consultation, the Ministry identified and considered a diverse range of environmental and social values to guide Project design and support the EA presented in the Project Description and Key Areas of Study document.</p> <p>Public consultation and feedback plays an important role throughout the EA process. The Ministry prepared a Public Consultation Plan (http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39675.html), to outline and guide public consultation activities during the Pre-Application and Application Phase of the EA and to satisfy the requirements for public consultation established by EAO in the section 11 Order. As required under the section 11 Order, the Ministry will provide public notice prior to the start of any formal public comment period, and will submit a Public Consultation Report with the submission of the Application for evaluation and at any other time specified by EAO.</p> <p>The Project entered the EA process on December 16, 2015. The Pre-Application Phase public comment period was held January 15 to February 15, 2016 and included two public open houses in Richmond and Delta. Pre-Application public consultation focused on receiving input on the Project Description and Key Areas of Study document, to further develop the scope of the EA. The Ministry responded to all public comments received during this period and the Ministry's responses are posted to EAO's website.</p> <p>Throughout the Application Review phase, the Ministry will continue to engage with the public and stakeholders, which will include but not be limited to, maintaining the Project Office, the Project website and the community relations program as described in the Public Consultation Plan. In addition, there will be a second public comment period of at least 45 days on the Application, which will be made publicly available upon EAO's acceptance of the Application.</p> <p>The Application will include a discussion on Public Consultation to date.</p> | <p>The section 11 Order, issued by EAO, describes the consultation requirements for the Project.</p> <p>Section 10 of the Application discusses public consultation undertaken for the Project to date.</p> <p>The Ministry continues to consult with the public on the Project to provide Project information and to understand and address concerns.</p> | <p>N/A</p> |

| Theme | Response | Action/Status | Applicable Mitigation |
|--|--|--|-----------------------|
| <p>Perception that the Project is being constructed to benefit the Port of Vancouver:</p> <ul style="list-style-type: none"> • Increased industrialization of the Fraser River • Port users should pay for a portion of the costs | <p>The Tunnel is B.C.'s worst traffic bottleneck. The new bridge will reduce congestion, improve travel time and reliability, improve safety, and provide new options for cyclists, pedestrians and transit users. It is anticipated that the Project will provide up to 30 minutes a day in time savings for rush hour commuters.</p> <p>Public and stakeholder feedback received over two phases of consultation prior to the start of the EA, existing conditions at the Tunnel, and growing traffic congestion, made it clear that road-based improvements at this crossing are a priority.</p> <p>The new bridge will be the same height above the water as the Alex Fraser Bridge. Removing the Tunnel will not appreciably increase the size of vessels using the Fraser River South Arm channel, as the top of the Tunnel is level with the bottom of the River. Tunnel elevations relative to the river bottom will be provided in the Application. Other factors, including the Metro Vancouver water main downstream of the Tunnel, other utility crossings upstream of the Tunnel including Metro Vancouver water and sewer lines and Fortis BC gas line infrastructure, and the width of the river, limit the size of vessels that can navigate the river.</p> <p>The Province intends to fund the Project at least in part through user tolls. Consistent with Provincial Tolling Guidelines (http://www2.gov.bc.ca/assets/gov/driving-and-transportation/reports-and-reference/reports-and-studies/planning-strategy-economy/mot_guidelines_for_tolling.pdf), tolling recognizes that those directly benefiting from the new infrastructure in terms of time savings and reliability should help pay for the Project. The Province is also seeking a contribution from the federal government.</p> <p>Port-related goods movers using the crossing to go to or from Deltaport will help pay for the Project through the tolls they pay to travel across the new bridge.</p> <p>The Project Description and Key Areas of Study document outlines the Project rationale and describes the benefits it will provide. These details will be included in the Application.</p> | <p>Section 1.1 of the Application discusses the project rationale and Project components.</p> <p>Section 1.1 of the Application discusses Project costs and tolling as a funding source.</p> <p>Section 5.2 of the Application discusses navigation and marine use.</p> | <p>N/A</p> |

| Theme | Response | Action/Status | Applicable Mitigation |
|---|---|--|--|
| <p>Concern about potential agricultural impacts:</p> <ul style="list-style-type: none"> • Rationale for anticipated “net gain” in agricultural land • Concern about loss of ALR • Impacts on farm access • Increased food costs • Food security concerns • Impacts to the salt wedge | <p>The Ministry recognizes the importance of agriculture and minimizing impacts to agricultural land has been a key goal since the onset of the Project and was one of the key factors in determining a new bridge as the preferred crossing scenario. Agricultural land impacts and access to and from agricultural areas were presented as draft criteria for evaluating the potential crossing scenarios in the Phase 2 Exploring the Options Consultation Discussion Guide (https://engage.gov.bc.ca/masseytunnel/files/2012/11/GMT-Phase-2-Discussion-Guide.pdf). The Evaluation of Crossing Scenarios (https://engage.gov.bc.ca/masseytunnel/files/2015/06/GMT-2014-March_Evaluation-of-Crossing-Scenarios.pdf) presents the evaluation of the draft criteria for each of the scenarios which found the new bridge scenario was preferable to all other scenarios in improving the connectivity between agricultural areas on either side of the corridor, while also minimizing the agricultural land impact as compared to most other solutions.</p> <p>Agricultural use is identified in the Project Description and Key Areas of Study as an important value to be considered in as part of the Project development and potential Project related effects to agricultural use will be assessed as part of the environmental assessment. Studies have been completed with regard to the salt wedge in the river. Details will be provided in the Agriculture and River Hydraulics and River Morphology sections of the Application.</p> <p>The Ministry has been working with Agricultural Land Commission staff, municipalities, the farming community, and individual farmers for the past three years in order to identify strategies that maximize benefits to agriculture. Based on the current Project design, the Ministry anticipates a net gain in agricultural land in Delta and Richmond primarily because of the smaller design footprint for replacement interchanges, particularly at Steveston Highway.</p> <p>Additionally, the Project will improve travel times and access between farms on both sides of Highway 99, improve drainage along Highway 99 which will also benefit farming, and provide wider shoulders and higher underpasses to make it easier to move farm equipment. The Application will assess potential adverse effects on agricultural use and identify mitigation measures and strategies for achieving a net benefit to agricultural use.</p> <p>The Ministry is required to obtain approval under the <i>Agricultural Land Commission Act</i> prior to starting construction.</p> | <p>Section 5.4 of the Application discusses potential Project related effects to Agricultural Use. Salinity and the salt wedge is discussed in the Agriculture Use (b) and River Hydraulics and River Morphology (Section 4.1) of the Application.</p> | <p>Measures for avoidance of effects to agricultural use integrated into Project design include accommodating Project components and activities within the Highway 99 ROW and incorporating drainage works and structures that meet standards for agricultural areas and purposes.</p> <p>An Agricultural Management Plan will be developed for construction and will describe standard best practices and Project-specific mitigation measures to prevent or minimize potential effects on drainage, water quality and irrigation, farm infrastructure and operations, and soil conservation, storage, and reclamation.</p> <p>Enhancement and offsetting measures will also be applied.</p> <p>A net benefit to agricultural use is anticipated.</p> |
| <p>Concern about increased congestion at Oak Street Bridge and other Fraser River North Arm crossings:</p> <ul style="list-style-type: none"> • Project will move the queue further north • Project will generate increased traffic • Oak Street Bridge is already congested | <p>The Tunnel is the worst traffic bottleneck in B.C. The new bridge will alleviate the current queues experienced at the Tunnel.</p> <p>The Project is not expected to result in any appreciable change in queues at the Oak Street and Knight Street bridges. Analysis showing that the majority of traffic using the Tunnel (60 per cent) is destined to or from Richmond is presented in the Traffic Data Overview Report (http://engage.gov.bc.ca/masseytunnel/files/2015/12/Traffic-Data-Overview-2015.pdf). In fact, traffic volumes over the Oak Street Bridge have declined over the past five years and the City of Vancouver has indicated similar patterns at the Knight Street Bridge.</p> <p>Local roads will benefit from the new Steveston Highway and Westminster Highway interchanges in Richmond and new Highway 17A interchange in Delta as well as from reduced congestion at the new bridge.</p> <p>Project related changes in traffic will be assessed as part of the environmental assessment. The assessment of potential project-related changes in traffic, during construction and operation, will support the assessment of noise, air quality, human health, land use, and terrestrial wildlife. While the Application will present information on future trends in traffic at other Fraser River crossings, changes to the (existing) Highway 99 corridor have been determined to have a negligible influence on traffic conditions at other crossings in the future. As such, future changes in traffic at other crossings are not assessed as a potential effect of the Project but will be discussed.</p> | <p>The Project will improve performance of the Highway 99 corridor with respect to safety, travel time, reliability, and mode share.</p> <p>Section 5.1 of the Application discusses potential Project related changes to traffic, and includes a discussion on Oak Street Bridge traffic trends.</p> | <p>The Project will incorporate components consistent with the Ministry’s approach to Intelligent Transportation Systems to better manage and operate the corridor.</p> |

| Theme | Response | Action/Status | Applicable Mitigation |
|---|--|---|--|
| <p>Traffic during construction:</p> <ul style="list-style-type: none"> • Concern over how traffic through the corridor will be maintained • Concern over how marine traffic will be maintained | <p>The Ministry will work to ensure that road and marine traffic continues to move while the new bridge is under construction and will implement a Traffic Management Plan and a Marine Access Management Plan. Key mitigation within these plans includes communication with users of the corridor and the navigation channel. Traffic is assessed in Section 5.1 and Marine Use is assessed in Section 5.2 of the Application.</p> | <p>Section 12 of the Application discusses the requirement of a Construction Traffic Management Plan and a Marine Access Management Plan to be developed prior to construction.</p> | <p>A Construction Traffic Management Plan will be developed to identify and address traffic management risks and approaches for managing traffic and communication with stakeholders and the public during the construction period. A Marine Access Management Plan will be developed to minimize potential construction-related access effects on marine users. The plan will outline communications protocols to establish and advise of instream construction activities, including periods of vessel restrictions.</p> |
| <p>Preference for transit:</p> <ul style="list-style-type: none"> • Rapid transit in lieu of project • Transit generally, instead of project | <p>A new bridge was determined to be preferable in serving the needs of all user groups, including transit users, given the local, regional, provincial and national importance of Highway 99, the variable trip purposes on this corridor (goods movement, commuter, special generators etc.), vehicle requirements, origins and destinations of existing traffic; and planned future population and employment growth. The Evaluation of Crossing Scenarios (http://engage.gov.bc.ca/masseytunnel/files/2015/06/GMT-2014-March_Evaluation-of-Crossing-Scenarios.pdf) provides further background information on the preliminary analysis on alternatives considered to the Project.</p> <p>The Ministry worked with TransLink and area municipalities, including the City of Richmond, Corporation of Delta, and Metro Vancouver, to identify the improvements that could be incorporated into the Project to provide needed capacity improvements while also further encouraging transit, car-pooling, walking and cycling as alternatives to single occupancy vehicles on this corridor.</p> <p>The Ministry recognizes that this route is the busiest transit route of all the Fraser River road crossings, carrying more than 10,000 transit users daily, and has reflected this in the substantial transit improvements that have been incorporated in the Project scope. Improvements for transit on opening day include dedicated transit/ HOV lanes within the median for 24 km in each direction, integrated transit stops within the Steveston and Highway 17A interchanges and a dedicated transit ramp at Bridgeport Road enabling direct transit access to and from the Canada Line at Bridgeport Station. These measures will make transit more convenient and improve the reliability of transit travel times. A pedestrian and cycling pathway on the bridge with connections to the existing trail and cycling network in Richmond and Delta will allow cyclists and pedestrians to freely cross the Fraser River at this location. In addition, the new bridge will be built to accommodate potential future rapid transit.</p> | <p>Section 1.1 of the Application discusses the Project components, and will include a discussion on transit infrastructure for the Project.</p> <p>The Ministry continues to consult with TransLink, local governments and other stakeholders on the incorporation of transit into the Project scope.</p> <p>During operation, the Project will support provincial and regional strategies to encourage mode shift to transit and carpooling by providing continuous, dedicated transit/HOV lanes in both directions along Highway 99 between Surrey and Vancouver.</p> | <p>N/A</p> |

| Theme | Response | Action/Status | Applicable Mitigation |
|--|---|--|--|
| <p>Desire for greenhouse gas emissions reduction:</p> <ul style="list-style-type: none"> Federal and provincial targets Concern about increased traffic Suggestions that better options are available to reduce GHGs | <p>Greenhouse gas (GHG) emissions are discussed in Section 4.9 Air Quality of the Application. The Project is expected to help decrease future greenhouse gas emissions as compared with maintaining the existing Tunnel, supporting provincial and federal GHG reduction targets. This is due to reduced congestion-related idling as well as the effect of travel-demand management measures that promote transit, cycling and walking as alternatives to the single-occupant vehicle, discouraging growth in vehicle traffic over time.</p> <p>The findings of the Traffic assessment (Section 5.1) have been used to inform the assessment of air quality.</p> | <p>Section 4.9 of the Application discusses Air Quality. This section includes a discussion on Greenhouse Gas emissions.</p> | <p>The 2031 scenario with the Project shows an improvement in air quality compared to existing conditions.</p> |
| <p>Project funding:</p> <ul style="list-style-type: none"> Rationale for toll framework as proposed Equity concerns Suggestions to toll all bridges Suggestion that port/marine users should pay for the bridge | <p>The Province intends to fund the Project, at least in part, through user tolls. Consistent with Provincial Tolling Guidelines (http://engage.gov.bc.ca/masseytunnel/files/2015/06/GMT-2014-March_Evaluation-of-Crossing-Scenarios.pdf), tolling recognizes that those directly benefiting from the new infrastructure in terms of time savings and reliability should help pay for the Project. Tolling also ensures that the needed improvements can proceed now, without taking funding away from health care and education and without having to wait for years in the future when improvements will be even more overdue.</p> <p>Tolling is aligned with Metro Vancouver's Regional Growth Strategy's vision of compact communities, shorter travel distances and less vehicle traffic by encouraging transit and car-pooling and limiting traffic growth over time. This will result in a reduction in overall daily traffic levels, reducing GHG emissions.</p> <p>Phase 3 Consultation, held from December 2015, to January 2016 on the Ministry's Project Definition Report sought public feedback on tolling as a funding source. Results of this phase of consultation (http://engage.gov.bc.ca/masseytunnel/files/2016/04/Phase-3-Consultation-Summary-Report-March-2016.pdf) indicate that most participants supported tolling as a funding mechanism, although many participants suggested that tolling should be applied in the context of a regional tolling policy.</p> <p>It is anticipated that discussions about regional tolling will continue for some time and encompass a broad range of considerations. Any changes to the Provincial Tolling Guidelines may affect additional crossings and would be considered in advance of the anticipated start of tolling the new bridge, scheduled to open in 2022. The Province will continue discussions with the federal government to explore a funding partnership and confirm Project funding plans.</p> | <p>Section 1.1 of the Application includes a discussion on tolls in the context of Project financing.</p> <p>The Province will continue discussions with the federal government to explore a funding partnership and confirm Project funding plans.</p> | <p>N/A</p> |
| <p>Project size</p> <ul style="list-style-type: none"> Why 10 lanes? Recommendations for fewer lanes | <p>The assessment undertaken by the Ministry to confirm the appropriate number of lanes for the replacement bridge considered current traffic data, forecast volumes, safety, and other factors. As outlined in the Traffic Data Overview Report (http://engage.gov.bc.ca/masseytunnel/files/2015/12/Traffic-Data-Overview-2015.pdf) the Ministry's analysis confirmed a 10 lane bridge: results in greater safety benefits; provides room for trucks and other slower-moving traffic; facilitates the large volume of traffic entering and exiting the highway at the interchanges on either side of the crossing; allows for continuous dedicated median transit/ HOV lanes between Highway 91 in Delta and Bridgeport Road in Richmond, accommodates potential future rapid transit and; provides the capacity to handle future population and employment growth. An eight lane bridge would result in congestion on opening day, and therefore would not achieve one of the Project's primary objectives.</p> <p>As outlined in the Project's Business Case (http://engage.gov.bc.ca/masseytunnel/files/2015/12/Business-Case-Oct-2015.pdf), and the Evaluation of Crossing Scenarios (http://engage.gov.bc.ca/masseytunnel/files/2015/06/GMT-2014-March_Evaluation-of-Crossing-Scenarios.pdf), analysis confirmed that a 10-lane bridge results in greater safety benefits, with a projected 35 per cent reduction in collisions relative to the average annual collisions at the Tunnel and adjacent infrastructure.</p> | <p>Section 1.1 of the Application discusses the Project components and Section 1.4 of the Application discusses the rationale for having 10 lanes.</p> | <p>N/A</p> |

| Theme | Response | Action/Status | Applicable Mitigation |
|--|--|--|--|
| <p>Traffic diversion effects of tolling</p> <ul style="list-style-type: none"> • What impact will tolling the new bridge have on the Alex Fraser Bridge, Highway 91 and connecting routes? • Why not just toll the existing crossing to reduce traffic and the need for a new bridge? | <p>Traffic forecasts for the Project have been developed based on a program of in-depth research, data collection and analysis including consideration of the Regional Growth Strategy and Regional Transportation Model projections. Traffic volumes and patterns at the new Port Mann Bridge have also been evaluated in developing traffic forecasts for the Project.</p> <p>This work shows that during rush hours, traffic volumes on the new bridge likely will increase as some people switch from the congested Alex Fraser Bridge to the new bridge to take advantage of the time savings and increased reliability. That is the experience from other tolled crossings including the Port Mann Bridge as outlined in the Traffic Data Overview Report (http://engage.gov.bc.ca/masseytunnel/files/2015/12/Traffic-Data-Overview-2015.pdf).</p> <p>Outside of rush hours, the Ministry anticipates that some people will divert from the new bridge to the Alex Fraser Bridge to avoid paying the toll, while others will use it at all times of the day because of the convenience. This could lead to a reduction in volumes on evenings and weekends on the new bridge.</p> <p>Tolling the existing Tunnel without improvements may lead to some reduction in traffic, but does not meet current tolling guidelines, would put extreme pressure on the already congested Alex Fraser Bridge, and would not serve the broader regional and provincial needs to move goods and people.</p> <p>The Application will assess the potential Project related changes in traffic, and will include a discussion on potential effects related to tolling.</p> | <p>Section 5.1 of the Application discusses the potential Project related effects on traffic and includes a discussion on the potential effects of tolling.</p> <p>Section 1.1 of the Application includes a discussion on tolls in the context of Project financing.</p> | <p>Tolling will assist in managing traffic congestion, reduce future growth in traffic; and emissions; and support more favourable mode-share choices.</p> |
| <p>Risk of urban sprawl:</p> <ul style="list-style-type: none"> • Concern that the Project will encourage more car-based travel • Concern that the Project will change regional development patterns | <p>The Project aligns with regional and local land use plans including population and employment projections contained in Metro Vancouver's Regional Growth Strategy: Metro 2040.</p> <p>As communities grow, the need for travel grows. This includes travel for goods and services, much of which cannot be done via transit.</p> <p>The Project will reduce congestion, improve travel time and reliability, improve transit service, provide new alternatives for cycling and walking, provide safe alternatives for slower moving traffic, help improve travel time and reliability for Highway 99 Rapid Bus service, and pave the way for future rapid transit as demand grows. Most of these would not be possible if the Tunnel is not replaced.</p> <p>Land use is assessed in Section 5.3 of the Application. The assessment of land use describes how the Project aligns with and supports the implementation of regional and local land use plans, and population and employment projections identified in such plans. The assessment of traffic, and potential project related changes in traffic supported the assessment of land use.</p> | <p>Section 5.3 of the Application discusses how the Project aligns with local, provincial, and regional land use plans and designations, and will assess potential Project related changes to land use.</p> | <p>The Project supports overall regional growth trends under the land use plan set out in Metro Vancouver's Regional Growth Strategy</p> |
| <p>Impacts to the Fraser River and species:</p> <ul style="list-style-type: none"> • Potential effects on salmon • Potential effects on whales • Potential effects on birds • Potential effects on other species generally | <p>The Ministry recognizes that the Fraser River is a very important ecological area for fish and wildlife species, including salmon, sturgeon, eulachon, marine mammals, and migratory birds. The Fraser River and associated fish and wildlife habitat will be discussed as part of the following components: Fish and Fish Habitat, Sediment and Water Quality, Underwater Noise, River Hydraulics and Morphology, Marine Mammals, Marine Use and Terrestrial Wildlife (including birds).</p> | <p>The following sections of the Application discuss the Fraser River and associated fish and wildlife habitat:</p> <ul style="list-style-type: none"> • Section 4.2 Water Quality • Section 4.4 Fish and Fish Habitat • Section 4.6 Marine Mammals • Section 4.8 Terrestrial Wildlife | <p>Measures to avoid, reduce, or mitigate effects to these components are discussed in each individual section.</p> |

| Theme | Response | Action/Status | Applicable Mitigation |
|--|--|--|---|
| <p>Options for non-single occupant vehicles:</p> <ul style="list-style-type: none"> • HOV lanes • Bike/pedestrian pathway • Bus lanes • Transit stops | <p>The Project scope includes substantial measures to promote transit, car-pooling, walking and cycling as alternatives to single occupant vehicles. Improvements on opening day include dedicated transit/ HOV lanes within the median for 24 km in each direction, integrated transit stops within the Steveston and Highway 17A interchanges and a dedicated transit ramp at Bridgeport Road enabling direct transit access to and from the Canada Line at Bridgeport Station. These measures will make transit more convenient and improve the reliability of transit travel times.</p> <p>Multi-use pathways on the new bridge will provide new and enhanced opportunities for cyclists and pedestrians, as well as enhanced connections to community trails and cycling routes for interchange and overpass reconstructions.</p> <p>The Ministry consulted with TransLink, local communities and cycling stakeholders and has initiated a GMT Cycling Working Group to further engage with these groups in finalizing cycling plans.</p> | <p>Section 1.1 of the Application discusses the Project components, and will include a discussion on transit infrastructure for the Project.</p> <p>The Ministry continues to consult with TransLink, local governments and other stakeholders, including cyclists on the incorporation of transit and cycling infrastructure into the Project scope.</p> | <p>The Project was developed to help mitigate current and anticipated traffic challenges that are resulting in adverse effects on environmental, economic, social, and health values.</p> |
| <p>Noise</p> <ul style="list-style-type: none"> • Noise during construction • Changes in noise related to changes in traffic | <p>An effects assessment for noise, both during construction and Project operation is included in Section 4.10 Atmospheric Noise the Application. The parameters of the assessment for noise study are based on the anticipated Project construction activities, and traffic-related noise during operation.</p> <p>The assessment of community noise impacts follows the British Columbia Ministry of Transportation and Infrastructure, Policy for assessing and mitigating noise impacts from new and upgraded numbered highways, April 2014 (http://www.th.gov.bc.ca/publications/eng_publications/environment/references/MoTI_Noise_Policy_April_23_2014.pdf).</p> | <p>Section 4.10 of the Application discusses Atmospheric Noise.</p> | <p>A Noise Management Plan will be developed as part of the Construction Environmental Management Plan and will describe standard best practices to be implemented to minimize temporary, unavoidable construction-related noise.</p> |
| <p>Impacts to Deas Island Regional Park:</p> <ul style="list-style-type: none"> • Park experience • Access to the Park • Habitat values of the Park | <p>The Project presents an opportunity to create environmental and recreational improvements on the Fraser River, and within Deas Island Regional Park and Deas Slough. The new bridge will allow for connection of Deas Island Regional Park, which is currently separated by Highway 99 and the Tunnel. This will provide opportunities for improved access to and within the Park. Access to the Park will be maintained, during and post construction.</p> <p>Environmental opportunities include re-alignment of Green Slough and the creation of marsh habitat to support fish and wildlife.</p> | <p>Section 5.3 of the Application discusses Deas Island Regional Park.</p> <p>Section 4.4 of the Application discusses enhancement opportunities associated with Green Slough.</p> <p>The Ministry will continue to work with Metro Vancouver Parks regarding the enhancements associated with Deas Island Regional Park.</p> | <p>The Project is being built within the existing Highway 99 ROW (i.e., an already disturbed and developed corridor).</p> <p>Enhancement opportunities associated with land use, fish, and vegetation/ecosystems are being explored and are presented in the Application.</p> |

11.2.4 Future Consultation

Throughout the Application Review stage, the Ministry will continue to engage with the public and stakeholders. This will include, but not be limited to maintenance of the Project website, Project Office, and community relations program as described in **Section 11.2.2**.

The Application Review will include a public comment period. Activities related to the public comment period will be undertaken in a similar format as during the pre-Application phase public comment period. The proposed format for this consultation period is outlined in the Public Consultation Plan

(http://a100.gov.bc.ca/appsdata/epic/html/deploy/epic_document_430_39675.html).

If an EAC is awarded, the Ministry will continue to consult and engage with stakeholders and the public as the Project moves into subsequent Project phases (i.e., construction and operation). Consultation and engagement activities may include but are not limited to:

- Providing updates on the Project website and to the Project database and responding to public enquiries that arise from these updates.
- Presentations to community groups.
- Consultation with property owners and community groups.
- Surveys and consultations to measure project success against performance measures noted on page 30 of the Project Definition Report
- Development and implementation of construction environmental management plans.

Table 11.2-4 Public Consultation Schedule Summary

| Activity | Responsibility | Anticipated Timing |
|---|-----------------------|-------------------------------|
| Ongoing public and stakeholder engagement | | |
| All phases | Ministry | Nov 2012-Dec 2022 |
| Initial Engagement – Project conception and planning | | |
| Phase 1 consultation | Ministry | Nov/Dec 2012 |
| Phase 2 consultation | Ministry | Mar/April 2013 |
| Phase 3 consultation | Ministry | Dec 2015/Jan 2016 |
| Pre-Application Phase – issuance of section 10 Order to Application submission | | |
| Notifications for public open houses and public comment period on Project Description and Key Areas of Study document | Ministry/EAO | Jan 2016 |
| Public comment period on Project Description and Key Areas of Study document, including public open houses | Ministry/EAO | Jan 15-Feb15, 2016 |
| Ministry responses to public comments on Project Description and Key Areas of Study document including Public Consultation Report | Ministry | Feb 15 – March 2016 |
| Technical Working Group Meetings | EAO/Ministry | 21 Jan 2016 10 Mar 2016 |
| Application Review Phase - Application submission date to end of the (up to) 180-day Application Review stage (current stage). | | |
| Notifications for public open houses and public comment period on Application for EAC | Ministry/EAO | Summer 2016 |
| Public comment period on EAC Application, including public open houses | Ministry/EAO | Summer 2016 |
| Ministry responses to public comments on EAC application | Ministry | Summer 2016 |
| Public consultation report on Application Review phase | Ministry | Summer 2016 |
| Technical Working Group Meetings | EAO/Ministry | Dates to be determined by EAO |
| Post-EA - Post EAC issuance including for permitting, and throughout construction | | |
| On-going engagement | Ministry | ~ Winter 2016– Dec 2022 |

Part E – Management Plans and Follow-Up Programs

12.0 Management Plans

This section presents a summary of construction and operation environmental management plans (EMPs) that will be developed for works to be undertaken during construction (Construction EMP (CEMP)) and post-construction/operation (Operations EMP (OEMP)) of the Project. The requirements for Traffic Management, Marine Access Management, and Health and Safety Plans are also described. This section outlines the framework and content to be provided in the described plans, including associated monitoring and follow-up programs that will be developed and implemented.

12.1 Construction Environmental Management Plan

The objectives and components of the CEMP will be developed based on the recommended mitigation measures described in the Application, applicable legislation (licenses, permits, and approvals), BMP guidance documents, and the Ministry's *2012 Standard Specifications for Highway Construction: Section 165 Protection of the Environment* (B.C. MOTI 2012).

In addition to the components of the CEMP described within this section, it is expected that site-specific environmental work plans (EWPs) will be developed for specific Project construction components or (temporal or spatial) phases of construction, as appropriate. Site-specific work plans will be supplementary to the CEMP and will address the construction activities and environmental considerations applicable to a specific site or activity. Environmental work plans will be developed as required during Project construction and are therefore not discussed further in this section.

The objective of the CEMP is to provide guidance on actions and activities that will be carried out during Project construction. It will describe the environmental protection measures to be implemented during Project activities to address potential environmental effects of Project construction, and will comply with the environmental commitments described in **Part B – Assessment of Environmental, Economic, Social, Heritage, and Health Effects**, and summarized in **Section 14.2 Summary of Mitigation Measures**, as well as any provincial and federal licenses, permits and approvals required for the Project.

The CEMP will identify measures to reduce the risk of occurrence of incidents that could affect the environment, and minimize any effects that are unavoidable. The CEMP will provide a description of the roles and responsibilities of the environmental management team, the environmental mitigation and monitoring that is required for each of the sub-components within the CEMP, and will identify and describe environmentally sensitive zones within the Project alignment.

An environmental management team will be engaged, and will be comprised of qualified individuals who will develop and implement the CEMP. The environmental management team will have primary responsibility for confirming that the environmental management measures, controls, and specifications described within the CEMP are properly implemented. Mitigation and environmental management measures proposed for Project construction follow guidance documents and best management practices (BMPs) for land and highway development projects, and will be used during EMP preparation (see **Part B – Assessment of Environmental, Economic, Social, Heritage, and Health Effects**, and summarized in **Section 14.2 Summary of Mitigation Measures**), including but not limited to:

- *Best Management Practices for Pile Driving and Related Operations* (B.C. MPDCA 2003).
- *Develop with Care 2014: Environmental Guidelines for Urban and Rural Land Development in British Columbia* (B.C. MOE 2014).
- *Dredge Management Guidelines* (FREMP 2005).
- *Guidelines for Amphibian and Reptile Conservation during Urban and Rural Development in British Columbia* (B.C. FLNR 2014).
- *Guidelines for Raptor Conservation during Urban and Rural Land Development in British Columbia* (B.C. MOE 2013).
- *Land Development Guidelines for the Protection of Aquatic Habitat* (Chilibeck et al. 1993).
- *Measures to Avoid Causing Harm to Fish and Fish Habitat* (DFO 2013a).
- *Riparian Areas Regulation Implementation Guidebook* (B.C. MWLAP 2006).
- *Standards and Best Practices for Instream Works* (B.C. MWLAP 2004).

General BMPs that will be followed during construction will include:

- Maintenance of appropriate riparian setbacks along the Fraser River, Green Slough, Deas Slough, upland watercourses, and ditches.
- Storage and usage of deleterious substances more than 30 m away from a watercourse.
- Implementing appropriate vegetated buffers around raptor nests to mitigate sensory disturbance.
- Minimizing undertaking work during severe weather, which may increase the potential for erosion and sedimentation.
- Conducting works in a manner that will prevent the discharge or introduction of deleterious substances (including soil, sediment, or sediment-laden water, or turbid water) into the environment.

- Operation and storage of land- and marine-based equipment in a manner that will prevent damage to sensitive ecosystems and habitat.
- Utilizing existing linear and developed areas wherever possible to avoid unnecessary disturbance to undeveloped areas.
- Identifying and demarcating wildlife features within the Project alignment both on site plans and in the field.
- Avoiding clearing vegetation during the applicable nesting seasons for breeding birds (March 15 to July 31) and raptors (February 1 to August 14) whenever possible.
- When clearing may be required during the nesting season, conducting pre-clearing surveys and establish and maintain species-appropriate setbacks around active nests.
- Conducting instream works within the applicable least-risk timing windows whenever possible, unless otherwise approved.

Environmental monitoring will be conducted during construction of the Project and will have the key objective of ensuring construction activities are undertaken in accordance with the mitigation described within the Application and EAC, CEMP, and associated permits, licenses, and approvals. The CEMP will describe the frequency and scope of environmental monitoring and reporting that will be implemented throughout construction of the Project.

Implementation of the environmental monitoring program will be overseen by a qualified environmental professional and will be carried out during all construction activities that have the potential to result in adverse environmental effects. The environmental monitor will assess the implementation of the CEMP and any permits or approvals assigned to the Project, as well the effectiveness of the mitigation applied. The environmental monitor will be authorized to suspend any activity resulting in or potentially resulting in a breach of the CEMP or associated environmental permits, licences, and approvals. The CEMP will describe:

- Procedures to be undertaken to ensure work is conducted in accordance with the conditions of the EAC, applicable regulatory permits, licences, approvals, authorizations, and Ministry standards.
- A summary of the specific monitoring components to be undertaken.
- A schedule of when certain monitoring is to be conducted to fulfill the objectives of CEMP and its sub-components.
- Procedures and communications to be followed to track progress of action items and remediation requirements.
- Reporting requirements including format, timing, and distribution of environmental monitoring reports.

The CEMP will also describe training objectives and procedures to be used to maintain awareness of Project personnel regarding environmental considerations relevant to Project construction. Project personnel will be required to undertake environmental and safety orientation and awareness training prior to commencing onsite work. Training will include educating Project personnel on:

- Health and safety, and environmental roles and responsibilities of Project personnel.
- Project contacts, incident reporting procedures, and communication protocols.
- The objectives and purpose of the CEMP.
- Potential environmental issues that could occur during construction.
- Applicable regulatory compliance requirements and mitigation measures that are to be implemented during construction activities.
- Environmentally sensitive areas within the Project alignment.

The CEMP requires the preparation of a series of component plans, which will address more specific mitigation measures. The sub-component plans are expected to include:

- Air Quality and Dust Control Management Plan
- Agricultural Management Plan
- Archaeological and Heritage Resources Management Plan
- Contaminated Sites Management Plan
- Emergency Response and Spill Contingency Plan
- Erosion and Sediment Control Plan
- Fish and Fish Habitat Management Plan
- Marine Mammal Management Plan
- Noise Management Plan
- Terrestrial Vegetation and Wildlife Management Plan
- Waste Management Plan

12.1.1 Air Quality and Dust Control Management Plan

An Air Quality and Dust Control Management Plan will be developed, and will describe standard industry and best management practices to control and minimize fugitive dust and other airborne emissions associated with the operation of construction equipment, demolition and related decommissioning activities, stockpiling and handling of soils, and other construction activities.

This plan will describe the:

- Regulatory permits necessary for the operation of construction equipment or machinery capable of producing point-source emissions.
- Mitigation to be implemented during construction may include:
 - Procedures for the application of dust suppressants to construction areas and stockpiles to control fugitive dust and other airborne emissions.
 - Routine maintenance of vessels and vehicles.
 - Implementation of engine idling restrictions and selection of quieter vessels and vehicles when possible.
 - Managing speeds of construction-related vehicles.
- Air quality monitoring to be undertaken during Project construction activities with the potential to generate fugitive dust.

12.1.2 Agricultural Management Plan

An Agricultural Management Plan will be developed which will describe measures to avoid or mitigate potential impacts to agricultural land and activities during construction. The mitigation measures will be developed in parallel with planning the design and construction methodology for the Project, and shared with appropriate regulatory agencies and farm organizations prior to being finalized. Mitigation will be developed to minimize potential construction-related impacts to agricultural operations due to delays or detours during construction, changes in utilities or drainage/irrigation, and temporary usage of Agricultural Land Reserve land.

The plan will describe standard best practices and Project-specific mitigation measures to prevent or minimize potential adverse effects on drainage, water quality, and irrigation; farm infrastructure and operations; and soil conservation, storage, and reclamation. The plan will include:

- Procedures required for the reconstruction or upgrading of ditches in accordance with the B.C. *Agricultural Drainage Criteria* (B.C. MOAFF 2002).
- Consultation and communication program that will be undertaken to pro-actively inform farm operators potentially affected by Project-related activities during construction including potential changes in noise, drainage and irrigation, utilities, fencing, land use, and traffic.
- Procedures required to minimize the disruption of utility services (particularly power and natural gas supply) during construction, including if alternative power sources (e.g., generators or temporary power lines) may be required.

- Replacement requirements for any agricultural fences that may be damaged or moved as a result of the Project.
- Traffic management that will be implemented along major and secondary roads to facilitate the efficient movement of agricultural traffic throughout the communities and mitigate for temporary disruptions and increased traffic during construction.
- Mitigation to be implemented to reduce the potential for degradation of agricultural soils including, where possible:
 - Using non-arable areas for temporary laydowns and roads.
 - Reducing traffic in agricultural fields.
 - Developing a soil salvage, stockpile, and reclamation plan.
 - Implementing the spill response and contingency measures (as part of an Emergency Response and Spill Contingency Plan of the CEMP).
 - Implementing the erosion and sediment control measures, as part of the Erosion and Sediment Control Plan of the CEMP.
- A monitoring program that will be developed to evaluate the effectiveness of the mitigation implemented.

12.1.3 Archaeological and Heritage Resources Management Plan

An Archaeological and Heritage Resources Management Plan will be developed to address heritage site stewardship and protection relative to Project construction activities. The plan will be developed with guidance, where applicable, from the B.C. Archaeology Branch, as well as existing Ministry policies and procedures. It is not anticipated that previously undiscovered archaeological sites will be encountered during construction. Consistent with regulatory requirements and recognized best practices, the plan will describe:

- A chance-find procedure to be followed during construction in the event that a previously unknown heritage resource is encountered.
- A human remains protocol to be followed during construction in the event that human remains are encountered.
- Proper identification, reporting, and management of archaeological, heritage, and historical resources within the Project alignment.
- Roles and responsibilities of a professional archaeologist to ensure archaeological monitoring is conducted as required.

12.1.4 Contaminated Sites and Sediment Management Plan

A Contaminated Sites and Sediment Management Plan will be developed to guide the management of known or encountered contaminated sites within the Project area in compliance with the *Environmental Management Act*, S.B.C. 2003, c. 53, Contaminated Sites Regulation, B.C. Reg. 375/96, and relevant best practices and appropriate BMPs. It will also be developed to ensure that imported material or fill moved between Project locations or brought from off-site locations is clean and conforms to the criteria established in the *Environmental Management Act*, Contaminated Sites Regulation. The plan will:

- Describe procedures to be undertaken to ensure proper reporting and management of known or encountered contaminated sites within the Project alignment.
- Identify criteria and describe procedures for site characterization of excavated riverbed material in preparation for Tunnel removal.
- Outline regulatory and permitting requirements for upland disposal of excavated material.
- Identify procedures for selection of upland sites for disposal of excavated material in conformance with the *Environmental Management Act*, *Contaminated Sites Regulation*, and applicable soil deposition permits.

12.1.5 Emergency Response and Spill Contingency Plan

An Emergency Response and Spill Contingency Plan will be developed and will describe how construction personnel will prevent, prepare for, respond to, and clean up spills. The plan will include a description of spill prevention measures and clean up equipment that will be required onsite, as well as the procedures (containment, clean-up, and disposal) to be undertaken for marine and terrestrial environments.

The plan will describe the appropriate BMPs and procedures for preparing for and responding to Project-related emergencies, such as:

- Spills of toxic or hazardous materials (e.g., hydrocarbon fuels, lubricants, or concrete) into terrestrial and aquatic habitat, including environmentally sensitive sites.
- Structural failure of a culvert, ditch, detention pond, or sediment containment facility resulting in localized flooding, erosion, sedimentation, or discharge of deleterious materials to the environment.
- Inappropriate operation of machinery or equipment that leads to the disturbance of environmentally sensitive habitat or impacts to wildlife.
- Accidents involving collisions between vehicles moving through or around construction areas at the Project site.
- Marine vessel grounding and collision with other vessels, marine facilities, or marine mammals.

The plan will describe the following key components:

- Site security and personnel safety.
- Pre-emergency planning and risk identification.
- Emergency organization and training, as well as emergency personnel responsibilities (including contact details, emergency telephone lines), and command structure.
- Emergency response, and evacuation procedures.
- Identification, storage, and management of potentially deleterious materials.
- Spill identification.
- Spill containment materials available onsite and how to use them.
- Specific spill reporting requirements in accordance with the Spill Reporting Regulation under the *BC Environmental Management Act*.
- Communication requirements, including a communications plan to inform applicable stakeholders of a spill.
- Site restoration and remediation requirements.
- Post-incident evaluation and follow up and preventative actions.

12.1.6 Erosion and Sediment Control Plan

An Erosion and Sediment Control Plan will be developed, and will describe standard BMPs, and mitigation measures that will be implemented to prevent or minimize adverse effects to water quality in upland ditches and the marine environment. The primary objective of the plan will be to ensure that, during Project construction, water from the site that is discharged into the receiving environment will meet suspended sediment requirements outlined in the Canadian Council of Ministers of the Environment (2002) and the B.C. (B.C. MOE 2006) water quality guidelines. Erosion prevention and sediment control measures that will be implemented during construction may include:

- Developing temporary drainage systems to receive, filter, and direct stormwater and runoff during construction.
- Installation of sediment control measures.
- Developing sediment settlement ponds, if required.
- Re-stabilization of vegetated areas that are cleared or disturbed during construction.
- Careful storage of waste material and soil to prevent possible entry into the aquatic environment.

The plan will describe:

- Measures to be applied to mitigate soil erosion and sediment transport to the receiving environment such as installing silt fences or other appropriate mitigation.
- Measures to control sediment-laden flows and prevent sediment-laden water from entering watercourses such as utilizing gravel filter dikes, sedimentation ponds, or other water quality management measures to be selected and implemented on a site-specific basis.
- Guidelines to be followed to mitigate erosion and sediment transport, such as:
 - Develop with Care: Environmental Guidelines for Urban and Rural Land Development in British Columbia (2014).
 - Standards and Best Practices for Instream Works (MWLAP 2004).
- Procedures for monitoring, maintenance, repair, or replacement of stormwater drainage and sediment control systems.
- Maintenance procedures for managing stockpiled material to minimize erosion or generation of fugitive dust.
- Measures to control the dispersion of re-suspended sediments during in-water activities with the potential to result in physical disturbance.
- Water quality monitoring to be undertaken during Project construction activities that have the potential to induce turbidity, including sampling locations and frequency, as well as federal and provincial water quality criteria to be used for the evaluation of water quality samples.
- Protocols to address and resolve issues in the event that water quality parameters exceed, or have the potential to exceed, federal and provincial guidelines.
- Incident reporting requirements and the approach to be undertaken in the event of a reportable release of sediment or sediment-laden water into a watercourse.
- Proper storage and disposal of construction waste, soil, or other potentially deleterious substances, to prevent entry to the aquatic environment.
- Applicable vegetated buffer areas to be applied on a site-specific basis.

12.1.7 Fish and Fish Habitat Management Plan

A Fish and Fish Habitat Management Plan will be developed to protect fish and fish habitat during construction. The objectives of the plan will be to protect aquatic, foreshore and riparian habitat by avoiding or minimizing impacts through Project design and construction methodology and the application of mitigation measures. The plan will comply with the *Fisheries Act*, and provincial standards and best practices, including the Ministry's 2012 *Standard Specifications for Highway Construction* (B.C. MOTI 2012), and the Ministry's *Environmental Best Practices for Highway Maintenance Activities* (B.C. MOTI 2010). The plan will be provided to applicable regulatory agencies for review prior to finalization.

The plan will as a minimum:

- Identify and classify fish habitat within the Project alignment.
- Describe protection zones to be delineated with fencing or other protection to minimize erosion or sedimentation including appropriate riparian setbacks on a site-specific basis.
- Describe regional least-risk timing windows to be applied during specific Project activities (e.g., Tunnel decommissioning, in-stream works in and around upland watercourses) that have the potential to cause adverse effects to fish and fish habitat.
- Describe watercourse isolation measures and fish salvage and relocation activities to be applied in the event that in-stream works in upland watercourses are to be undertaken outside least-risk timing windows (in consultation with FLRN and DFO).
- Describe ditch realignment and applicable riparian restoration guidelines (e.g., B.C. MELP 1996, B.C. MOE 2008b).
- Describe construction and post-construction fish and fish habitat monitoring requirements.

12.1.8 Marine Mammal Management Plan

A Marine Mammal Management Plan will be developed to reduce the potential for effects of the Project on marine mammals during construction. The plan will describe standard best practices and mitigation measures that will be implemented to minimize underwater noise generated during marine-based construction activities, and to mitigate the potential for physical injury to marine mammals. Mitigation and monitoring measures that will be described in the plan will include, but will not be limited to:

- Limited use of engines and propellers on stationary vessels, whenever possible.
- Maintaining consistent navigation courses and speeds.
- Conducting land-based pile driving whenever possible.
- Conducting activities with the potential to generate underwater noise as efficiently as possible.
- Avoiding unnecessary idling of marine-based equipment.
- Procedures to prevent direct or indirect discharge of deleterious substances (including soil, sediment, sediment laden or turbid water, or fuel, and oils) into the marine environment.
- Implementation of marine mammal monitoring during activities anticipated to generate underwater noise, including an underwater noise monitoring program.
- Underwater noise monitoring to be conducted during Project construction activities that have the potential to generate underwater sound levels that may exceed auditory thresholds that can cause physical injury to fish and marine mammals.

12.1.9 Noise Management Plan

A Noise Management Plan will be developed to describe measures that will be implemented to minimize community impacts to temporary, unavoidable construction-related noise. Noise abatement measures and timing of specific construction activities will be planned to limit disruption to sensitive receptors including adjacent residential communities, educational facilities, places of worship, recreational areas, and wildlife. Construction-related noise will be reduced by implementing best practices and measures to reduce noise created by machinery used during construction as much as possible.

The plan will describe mitigation to be implemented to reduce, wherever possible, noise generated by marine and land-based construction activities. The plan will describe:

- Equipment and activity restrictions to be implemented to minimize noise emissions.
- Site-specific construction schedules and activities.
- Procedures and best management practices to control construction noise emissions such as using mufflers on equipment and maintaining equipment in good working order.
- Developing and implementing a community relations/stakeholder communication program to inform potentially affected communities of construction schedules and activities that may create temporary increases in noise. Communication methods may include signage, a telephone line, web-based updates and communications, newspaper ads, or direct communication.
- Noise monitoring to be undertaken during Project construction activities with the potential to generate fugitive dust and increased noise.
- Developing and implementing a construction noise monitoring program to document community noise exposures and assess effectiveness of implemented mitigation measures.

12.1.10 Terrestrial Vegetation and Wildlife Management Plan

A Terrestrial Vegetation and Wildlife Management Plan will be developed to avoid or mitigate potential impacts to vegetation and wildlife species during Project construction. The plan will be developed in parallel with finalizing the design and construction methodology of the Project and will be provided to applicable regulatory agencies (such as the B.C. Ministry of Forests, Lands and Natural Resource Operations).

The plan will:

- Provide current information on the presence of environmentally sensitive areas within the Project alignment and any specific procedures that may be required within each sensitive area.
- Provide guidelines on minimizing Project disturbance, use of heavy machinery to avoid soil compaction, and duration of construction.
- Describe pre-construction requirements including permitting, nest survey protocols, timing windows, buffer zones, and wildlife salvage and translocation procedures that may be required.
- Procedures for managing and reporting on interactions with wildlife, including wildlife observations, and wildfire injury or mortality as a result of construction activities.
- Describe rehabilitation requirements that should be undertaken following unavoidable disturbance to terrestrial habitat.
- Describe measures to offset unavoidable habitat loss effects to terrestrial vegetation and wildlife.
- Describe during and post-construction monitoring requirements to confirm offsetting measures are functioning as intended.

Mitigation measures that will be implemented during construction will include procedures such as:

- Site preparation activities to be undertaken prior to commencement of construction, including:
 - Identification on site plans and demarcation in the field of wildlife habitat areas, including nests or wildlife trees.
 - Providing training and education on wildlife that could be expected to occur within the Project alignment.
- Appropriate storage and waste disposal procedures to reduce wildlife attraction.
- Appropriate mitigation for decommissioning of the Deas Slough Bridge to mitigate impacts to barn swallows.
- Appropriate measures to be undertaken for vegetation clearing activities including undertaking clearing within the least-risk timing window for breeding birds (approximately August 1 to March 14) and raptors (approximately August 15 to January 30).
- If works cannot be conducted within the appropriate timing windows, pre-clearing nest surveys will be undertaken by a qualified professional.
- Maintenance of appropriate disturbance buffer zones around active raptor nests.

- Invasive species management requirements to be implemented to mitigate the introduction, transport, and expansion of invasive plant species and noxious weeds to, within, and from the Project area, including:
 - Identification of invasive plants and noxious weeds known to be, or having the potential to be present within the Project alignment including species for which there is a requirement to control under the B.C. *Weed Control Act*, R.S.B.C. 1996, c. 487, as well as species that are listed by the Invasive Species Council of Metro Vancouver.
 - Appropriate monitoring and control methods.

12.1.11 Waste Management Plan

A Waste Management Plan will be developed and will describe the provisions for minimizing waste production, and appropriate methods for management of hazardous and non-hazardous material. The plan will describe the transport, recycling and disposal procedures that will be required to manage waste that is expected to be generated during construction activities. Waste materials produced during construction may include steel and concrete materials, sand and gravel, and organic materials generated from vegetation clearing. Waste management that will be described within the plan will include:

- Appropriate disposal procedures to manage construction materials, waste material, sediment and soil, or other materials or substances potentially deleterious to the marine or terrestrial environment.
- Appropriate management measures for managing material (such as garbage) that may attract wildlife.
- Disposal of solid waste at an appropriate disposal or recycling facility.
- Reusing and recycling materials whenever possible.

In the event that hazardous materials are encountered, they will be transported, handled, and disposed of in accordance with the *Environmental Management Act*, Hazardous Waste Regulation, B.C. Reg. 63/88. The plan will describe how construction debris will be managed to ensure compliance with the *Environmental Management Act* as well as the procedures for waste reduction, re-use and recycling, and appropriate waste disposal. Where construction activities will involve the handling, storage, and removal of hazardous waste, a description and quantity of the hazardous waste generated, stored, or removed will be recorded. Any hazardous wastes recovered from a spill will be disposed of at an appropriate off-site disposal facility.

12.2 Construction Traffic Management Plan

A Construction Traffic Management Plan will be developed to describe measures that will be applied to avoid or mitigate potential effects to traffic associated with Project construction. The plan will address land-based construction traffic, traffic control, and potential traffic hazards associated with construction of the Project. The plan will be prepared in accordance with applicable regulations and standards including the *BC Workers Compensation Act* and *Occupational Health and Safety Regulation*, and the Ministry of Transportation Traffic Control Manual for Work on Roadways (MOTI 1999).

Traffic will be managed to ensure construction, public, and emergency vehicles; cyclists; and pedestrians can pass through the Project area safely during the construction period. Traffic management will involve detour routes with appropriate signage, transition zones, and buffer areas. Traffic personnel will be located at key traffic control areas to guide traffic and to monitor the effectiveness of the traffic routes.

The Construction Traffic Management Plan will be shared with appropriate agencies and local governments prior to being finalized. The plan will:

- Identify how current information regarding construction activities, construction periods, and route options will be communicated to stakeholders, emergency responders, municipalities, and adjacent land users, such as through radio notices, signage, a website, a telephone line, and message boards.
- Describe communication requirements to share information regarding traffic management during Project construction, traffic control measures, traffic interruptions, restrictions, and re-routing scenarios.
- Include how access will be provided for emergency vehicles including access in the event of an incident or emergency both within and externally to the Project where emergency vehicle and response personnel require passage through the site.
- Identify key detours and traffic changes and schedules for such detours and changes.
- Describe the communication activities to be undertaken to provide information to the public regarding changes in traffic, including vehicular, pedestrian, cyclist, and recreational traffic.
- Describe the requirements for consultation with the agricultural community to facilitate efficient movement of agricultural traffic, goods, and services during construction.
- Describe the duties and responsibilities of traffic control personnel that will be involved in the development, implementation, and management of the Construction Traffic Management Plan.

12.3 Marine Access Management Plan

A Marine Access Management Plan will be developed that will outline the measures to be implemented to avoid or minimize potential Project-related effects on marine use during marine-based construction activities. The plan will address marine-based construction traffic, traffic control, and potential traffic hazards associated with the Project. Specific mitigation will be developed based on the final designs and confirmed construction approach for the marine-based construction components, including location of staging areas and navigation routes to and from the construction site.

The plan will be shared with marine stakeholders, including Aboriginal Groups, the Vancouver Fraser Port Authority, Canadian Coast Guard, Metro Vancouver, the City of Richmond, the Corporation of Delta, and other local marine users, construction contractors, and representatives of marine communications and traffic services. The plan will adhere to the requirements of Transport Canada's Navigation Protection Program, pursuant to the *Navigation Protection Act*, R.S.C., 1985, c. N-22, and will:

- Identify any marine-based staging areas that may be required during Project construction.
- Identify travel corridors for marine vessels and equipment into and within the Project alignment.
- Describe the anticipated construction schedule for marine-based activities.
- Identify priorities for the timing and location of marine access, and options for the alternative movement of vessels and boats.
- Describe any required navigational aids, markers, and signs that will be used to delineate construction areas.
- Detail local marine communications and emergency preparedness procedures, including but not limited to:
 - Marine stakeholder communication program to inform the marine community of construction and decommissioning activities that may interfere with navigation.
 - Establishment of an emergency telephone line that will be available to the marine community during new bridge construction and Tunnel decommissioning.
 - Issuance and posting of notices regarding construction schedule.
 - Processes and procedures to inform marine traffic (e.g., through signage, a website, a direct telephone line for information) of any in-river activities that may encroach the navigation channel and other areas frequented by marine users, construction phasing, work scheduling, location of in-river staging areas, and times and duration of temporary navigation channel closures.

12.4 Health and Safety Plan

A Health and Safety Plan will be developed in accordance with the *Workers Compensation Act* and appropriate regulations. Contractors will be required to develop a health and safety plan for applicable components of work prior to the start of construction.

The Project Health and Safety Plan will include but not be limited to:

- Identification of potential site hazards
- Mitigation procedures and protocols for working around construction sites
- Site location and local emergency and Project contact telephone numbers
- Description and map of emergency routes
- Safety equipment required
- Safety training requirements

12.5 Operation Environmental Management Plan

Following completion of Project construction, an OEMP will be developed. The plan will describe the post-construction environmental management measures and BMPs that will be in place. The OEMP will be developed to avoid or minimize the potential for adverse environmental effects that may occur during post-construction Project activities such as maintenance and rehabilitation and implementation of follow-up plans. The plan will describe:

- The objectives and scope of the OEMP.
- Environmental monitoring frequency and activities to be undertaken during routine Project operations and requirements to be undertaken during specific maintenance activities.
- Implementation of post-construction/follow-up monitoring program and reporting requirements.
- Emergency maintenance procedures.
- Emergency spill response containment and management procedures.
- Management of stormwater and surface water runoff and maintenance of stormwater management features and facilities.
- Road and structure maintenance procedures.
- Vegetation and Wildlife management plans.

- Fish and Fish Habitat management including a Fish Habitat Offsetting Plan, if required, which will comply with the Fisheries Act, and will be guided by Fisheries and Oceans Canada Fisheries *Productivity Investment Policy: A Proponent's Guide to Offsetting* (DFO 2013b). The plan will:
 - Identify on- or near-site offsetting opportunities and concepts.
 - Outline offsetting implementation methods.
 - Describe post-construction monitoring requirements to determine efficacy of fish habitat offsetting efforts.

13.0 Monitoring and Follow-up Programs

This section describes how the results of monitoring programs, described in **Section 12 Management Plans**, will be used to support Project-related reporting and follow up programs, including EAO compliance reporting. In addition, this section provides an overview of the reporting structure that will support the delivery of the conditions of the EAC including the roles of the Contractor and Ministry.

13.1 Monitoring and Reporting

All of the management plans identified in **Section 12**, which are part of the CEMP and/or OEMP, will have a monitoring component to support reporting to the Contractor, Ministry, and in some cases external parties including the EAO, regulatory agencies, and members of the Technical Working Group.

Monitoring of the implementation of management plans will be supported by the collection and analysis of information, including technical data as well as onsite conditions collected during site visits. Information collected to support monitoring of EMP implementation, will be used to confirm the effective implementation of mitigation measures and compliance with conditions of the EAC.

Data to be collected and the frequency of data collection, for specific VCs and ICs, will be management plan specific and described in the detailed EMPs to be developed by the Contractor.

In terms of reporting during the construction phase, environmental monitoring reports will be developed that will include:

- General Project status including completion of key milestones
- Summary of the results of environmental monitoring activities
- Environmental incidents that may have occurred in addition to how incidents were responded to or addressed
- Potential areas for corrective action where applicable

An environmental report for the Project will also be undertaken that summarizes overall implementation of Project EMPs and the status of implementation of conditions associated with the EAC. The frequency and duration of environmental monitoring and reporting following completion of construction will be confirmed during the review of the Application in consultation with the EAO.

13.2 Follow Up Program

Monitoring data will also be used to support the implementation of the Follow Up Program for the Project. The program focuses on the implementation of Follow Up Strategies for specific VCs and ICs as described in **Section 3.11** and presented in VC and IC sections where it has been determined that there is the potential for a residual effect following implementation of mitigation measures. Monitoring is an important aspect of follow up strategies and serves to:

- Evaluate accuracy of original effects predictions
- Evaluate the effectiveness of mitigation
- Support identification of additional or different mitigation where original effects prediction and/or effectiveness of mitigation were not as anticipated

The majority of the residual effects identified for the Project are temporary in nature and associated with the construction phase. Follow up strategies that have been identified apply to the post-construction/operations phase of the Project and are proposed for the following VCs and ICs:

- River hydraulics
- Fish and Fish Habitat
- Vegetation
- Terrestrial Wildlife
- Atmospheric Noise

13.3 Reporting structure

During delivery of the Project (i.e., construction and post-construction phases), implementation of conditions of environmental approvals, including but not limited to the EAC, will be the responsibility of the Contractor, except in scenarios where works are undertaken by the Ministry. The Contractor will lead the development and implementation of EMPs discussed in **Section 12** as well as meeting environmental reporting requirements associated with the EAC.

The Contractor's team will include an Environmental Manager that will oversee technical specialists with expertise in relevant areas (e.g., noise, air quality, water quality, fisheries etc.) that:

- Provides environmental technical advice and support to the Contractor in relevant areas
- Provides input into the final Project design and development of construction plans

- Develops and implements mitigation consistent with the conditions of the EAC and all other required environmental approvals
- Undertakes environmental monitoring and reporting
- Provides support to the Contractor in responding to environmental incidents

A detailed description of the specific environmental resources, and roles and responsibilities, within the Contractor's environmental team will be provided in the CEMP that will be finalized following award of the Concession contract.

During Project delivery, the Ministry will oversee the work of the Contractor to ensure compliance with contractual environmental requirements including the conditions of the EAC. The Ministry will be supported by environmental specialists that will assist in undertaking audits focused on delivery of environmental requirements.

13.4 EAO Compliance Monitoring

Compliance monitoring, led by EAO, is undertaken to ensure that the Proponent advances approved projects in a manner that is consistent with the conditions of the EAC. Compliance monitoring activities, led by EAO, include the review of reports submitted to the EAO in accordance with established compliance monitoring requirements as well as planned site visits to support compliance monitoring and verify information provided in written reports.

During construction, the Contractor will report on implementation of the CEMP and status of the Project commitments within a defined reporting schedule developed as part of the conditions of the EAC. In the event of an environmental incident, monitoring and follow-up reporting will be implemented as required.

During construction, the Ministry will submit reports on the status of compliance with the terms and conditions of the EAC at a frequency confirmed with EAO during the Application review. It is anticipated that the reporting period will commence at the issuance of the EAC.

Environmental monitoring during construction that will support EAO compliance monitoring is expected to include the following;

- Environmental monitoring reports providing results of monitoring of conditions of VCs/ICs (e.g., water quality, air quality, noise etc.)
- Summary reports to EAO on the status of Project construction and status of conditions associated with the EAC

- Compliance reports describing audits conducted by the Contractor(s), Ministry, and regulatory agencies, including findings and follow-up items
- Monitoring reports associated with environmental permits and approvals (such as a fisheries authorization), where applicable
- Reporting on accidents, malfunctions, or spills to appropriate agencies and authorities

Some limited environmental monitoring is anticipated to continue post-construction with such requirements to be confirmed by EAO and may include:

- Reports to EAO on the status of ongoing Project commitments if applicable
- Compliance reports describing audits conducted by the Ministry, Contractor, and regulatory agencies, including findings and follow-up items
- Reports on the effectiveness of applicable post-construction mitigation (e.g., noise mitigation; river hydraulics, fisheries offsetting sites, vegetation, and wildlife etc.)
- Monitoring reports associated with environmental permits and approvals (such as a fisheries authorization), if applicable

14.1 Summary of Residual Effects

A summary of the results of the assessment of potential Project-related effects on valued components (VCs) and intermediate components (ICs) presented in Part B of the Application is provided in a table format (**Table 14.1-1 – Summary of Assessment of Potential Project-related Effects**) in this section. An overview of the following is included in the table:

- Potential Project-related effects on each VC and IC
- Project phases/activities that the effects are associated with.
- Brief overview of mitigation strategies proposed to address potential effects
- Residual effects, i.e. effects remaining after implementation of mitigation measures
- Result of determination of significance of residual effects for each VC
- Cumulative effects, where applicable

Further detail on specific mitigation measures proposed to address potential Project-related effects on each VC and IC is provided in **Table 14.2 Summary of Mitigation Measures**.

Table 14.1-1 Summary of Assessment of Potential Project-related Residual Effects

| Potential Effect | Project Phase/Activity | Mitigation | Residual Effects | Significance ¹ | Cumulative Effect |
|---|---|--|---|---------------------------|---|
| River Hydraulics and River Morphology | | | | | |
| <ul style="list-style-type: none"> Increase in volume of suspended sediment in Fraser River South Arm during Tunnel decommissioning Change in riverbed associated with Tunnel removal, and potential for associated effects on the Lulu Island-Delta watermain | Construction <ul style="list-style-type: none"> Tunnel Decommissioning | <ul style="list-style-type: none"> Implementation of standard best management practices Engagement with Metro Vancouver, who owns the watermain Monitoring of riverbed during and post Tunnel removal Follow-up action, if required, to address effects on the watermain | <ul style="list-style-type: none"> Temporary, short-term increase in volume of suspended sediment during Tunnel removal Riverbed lowering between the Tunnel alignment and the Lulu Island-Delta water main for one to two years after Tunnel removal | N/A | No overlap or interaction of Project-related residual effects with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| Sediment and Water Quality | | | | | |
| <ul style="list-style-type: none"> Temporary, localized disturbance of sediment during works within or near upland watercourses | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements | <ul style="list-style-type: none"> Implementation of best management practices Development and implementation of Construction Environmental Management Plan (CEMP) Control of suspended sediment during instream works Water quality monitoring | <ul style="list-style-type: none"> Suspended sediment loads in the river | N/A | No overlap or interaction of Project-related residual effect with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| <ul style="list-style-type: none"> Sediment generation or re-suspension during activities that involve localized disturbance of bed sediments, specifically Tunnel removal Localized re-distribution of bed sediments through scouring and deposition, with entrained sediment deposited immediately downstream | Construction <ul style="list-style-type: none"> Tunnel Decommissioning | <ul style="list-style-type: none"> Implementation of best management practices Development and implementation of CEMP Water quality monitoring | | | |
| <ul style="list-style-type: none"> Localized disturbance of surficial sediments during geotechnical investigations along the edges of Deas Slough and Green Slough and demolition of the Deas Slough Bridge | Construction <ul style="list-style-type: none"> Decommissioning of Deas Slough Bridge Installation of Bridge Support Piers | <ul style="list-style-type: none"> Implementation of best management practices Development and implementation of CEMP Control of suspended Sediment during Project construction in and adjacent to Deas and Green Sloughs Water quality monitoring | | | |
| <ul style="list-style-type: none"> Increased rate of stormwater runoff due to increased impervious surface area | Operation | <ul style="list-style-type: none"> Minimization and avoidance through Project design Development and implementation of Operation Environmental Management Plan (OEMP) Development of biofiltration measures | | | |

¹ N/A indicates that significance was not determined for ICs

| Potential Effect | Project Phase/Activity | Mitigation | Residual Effects | Significance ¹ | Cumulative Effect |
|---|--|---|--|---------------------------|---|
| Underwater Noise | | | | | |
| <ul style="list-style-type: none"> Increase in underwater noise levels in Fraser River South Arm, Deas Slough, and Green Slough. | Construction <ul style="list-style-type: none"> New Bridge Construction Tunnel Decommissioning | <ul style="list-style-type: none"> Minimization and avoidance through Project design and construction scheduling Implementation of best management practices Development and implementation of CEMP Monitoring Follow up action, if required | <ul style="list-style-type: none"> Minor, temporary increase in underwater noise levels in Fraser River South Arm, Deas Slough, and Green Slough | N/A | No overlap or interaction of Project-related residual effect with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| Fish and Fish Habitat | | | | | |
| <ul style="list-style-type: none"> Behavioural changes due to increase in underwater noise levels Effects due to changes in ambient water quality | Construction <ul style="list-style-type: none"> Site Preparation | <ul style="list-style-type: none"> Minimization and avoidance through Project design and construction scheduling Implementation of best management practices Development and implementation of CEMP Erosion prevention and sediment control measures Environmental monitoring | <ul style="list-style-type: none"> Physical injury or mortality to fish from crushing or entrainment Physical injury or mortality due to exposure to elevated levels of total suspended solids | Not significant | No overlap or interaction of Project-related residual effects with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| <ul style="list-style-type: none"> Alteration of fish habitat Physical injury or mortality due to exposure to elevated levels of total suspended solids Physical injury or mortality to fish through exposure to underwater noise Behavioural changes due to increase in underwater noise levels Changes in ambient water quality Changes in quantity of fish habitat | Construction <ul style="list-style-type: none"> New Bridge Construction | <ul style="list-style-type: none"> Minimization and avoidance through Project design and construction scheduling Implementation of best management practices Development and implementation of CEMP Erosion prevention and sediment control measures Environmental monitoring Adherence to appropriate timing windows Adaptive underwater noise mitigation Habitat enhancement and follow-up monitoring | | | |
| <ul style="list-style-type: none"> Changes in ambient water quality | Construction <ul style="list-style-type: none"> Highway Improvements Deas Slough Bridge Decommissioning | <ul style="list-style-type: none"> Implementation of best management practices Development and implementation of CEMP Erosion prevention and sediment control measures Environmental monitoring Adherence to appropriate timing windows | | | |
| <ul style="list-style-type: none"> Physical injury or mortality to fish through crushing or entrainment Physical injury or mortality due to exposure to elevated levels of total suspended solids Alteration of fish habitat Behavioural changes due to increase in underwater noise levels Changes in ambient water quality | Construction <ul style="list-style-type: none"> Tunnel Decommissioning | <ul style="list-style-type: none"> Minimization and avoidance through Project design and construction scheduling Implementation of best management practices Development and implementation of CEMP Erosion prevention and sediment control measures Environmental monitoring Adherence to appropriate timing windows Habitat enhancement and follow-up monitoring | | | |

| Potential Effect | Project Phase/Activity | Mitigation | Residual Effects | Significance ¹ | Cumulative Effect |
|--|--|--|------------------|-------------------------------|---|
| <ul style="list-style-type: none"> Changes in ambient water quality Alteration of fish habitat | Operation <ul style="list-style-type: none"> Highway and Bridge Maintenance | <ul style="list-style-type: none"> Implementation of best management practices Development and implementation of OEMP Erosion prevention and sediment control measures Environmental monitoring Adherence to appropriate timing windows | | | |
| At-risk Amphibians | | | | | |
| <ul style="list-style-type: none"> Mortality during instream works Loss of habitat Change in water quality | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements Deas Slough Decommissioning | <ul style="list-style-type: none"> Minimization and avoidance through Project design Salvage and relocation Implementation of best management practices Development and implementation of CEMP | None | No residual effect identified | No Project-related residual effect has been identified. |
| <ul style="list-style-type: none"> Changes to water quality in potential at-risk amphibian living habitat | Operation <ul style="list-style-type: none"> Highway Maintenance | <ul style="list-style-type: none"> Implementation of best management practices | | | |
| Marine Mammals | | | | | |
| <ul style="list-style-type: none"> Physical injury due to underwater noise Behavioural disturbance due to underwater noise | Construction <ul style="list-style-type: none"> New Bridge Construction Tunnel Decommissioning | <ul style="list-style-type: none"> Minimization and avoidance through Project design and construction scheduling Implementation of best management practices Underwater noise monitoring Development and implementation of CEMP | None | No residual effect identified | No Project-related residual effect has been identified. |
| Vegetation | | | | | |
| <ul style="list-style-type: none"> Loss of at-risk ecosystems Introduction of invasive species | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements New Bridge Construction Operation <ul style="list-style-type: none"> Highway Maintenance | <ul style="list-style-type: none"> Minimization and avoidance through Project design Implementation of best management practices Development and implementation of CEMP Vegetation restoration and habitat enhancement Habitat off-setting Invasive species management | None | No residual effect identified | No Project-related residual effect has been identified. |

| Potential Effect | Project Phase/Activity | Mitigation | Residual Effects | Significance ¹ | Cumulative Effect |
|--|---|--|---|---------------------------|---|
| Terrestrial Wildlife | | | | | |
| <ul style="list-style-type: none"> Habitat loss Habitat Alteration Sensory Disturbance Mortality | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements New Bridge Construction Deas Slough Bridge Decommissioning | <ul style="list-style-type: none"> Minimization and avoidance through Project design and construction scheduling Implementation of best management practices, including least-risk timing windows Development and implementation of CEMP Pre-construction surveys Habitat enhancement | <ul style="list-style-type: none"> Barn swallow habitat loss | Not significant | No overlap or interaction of Project-related residual effects with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| <ul style="list-style-type: none"> Collision related mortality | Operation | <ul style="list-style-type: none"> Habitat enhancement Development and implementation of OEMP | <ul style="list-style-type: none"> Barn owl mortality | | |
| Air Quality | | | | | |
| <ul style="list-style-type: none"> Increase in emissions | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements New Bridge Construction Deas Slough Bridge Decommissioning Tunnel Decommissioning | <ul style="list-style-type: none"> Minimization through Project design Implementation of best management practices Development and implementation of CEMP Monitoring | <ul style="list-style-type: none"> Potential incremental changes to air quality associated with highway construction | N/A | No overlap or interaction of Project-related residual effect with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| Atmospheric Noise | | | | | |
| <ul style="list-style-type: none"> Increase in noise emissions Increase in ground-borne vibration | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements New Bridge Construction Deas Slough Bridge Decommissioning Tunnel Decommissioning | <ul style="list-style-type: none"> Implementation of best management practices Development and implementation of CEMP Monitoring Community engagement | <ul style="list-style-type: none"> Increase in noise emissions during construction | N/A | No overlap or interaction of Project-related residual effect with effects of other project or activities is expected; thus, no cumulative effects are anticipated.. |
| <ul style="list-style-type: none"> Increase in traffic-related noise emissions | Operation | <ul style="list-style-type: none"> Mitigation in accordance with the Ministry's 2014 Noise Policy Monitoring | | | |

| Potential Effect | Project Phase/Activity | Mitigation | Residual Effects | Significance ¹ | Cumulative Effect |
|--|---|---|--|---------------------------|---|
| Traffic | | | | | |
| <ul style="list-style-type: none"> • Change in traffic volume • Influence of construction on mode share • Change in travel time and reliability | Construction <ul style="list-style-type: none"> • Site preparation • Highway Improvements • New bridge construction • Deas Slough Bridge Decommissioning • Tunnel Decommissioning | <ul style="list-style-type: none"> • Minimization and avoidance through Project design and construction scheduling • Development and implementation of a Traffic Management Plan • Monitoring • Community engagement | <ul style="list-style-type: none"> • Temporary change in traffic volume during construction • Temporary influence of construction on mode share • Temporary change in travel time and reliability during construction | N/A | No overlap or interaction of Project-related residual effects with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| <ul style="list-style-type: none"> • Change in traffic volume • Change in travel time and reliability | Operation <ul style="list-style-type: none"> • Highway Maintenance | <ul style="list-style-type: none"> • Application of Ministry Standards and Guidelines • Monitoring | <ul style="list-style-type: none"> • Increased transit/carpool and active transportation • Improve travel time and reliability | | |
| Marine Use | | | | | |
| <ul style="list-style-type: none"> • Change to commercial navigation; commercial, recreational, and Aboriginal fisheries navigation; and recreational navigation | Construction <ul style="list-style-type: none"> • New Bridge Construction • Deas Slough Bridge Decommissioning • Tunnel Decommissioning | <ul style="list-style-type: none"> • Minimization and avoidance through Project design and construction scheduling • Authorization under the Navigation Protection Act, as appropriate • Development and implementation of a Marine Access Management Plan • Engagement with Marine Users Group | <ul style="list-style-type: none"> • Temporary change to commercial navigation, CRA fisheries navigation, and recreational navigation | Not significant | No overlap or interaction of Project-related residual effects with effect of other project or activities is expected; thus, no cumulative effects are anticipated. |

| Potential Effect | Project Phase/Activity | Mitigation | Residual Effects | Significance ¹ | Cumulative Effect |
|--|---|---|---|---------------------------|---|
| Land Use | | | | | |
| <ul style="list-style-type: none"> • Change in access • Disturbance to residential, commercial, and industrial land uses • Change in regional population growth and distribution • Change in non-residential land development and distribution | Construction <ul style="list-style-type: none"> • Site Preparation • Highway Improvements • New Bridge Construction • Deas Slough Decommissioning • Tunnel Decommissioning | <ul style="list-style-type: none"> • Minimization and avoidance through Project design • Implementation of best management practices • Development and implementation of CEMP • Application of mitigation measures described for potential Project-related effects to air quality, noise, vegetation, visual quality, traffic, and marine use • Community engagement • Trail reconnection | <ul style="list-style-type: none"> • Temporary disturbance to residential, commercial and industrial land uses • Temporary disturbance to recreational uses near the new bridge | Not significant | No overlap or interaction of Project-related residual effects with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |
| <ul style="list-style-type: none"> • Disturbance to residential, commercial and industrial land uses | Operation <ul style="list-style-type: none"> • Highway Maintenance | <ul style="list-style-type: none"> • Application of mitigation measures described for potential Project-related effects to air quality, noise, vegetation, visual quality, traffic, and marine use • Community engagement | | | |
| Agriculture | | | | | |
| <ul style="list-style-type: none"> • Loss of agricultural land • Degradation of agricultural soils • Degradation of water availability and quality • Farm parcel fragmentation • Change to on-farm utilities • Change in farm economic viability | Construction <ul style="list-style-type: none"> • Site Preparation • Highway Improvements • New Bridge Construction • Deas Slough Bridge Decommissioning • Tunnel Decommissioning | <ul style="list-style-type: none"> • Minimization and avoidance through Project design • Implementation of best management practices • Development and implementation of CEMP • Engagement with agricultural community • Traffic management • Consolidation of small farm parcels • Richmond Backlands considerations • Off-setting | <ul style="list-style-type: none"> • Changes to parcel boundaries of three farms | Not significant | No overlap or interaction of Project-related residual effect with effects of other project or activities is expected; thus, no cumulative effects are anticipated.. |
| Visual Quality | | | | | |
| <ul style="list-style-type: none"> • Addition of anthropogenic features into the landscape | Operation | <ul style="list-style-type: none"> • Installation of vegetated barriers at selected locations on either side of the bridge alignment | <ul style="list-style-type: none"> • Changes in visual conditions | Not significant | No overlap of Project-related residual effect with effects of other project or activities is expected; thus, no cumulative effects are anticipated. |

| Potential Effect | Project Phase/Activity | Mitigation | Residual Effects | Significance ¹ | Cumulative Effect |
|---|---|---|------------------|---------------------------|---|
| Heritage | | | | | |
| <ul style="list-style-type: none"> Disturbance to unidentified archaeological or heritage resource | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements New Bridge Construction Deas Slough Bridge Decommissioning Tunnel Decommissioning | <ul style="list-style-type: none"> Development and implementation of CEMP, including a chance-find protocol Additional archaeological surveys, if required Adherence to the terms and conditions of a Heritage Conservation Act permit | None | Not significant | No Project-related residual effect has been identified. |
| Health | | | | | |
| <ul style="list-style-type: none"> Increased exposure to air or noise emissions | Construction <ul style="list-style-type: none"> Site Preparation Highway Improvements New Bridge Construction Deas Slough Bridge Decommissioning Tunnel Decommissioning | <ul style="list-style-type: none"> Measures to mitigate potential Project-related effects to air quality and noise | None | Not significant | No Project-related residual effect has been identified. |

14.2 Summary of Mitigation Measures

Table 14.2-1 provides a list of measures that were developed to avoid, minimize, or offset potential adverse effects of the Project on environmental, socio-economic, heritage, and health pillars as discussed in **Part B – Effects Assessment**.

Since the same mitigation measure may apply to more than one topic, the measure is fully described in the first section in which it appears, and is referenced by its number thereafter. Project design considerations or other measures that avoid or minimize potential Project-related effects, in addition to the mitigation measures included in **Table 14.2-1**, are discussed in the effects assessment of each valued component.

In the table, timing refers to when the mitigation measure will be finalized and implemented. Where permits or authorizations are attached to a mitigation measure, the associated legislation and regulatory agency responsible for issuing the permit or authorization are identified in the table under columns titled Legal Requirement and Responsible Agency, respectively.

Table 14.2-1 Proposed Mitigation Measures

| No. | Valued Component/Intermediate Component and Effect | Proposed Mitigation Measure | Timing | Legal Requirement? | Responsible Agency |
|----------------------|---|---|------------------------------|--------------------|--------------------|
| Environmental | | | | | |
| M1 | River Hydraulics and River Morphology: <ul style="list-style-type: none"> Minor increase in volume of suspended sediment during Tunnel decommissioning activities | <ul style="list-style-type: none"> Measures to mitigate effects from turbidity or elevated levels of suspended sediments; also see mitigation M4. | Construction | N/A | |
| M2 | River Hydraulics and River Morphology: <ul style="list-style-type: none"> Temporary lowering of riverbed between the Tunnel and the Lulu Island-Delta water main | <ul style="list-style-type: none"> Early engagement and coordination with Metro Vancouver (owner of the water main). Monitoring riverbed within 100 m upstream and downstream of the water main. Regular monitoring at appropriate intervals will begin during Tunnel removal. Stockpiling appropriate-sized rock near the Project site for priority scour protection repairs at the water main crossing, if required. Establishing on-call contracts with a qualified registered professional and a qualified marine contractor prior to Tunnel removal to facilitate the design and implementation of scour protection repairs on short notice if required. | Project Planning/ Ongoing | N/A | |
| M3 | Sediment and Water Quality: <ul style="list-style-type: none"> Sediment generation, or re-suspension associated with Tunnel removal Localized disturbance of surficial sediments during installation of temporary barging facilities, and removal of Tunnel segments | <ul style="list-style-type: none"> Removing fill materials adjacent to the Tunnel will be conducted using appropriate equipment to minimize re-suspension of sediments. Transporting removed fill material off-site using appropriate sediment containment systems. | Construction | N/A | |
| M4 | Sediment and Water Quality: <ul style="list-style-type: none"> Sedimentation or sediment suspension during construction | <ul style="list-style-type: none"> Conducting water quality monitoring during construction activities with the potential to induce turbidity to ensure turbidity levels do not exceed Canadian Council of Ministers of the Environment (CCME) and B.C. Water Quality Guidelines (WQG). Identifying specific environmental protection measures that will be implemented during Project construction and operation to avoid or minimize environmental effects in a Construction Environmental Management Plan (CEMP). This will include: <ul style="list-style-type: none"> Measures to mitigate soil erosion and sediment transport to the receiving environment such as installing silt fences or other appropriate mitigation Measures to control sediment-laden flows and prevent sediment-laden water from entering watercourses. | Construction | N/A | |
| M5 | Sediment and Water Quality: <ul style="list-style-type: none"> Changes in sediment and water quality as a result of stormwater runoff | <ul style="list-style-type: none"> Incorporating a stormwater collection and distribution system into the bridge and interchange design that will convey and discharge stormwater runoff to appropriate upland infrastructure for proper treatment (e.g., stormwater detentions ponds or biofiltration swales) before discharging to any receiving aquatic environment). | Project Planning | N/A | |

| No. | Valued Component/Intermediate Component and Effect | Proposed Mitigation Measure | Timing | Legal Requirement? | Responsible Agency |
|-----|--|--|--------------|--|---|
| M6 | <p>Underwater Noise:</p> <ul style="list-style-type: none"> Temporary exceedance of the auditory injury threshold for marine mammals during construction activities within and near the marine environment | <ul style="list-style-type: none"> Scheduling activities with the potential to generate underwater noise levels above the auditory threshold for injury to marine mammals during periods of low tide, when work can be completed under shallow water conditions or in the dry. Conducting underwater noise monitoring during applicable activities to ensure underwater noise levels do not exceed auditory injury thresholds. Developing a Marine Mammal Management Plan as part of the CEMP (see M15). | Construction | N/A | |
| M7 | <p>Fish and Fish Habitat:</p> <ul style="list-style-type: none"> Temporary, localized streamside disturbance, erosion, or sedimentation resulting in increased total suspended solids levels | <ul style="list-style-type: none"> Developing and implementing environmental protection measures that will be outlined in the Fish and Fish Habitat Management Plan, and Erosion and Sediment Control Plan, components of the CEMP, as well as an Operational Environmental Management Plan (OEMP). The plans will describe the mitigation measures to avoid or minimize potential erosion, sedimentation, or increased total suspended solids. Conducting instream works in accordance with provincial standards and best practices, including the Ministry's <i>Environmental Best Practices for Highway Maintenance Activities</i> and the B.C. <i>Water Sustainability Act</i> (where applicable). | Construction | <i>Water Sustainability Act</i> permitting | Ministry of Forests, Lands, and Natural Resource Operations |
| M8 | <p>Fish and Fish Habitat:</p> <ul style="list-style-type: none"> Loss of fish habitat | <ul style="list-style-type: none"> Minimizing potential encroachment on fish habitat, as well as potential effects resulting from instream works, ground disturbance and clearing and grubbing of riparian vegetation, by limiting Highway 99 improvements to the Highway 99 ROW. Developing and implementing a Fish Habitat Offsetting Plan. Offsetting unavoidable footprint effects through the development of comparable habitat. | Construction | N/A | |
| M9 | <p>Fish and Fish Habitat:</p> <ul style="list-style-type: none"> Temporary changes in ambient water quality during Tunnel removal | <ul style="list-style-type: none"> Implementing mitigation measures to maintain turbidity levels within the B.C. WQG and CCME <i>Water Quality Guidelines for the Protection of Aquatic Life</i>, including: <ul style="list-style-type: none"> undertaking instream activities within the applicable least-risk timing window to the extent that is technically feasible and viable using appropriate equipment to minimize the amount of re-suspended sediment. | Construction | N/A | |
| M10 | <p>Fish and Fish Habitat:</p> <ul style="list-style-type: none"> Temporary changes in ambient water quality | <ul style="list-style-type: none"> Conducting works in and around upland ditches within the applicable timing windows, in isolation of water flows, and with fish salvages as required. Undertaking works in and around upland ditches in accordance with provincial standards and best practices, including the Ministry's <i>Standard Specifications for Highway Construction</i> (B.C. MOTI 2012), and complying with the B.C. <i>Water Sustainability Act</i>. <p>Operations:</p> <ul style="list-style-type: none"> Designing roadside ditches to maintain ambient water quality and pre-development flow regimes. Incorporating vegetated shoulders and drainage swales, stormwater storage facilities to control runoff rates, headwall structures in culverts, wide bottom ditches, and stormwater management ponds. | Construction | <i>Water Sustainability Act</i> permitting | Ministry of Forests, Lands, and Natural Resource Operations |
| M11 | <p>Fish and Fish Habitat:</p> <ul style="list-style-type: none"> Direct or indirect fish injury or mortality to fish | <ul style="list-style-type: none"> Describing requirements for application of appropriate fisheries timing windows in the Fish and Fish Habitat Management Plan (see M7). | Construction | N/A | |

| No. | Valued Component/Intermediate Component and Effect | Proposed Mitigation Measure | Timing | Legal Requirement? | Responsible Agency |
|-----|--|--|--------------|--------------------|--------------------|
| M12 | Fish and Fish Habitat: <ul style="list-style-type: none"> Physical injury, mortality, or behavioural disturbance to fish through exposure to underwater noise during construction | <ul style="list-style-type: none"> Adhering to BMPs and other standard industry practices that set appropriate sound thresholds for fish protection during activities that may generate underwater noise. Implementing measures to mitigate underwater noise effects, including undertaking underwater noise monitoring (see M6 and M15). | Construction | N/A | |
| M13 | At-risk Amphibians: <ul style="list-style-type: none"> Temporary loss of or change in at-risk amphibian habitat during instream works including clearing and grubbing of riparian vegetation, temporary de-watering of upland ditches, and installation of temporary drainage structures | <ul style="list-style-type: none"> Developing and implementing mitigation to prevent or minimize potential effects on at-risk amphibians as part of the CEMP. Developing and implementing the Erosion and Sediment Control Plan, Fish and Fish Habitat Management Plan, and Terrestrial Vegetation and Wildlife Management Plan to further prevent or minimize potential adverse effects on at-risk amphibians (see M4, M7, and M16). Minimizing Project footprint disturbance by flagging construction boundaries in the field and marking clearing perimeters to minimize the potential for accidental encroachment on forested areas and wetlands that may be suitable living habitat for at-risk amphibians. Offsetting Project footprint effects on the cattail marsh near Green Slough through the creation of a cattail marsh within a biofiltration pond near the existing south portal of the Tunnel. Removing invasive species and garbage from the marsh and revegetating using native species in the area surrounding the new bridge support piers. Conducting monitoring during and after construction to ensure that it is functioning as intended. | Construction | N/A | |
| M14 | At-risk Amphibians: <ul style="list-style-type: none"> Mortality from vegetation grubbing and clearing, and instream construction activities | <ul style="list-style-type: none"> Conducting amphibian salvage and translocation as required to avoid or minimize potential Project-related mortality to at-risk amphibians (and other native amphibians) from instream works during Project construction. | Construction | N/A | |
| M15 | Marine Mammals: <ul style="list-style-type: none"> Physical injury or behavioural disturbance due to underwater noise | <ul style="list-style-type: none"> Developing and implementing a Marine Mammal Management Plan as part of the CEMP, which will describe measures to mitigate potential Project-related effects to marine mammals during construction activities and measures to minimize underwater noise. Applying measures to mitigate construction activities that may generate underwater noise (see M6). Conducting underwater noise monitoring during Project construction in the Fraser River South Arm and Green Slough to measure underwater noise levels and ensure that injury thresholds are not exceeded | Construction | N/A | |
| M16 | Vegetation: <ul style="list-style-type: none"> Overlap between at-risk plant communities and Project components | <ul style="list-style-type: none"> Developing and implementing a Terrestrial Vegetation and Wildlife Management Plan as part of the CEMP to minimize potential construction-related effects on vegetation. The plan will describe measures to minimize disturbance and loss of vegetation, prevent soil compaction, minimize clearing, and identify appropriate storage areas and reclamation requirements. Confining unavoidable overlap of cattail marsh adjacent to Green Slough to the edges of the marsh, where it will not affect the functionality of the ecosystem. Offsetting unavoidable Project footprint effects on cattail marsh near River Road by creating comparable cattail marsh habitat within Project alignment. Implementing environmental protection measures outlined in the CEMP during Project construction and operation to prevent or minimize potential effects on vegetation. The CEMP will include a Terrestrial Vegetation and Wildlife Management Plan, and an Invasive Species Management Plan. | Construction | N/A | |

| No. | Valued Component/Intermediate Component and Effect | Proposed Mitigation Measure | Timing | Legal Requirement? | Responsible Agency |
|-----|--|--|--------------|---------------------|---|
| M18 | Vegetation: <ul style="list-style-type: none"> Invasive species | <ul style="list-style-type: none"> Developing and implementing an Invasive Species Management Plan that includes site-appropriate monitoring and control methods for different species and conditions as part of the CEMP. Controlling invasive plant species during construction in accordance with the B.C. <i>Weed Control Act</i>, as well as species that are listed by the Invasive Species Council of Metro Vancouver. | Construction | N/A | |
| M19 | Terrestrial Wildlife: <ul style="list-style-type: none"> Loss of terrestrial wildlife and wildlife habitat as a result of clearing and grubbing for Project components | <ul style="list-style-type: none"> Implementing measures described in Terrestrial Vegetation and Wildlife Management Plan (see M16). Flagging sites important to wildlife species in the field and marking them on Project plans to provide a visual barrier to contractors, indicating that such areas need special provisions (as specified in Environmental Protection Plans for the site) during construction. To the extent feasible, planning Project construction activities to coincide with least-risk timing windows for wildlife. The Terrestrial Vegetation and Wildlife Management Plan will define timing windows during which there is potential for adverse effects on terrestrial and semi-aquatic wildlife; identifying low-risk periods for construction and operation activities. Conducting nest surveys in advance if clearing and grubbing must proceed during the bird breeding season to confirm the presence/absence of breeding birds, and location of nesting sites. Construction can proceed if identified nests are unoccupied and are not of a species protected year-round by the <i>Wildlife Act</i>. Undertaking wildlife salvage prior to clearing and grubbing if there are locations of known small mammal occurrences. | Construction | <i>Wildlife Act</i> | Ministry of Forests, Lands, and Natural Resource Operations |
| M20 | Terrestrial Wildlife: <ul style="list-style-type: none"> Temporary sensory disturbance to terrestrial wildlife during construction | <ul style="list-style-type: none"> Applying mitigation to address construction-related effects on noise (see M25). Applying mitigation to address construction-related effects on air quality (see M24). Implementing measures within Terrestrial Vegetation and Wildlife Management Plan (see M16). | Construction | N/A | |
| M21 | Terrestrial Wildlife: <ul style="list-style-type: none"> Sensory disturbance to terrestrial wildlife during Project operation | <ul style="list-style-type: none"> Incorporating standard practices for lighting systems for highways and roadways under the jurisdiction of the Ministry into the Project design. The lighting design will address safety requirements and will minimize sensory disturbance to terrestrial wildlife from changes in the ambient light environment and the currently lit areas of Highway 99. | Operation | N/A | |
| M22 | Terrestrial Wildlife: <ul style="list-style-type: none"> Increased mortality of barn owls as a result of collision with vehicles. | <ul style="list-style-type: none"> Constructing highway width in accordance with applicable geometric standards, and minimally vegetating the right-of-way, which can limit infrequently disturbed grass habitat that is suitable for barn owl prey resources (i.e., small mammals including Townsend's vole), thus reducing barn owl attractiveness to the Project alignment and lowering the collision risk. Installing flight deflectors such as hedgerows at appropriate locations along the highway. | Operation | N/A | |
| M23 | Terrestrial Wildlife: <ul style="list-style-type: none"> Removal of the Deas Slough Bridge, resulting in the loss of barn swallow nesting habitat | <ul style="list-style-type: none"> Approach of the new bridge in the immediate vicinity of the Deas Slough Bridge is expected to provide nesting opportunities for barn swallows. | Construction | N/A | |

| No. | Valued Component/Intermediate Component and Effect | Proposed Mitigation Measure | Timing | Legal Requirement? | Responsible Agency |
|---------------|---|---|-------------------------|---|--------------------|
| M24 | Air Quality: <ul style="list-style-type: none"> Emissions and road dust generated from vehicles and equipment, resulting in a temporary change in air quality during construction | <ul style="list-style-type: none"> Developing and implementing an Air Quality and Dust Control Management Plan as part of the CEMP, which will describe measures to control and minimize fugitive dust and other airborne emissions associated with construction equipment, demolition, and other decommissioning activities, as well as soil handling. Including industry standards and best management practices in the Air Quality and Dust Control Managing road dust during Project operation by cleaning the road where dirt, debris, sand, and gravel have accumulated. | Construction | N/A | |
| M25 | Atmospheric Noise: <ul style="list-style-type: none"> Traffic-related changes in noise levels at adjacent receptors during construction | <ul style="list-style-type: none"> Developing and implementing a Noise Management Plan as part of the CEMP, which will describe standard best practices and Project-specific mitigation measures to prevent or minimize community impacts due to temporary construction-related noise. | Construction | N/A | |
| M26 | Atmospheric Noise: <ul style="list-style-type: none"> Traffic-related changes in noise levels at adjacent receptors during operation | <ul style="list-style-type: none"> Undertaking mitigation in accordance with the Ministry's 2014 Noise Policy. Conducting post-project, 24-hour noise monitoring at selected, representative noise receiver locations to confirm noise predictions and assess the effectiveness of mitigation measures. | Operation | N/A | |
| Social | | | | | |
| M27 | Traffic: <ul style="list-style-type: none"> Temporary delays and lane closures during construction | <ul style="list-style-type: none"> Developing and implementing a Traffic Management Plan that will identify and describe approaches for managing traffic and communicating with stakeholders and the public during the construction period. This will include: <ul style="list-style-type: none"> Traffic management strategies, including access routes, to ensure continued movement of traffic on the Highway 99 corridor and initiatives to minimize disruption and maximize predictability for Highway 99 travellers, cycling and pedestrian network users, and nearby residents and businesses Safety requirements to maintain a safe corridor at all times for travellers and workers Communication and engagement activities Incident management and response plans | Construction | N/A | |
| M28 | Marine Use: <ul style="list-style-type: none"> Temporary change to commercial navigation, commercial, recreational, and Aboriginal fisheries navigation, and recreational navigation | <ul style="list-style-type: none"> Submitting a Notice of Works form to Transport Canada to address the requirements of the <i>Navigation Protection Act</i> for construction activities that may interfere with navigation. Developing and implementing measures to maintain the navigation channel during construction, including establishing navigation protection zones. Developing a Marine Access Management Plan that includes measures to minimize potential construction-related access effects on marine users. This will include communications protocols to establish and advise of instream construction activities, including periods of vessel restrictions. | Construction | <i>Navigation Protection Act</i> permitting | Transport Canada |
| M29 | Land Use: <ul style="list-style-type: none"> Potential acquisition of additional portions of adjacent land parcels to accommodate Project alignment, which may influence land use within or adjacent to those parcels | <ul style="list-style-type: none"> Designing the Project to be largely within the Highway 99 right of way, avoiding effects to nearby land uses where possible. Incorporating land use considerations in the Traffic Management Plan (see M27), Marine Access Management Plan (see M28), Noise Management Plan (see M25), and Air Quality and Dust Control Management Plan (see M24). | Construction, Operation | N/A | |

| No. | Valued Component/Intermediate Component and Effect | Proposed Mitigation Measure | Timing | Legal Requirement? | Responsible Agency |
|-----|---|--|--------------|--------------------|--------------------|
| M30 | Land Use: <ul style="list-style-type: none"> Temporary restricted use of Millennium Trail, Island Tip Trail, and recreational watercraft in Deas Slough during construction | <ul style="list-style-type: none"> Reconnecting, restoring, or enhancing trails following Project construction, in consultation with Metro Vancouver Parks and Delta Department of Parks, Recreation and Culture. | Construction | N/A | |
| M31 | Land Use: <ul style="list-style-type: none"> The new bridge will add noticeable visual features to the landscape and result in changes in visual conditions at certain viewpoints | <ul style="list-style-type: none"> Addressing potential effects to visual quality where feasible (see M40). | Operation | N/A | |
| M32 | Agricultural Use: <ul style="list-style-type: none"> Temporary changes to irrigation and drainage systems | <ul style="list-style-type: none"> Constructing the Project in a way that enables key ditch systems to continue to function and water quality to be suitable for irrigation. Developing an Agricultural Management Plan as part of the CEMP, which will describe standard best practices and Project-specific mitigation measures to prevent or minimize potential effects on drainage, water quality and irrigation, farm infrastructure and operations, and soil conservation, storage, and reclamation. The plan will include measures to reconstruct or upgrade ditches in accordance with the B.C. <i>Agricultural Drainage Criteria</i>. | Construction | N/A | |
| M33 | Agricultural Use: <ul style="list-style-type: none"> Temporary changes to transportation and access | <ul style="list-style-type: none"> Implementing a Traffic Management Plan during construction (see M27) that will facilitate the efficient movement of agricultural traffic and mitigate temporary disruptions and increased traffic during construction. The plan will be shared with the agricultural community prior to implementation. | Construction | N/A | |
| M34 | Agricultural Use: <ul style="list-style-type: none"> Temporary disturbance to livestock | <ul style="list-style-type: none"> Mitigating sensory disturbances related to air quality (see M24) and noise (see M25). | Construction | N/A | |
| M35 | Agricultural Use: <ul style="list-style-type: none"> Temporary potential for accidental spills of deleterious substances | <ul style="list-style-type: none"> Incorporating measures to be undertaken in the event of a spill or release of deleterious substance in the CEMP. | Construction | N/A | |
| M36 | Agricultural Use: <ul style="list-style-type: none"> Temporary degradation of ditches due to sedimentation | <ul style="list-style-type: none"> Developing and implementing a Erosion and Sediment Control Plan (part of the CEMP) to prevent soil erosion and sediment transport. | Construction | N/A | |
| M37 | Agricultural Use: <ul style="list-style-type: none"> Temporary degradation of agricultural soils | <ul style="list-style-type: none"> Reducing the potential for degradation of agricultural soils during Project construction. Salvaging topsoil and subsoil along temporary roads or laydown areas, and making it available for agricultural use if appropriate. Developing and implementing an Agricultural Management Plan (see M32). Including measures to be implemented to prevent and manage spills in the CEMP (see M35). Developing and implementing an Erosion and Sediment Control Plan (see M36). | Construction | N/A | |

| No. | Valued Component/Intermediate Component and Effect | Proposed Mitigation Measure | Timing | Legal Requirement? | Responsible Agency |
|-----------------|--|---|------------------|--|------------------------------|
| M38 | Agricultural Use: <ul style="list-style-type: none"> Temporary changes to farm utilities and infrastructure | <ul style="list-style-type: none"> Informing potentially affected farm operators in advance of any potential disruption to utility services—specifically power and natural gas supply—during construction. Minimizing the Project footprint and consolidating farm parcels into more economically viable units; this measure will also mitigate the effects of the Project on stakeholder perceptions of agricultural land in the LAA. | Construction | N/A | |
| M39 | Agricultural Use: <ul style="list-style-type: none"> Changes to three parcels of agricultural land within the Project alignment | <ul style="list-style-type: none"> Making suitable land parcels available for agricultural use to offset the acquisition of small portions of farmland for the Project. These parcels are located adjacent to existing farm fields, and can be restored to comparable land capability, enhancing their agricultural potential. Project-related offsetting is expected to result in a net gain of agricultural land. | Project Planning | <i>Agricultural Land Commission Act</i> permitting | Agricultural Land Commission |
| M40 | Visual Quality: <ul style="list-style-type: none"> Introduction of an anthropogenic feature into the existing landscape | <ul style="list-style-type: none"> Installing vegetation buffers to partially reduce the visual effects of the Project in select areas on either side of the new bridge. | Project Planning | N/A | |
| Heritage | | | | | |
| M41 | Heritage Resources: <ul style="list-style-type: none"> Chance encounter of an unidentified archaeological or heritage resource during construction | <ul style="list-style-type: none"> Developing and implementing an Archaeological and Heritage Resources Management Plan as part of the CEMP, which will include chance find procedures to be implemented if previously unknown heritage resources are encountered during Project construction. Developing the plan with guidance, where applicable, from the B.C. Archaeology Branch, in accordance with existing Ministry policies and procedures, and in consultation with Aboriginal groups. Undertaking further assessment of previously inaccessible sites, if required, under the terms and conditions of a <i>Heritage Conservation Act</i> permit prior to or during Project construction. | Construction | N/A | |
| Health | | | | | |
| M42 | Human Health: <ul style="list-style-type: none"> Change in atmospheric noise during construction and operation | <ul style="list-style-type: none"> Developing and implementing a Noise Management Plan (see M25), which will include communicating with potentially affected parties. Implementing noise mitigation in accordance with the Ministry's 2014 Noise Policy (see M25 and M26). | Operation | N/A | |
| M43 | Human Health: <ul style="list-style-type: none"> Change in air quality during construction | <ul style="list-style-type: none"> Developing and implementing an Air Quality and Dust Control Management Plan (see M24). | | N/A | |

15.0 Reference Material

Reference material used in developing the George Massey Tunnel Replacement Project Application for Environmental Assessment Certificate has been included in each of the preceding sections, where appropriate.



George Massey Tunnel Replacement Project



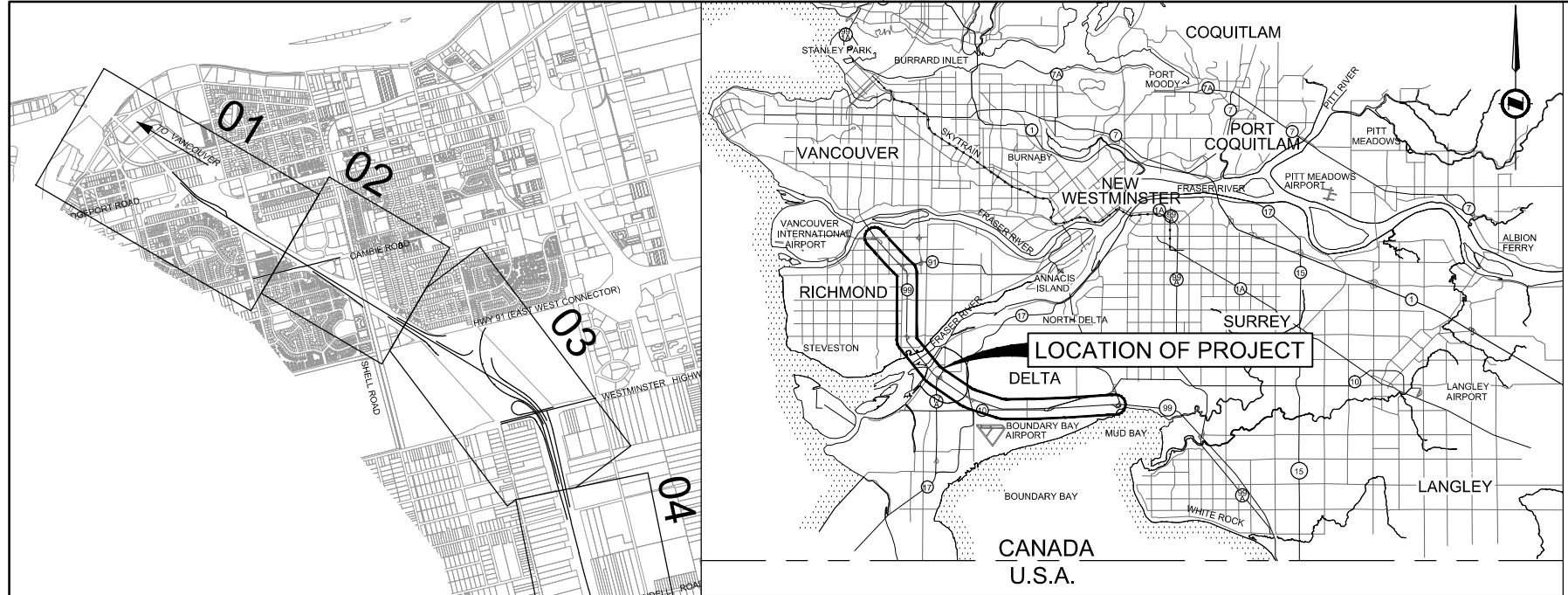
Section 16.1 Reference Concept



May 2016



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**Ministry of
Transportation
and Infrastructure**

PROVINCE OF BRITISH COLUMBIA
MINISTRY OF TRANSPORTATION & INFRASTRUCTURE



PROJECT:

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

HIGHWAY No. 99: DRAFT CONCEPT



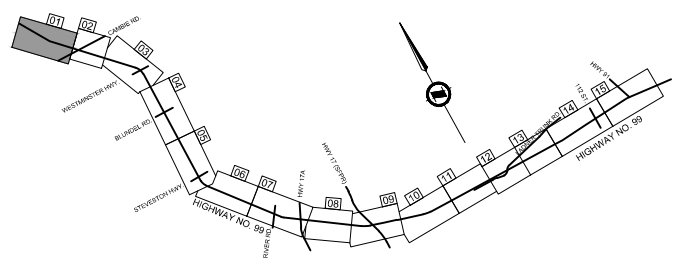
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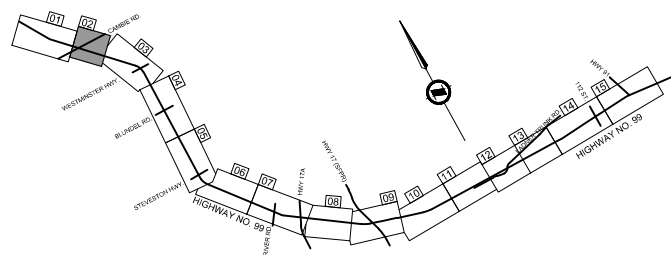
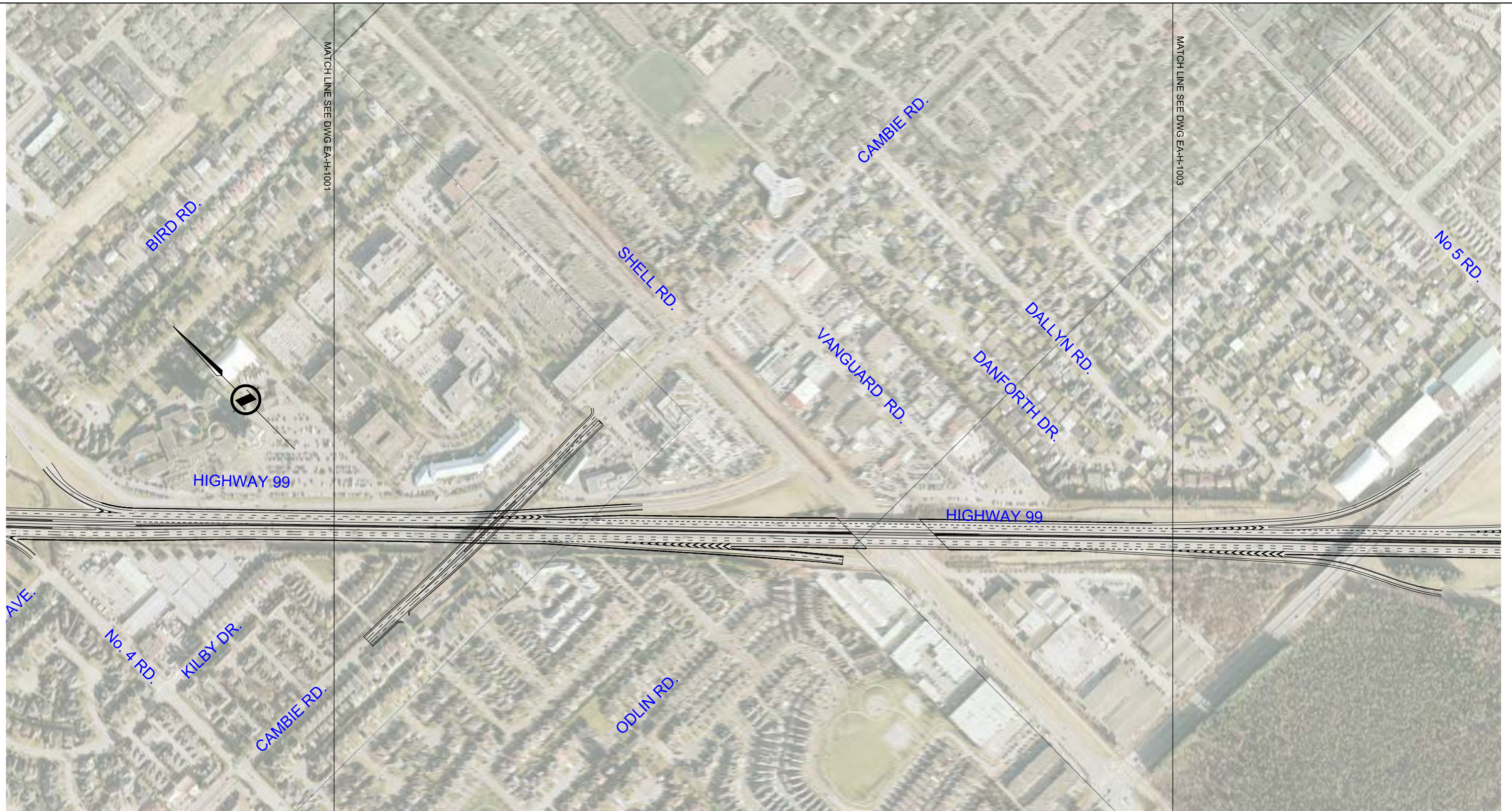
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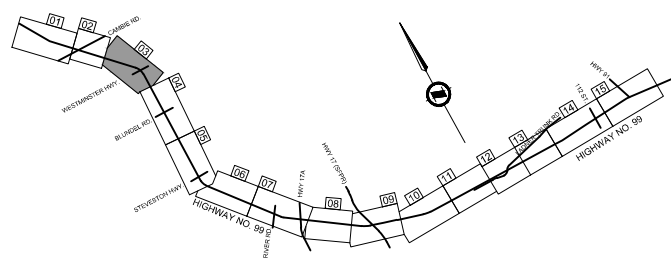


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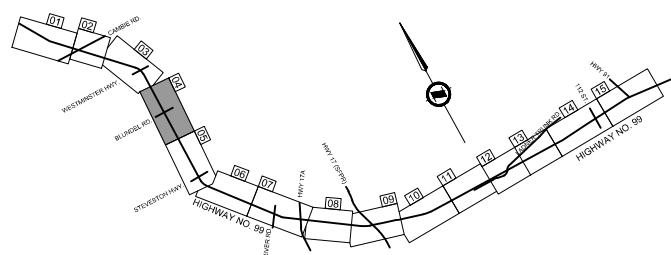
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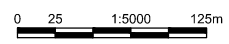


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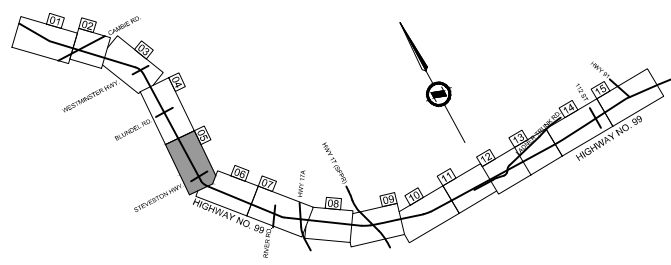
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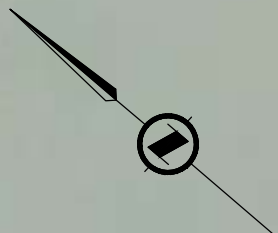
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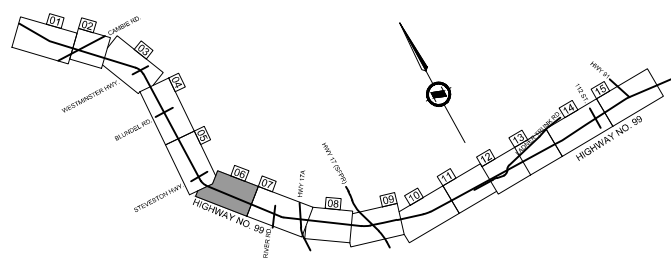
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May 19, 2016 - 10:55am P:\2014\14-137\00 - CAD File\Design\Drawings\20160509 Drawings for EA\GMTR-100RC.dwg



MATCH LINE SEE DWG EA-H-1005

MATCH LINE SEE DWG EA-H-1007

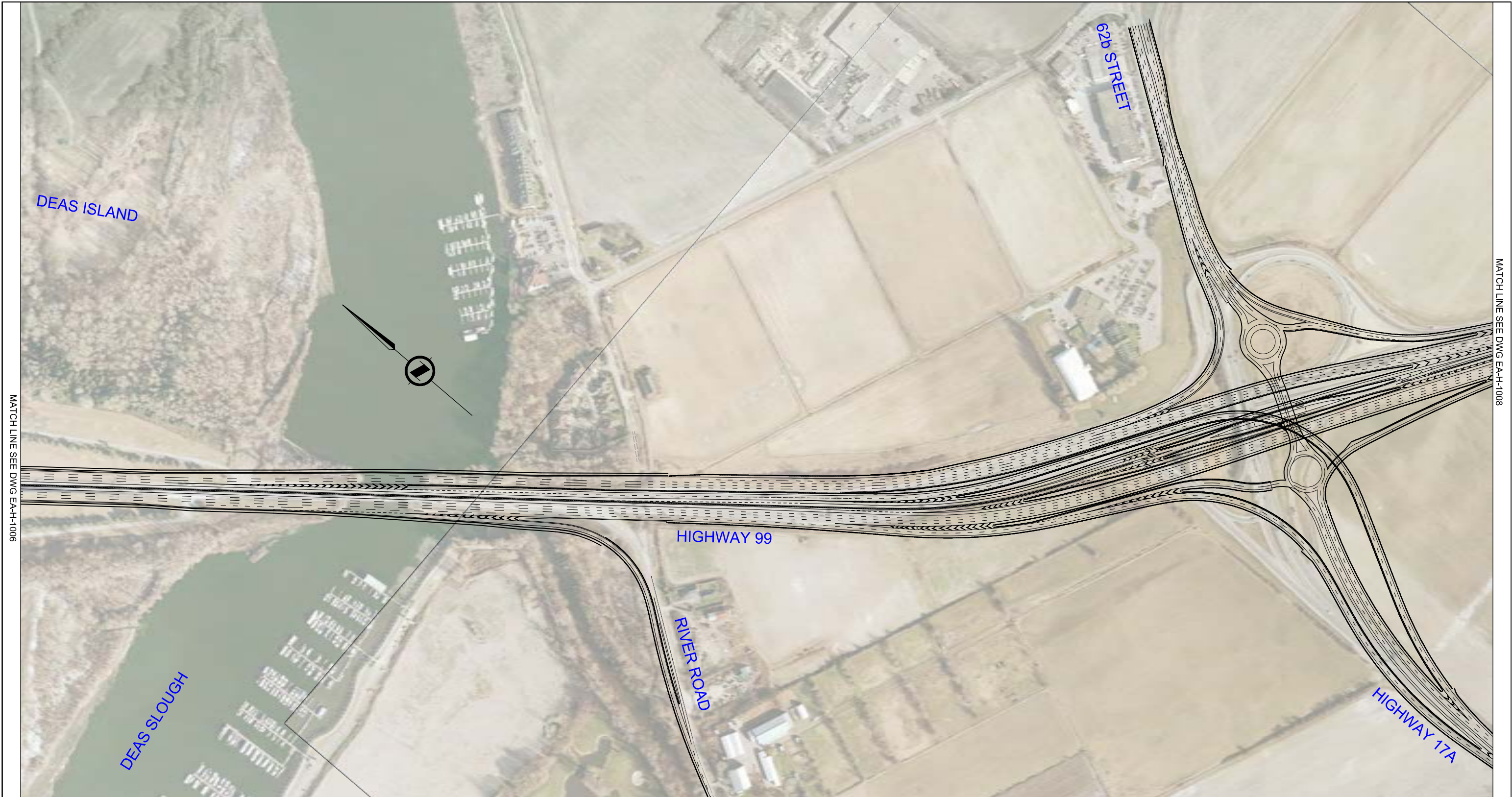


GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
PLAN

SCALE 0 25 1:5000 125m

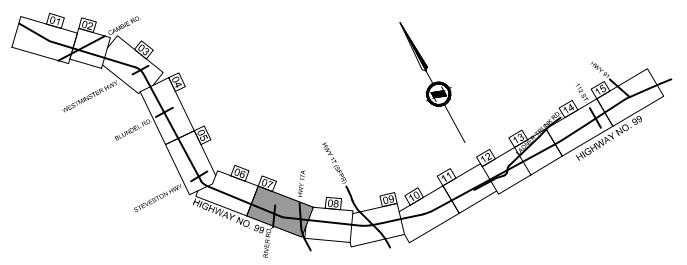
CAD FILENAME GMTR-100RC.DWG
DATE 2016-05-19

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| | | | EA-H-1006 | |

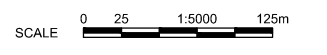


MATCH LINE SEE DWG EA-H-1006

MATCH LINE SEE DWG EA-H-1008



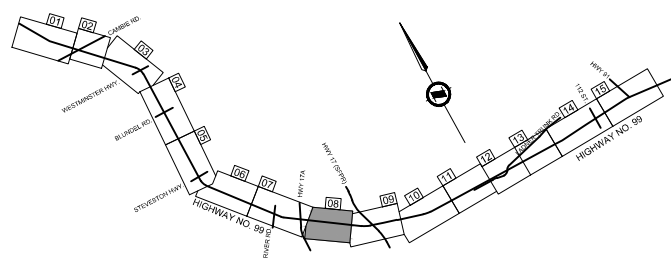
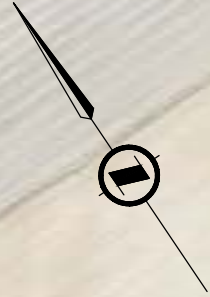
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
PLAN



CAD FILENAME: GMTR-100RC.DWG
 DATE: 2016-05-19

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| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
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May 19, 2016 - 11:01am P:\2014\14-137\00 - CAD Files\Design Drawings\20160509 Drawings for EA\EA-H-1008.dwg

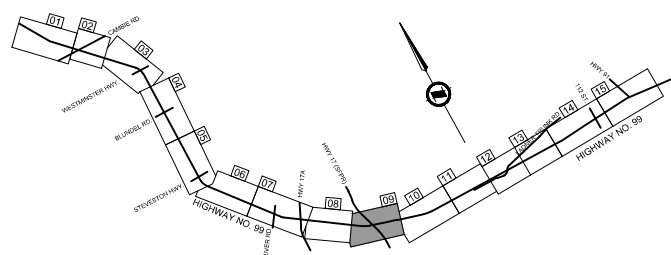
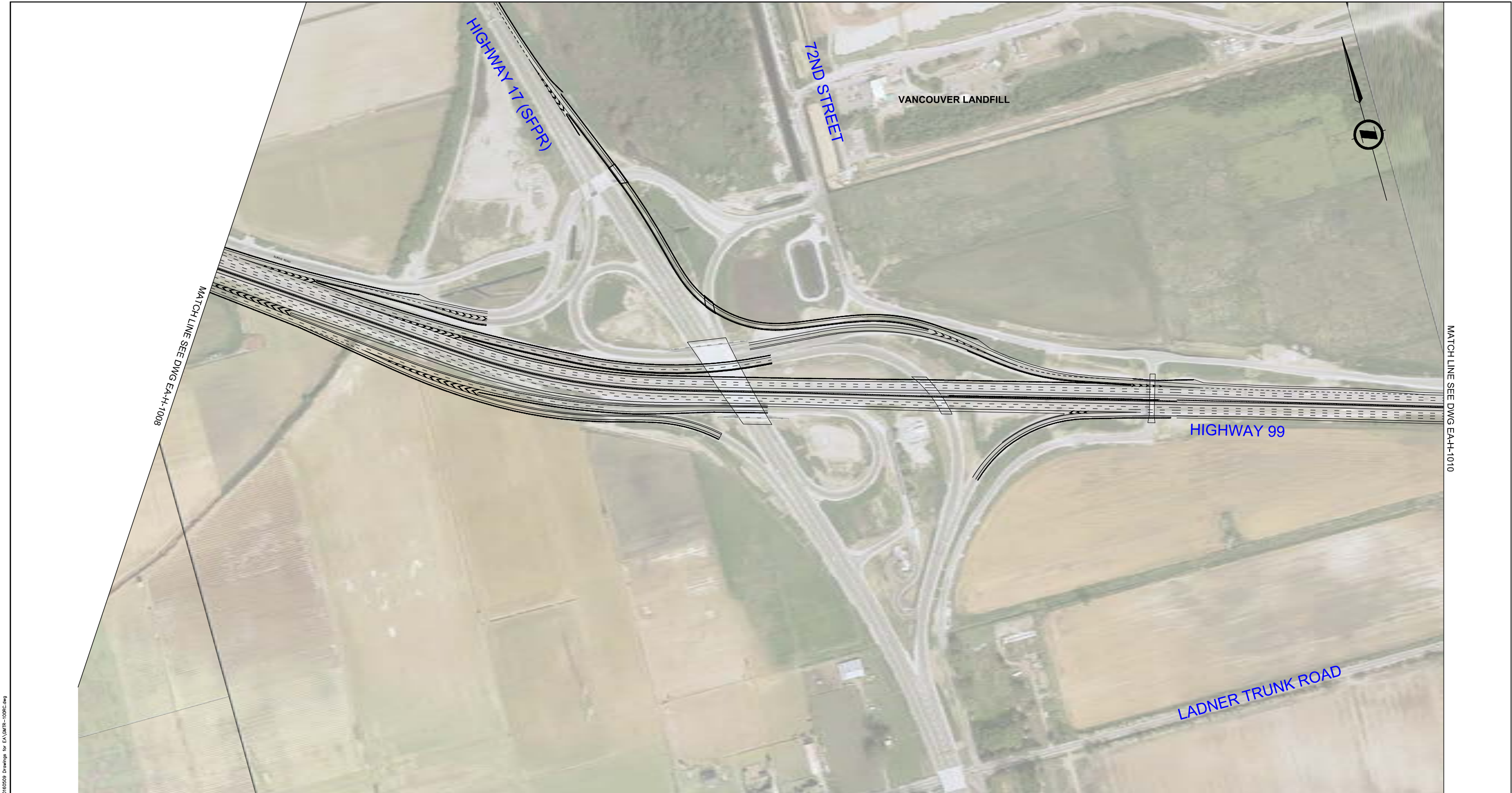


GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
PLAN

SCALE 0 25 1:5000 125m

CAD FILENAME: GMTR-100RC.DWG
DATE: 2016-05-19

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|-------------|----------------|-----|----------------|-----|
| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-1008 | |



May 18, 2016 - 11:04am P:\2014\14-137\00 - CAD Files\Design Drawings\20160509 Drawings for EA\GMR-100RC.dwg


BRITISH COLUMBIA

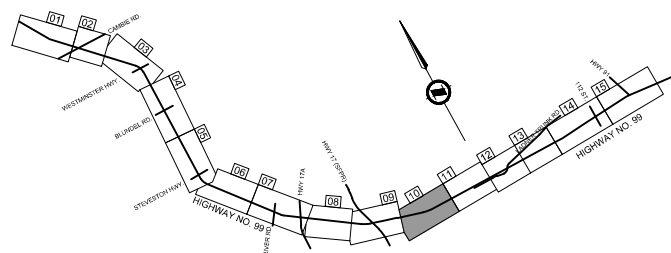
MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT PLAN

SCALE 0 25 1:5000 125m

CAD FILENAME: GMR-100RC.DWG
DATE: 2016-05-19

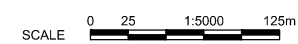
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May 19, 2016 - 11:35am D:\Temp\yup\Subarea_3628\GMR-100RC.dwg



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT DRAFT CONCEPT PLAN



CAD FILENAME: GMR-100RC.DWG
DATE: 2016-05-19

| | | | | |
|-------------|----------------|-----|----------------|-----|
| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-1010 | |

MATCH LINE SEE DWG EA-H-1010

MATCH LINE SEE DWG EA-H-1012

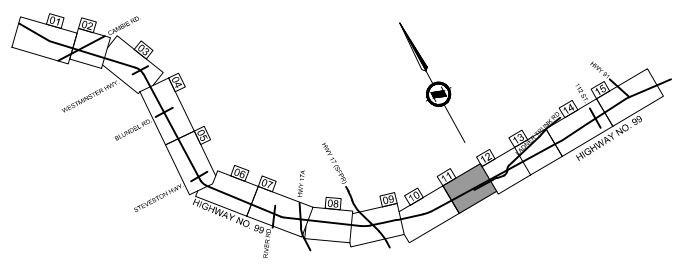


88TH STREET

HIGHWAY 99

BURNS DRIVE

LADNER TRUNK ROAD

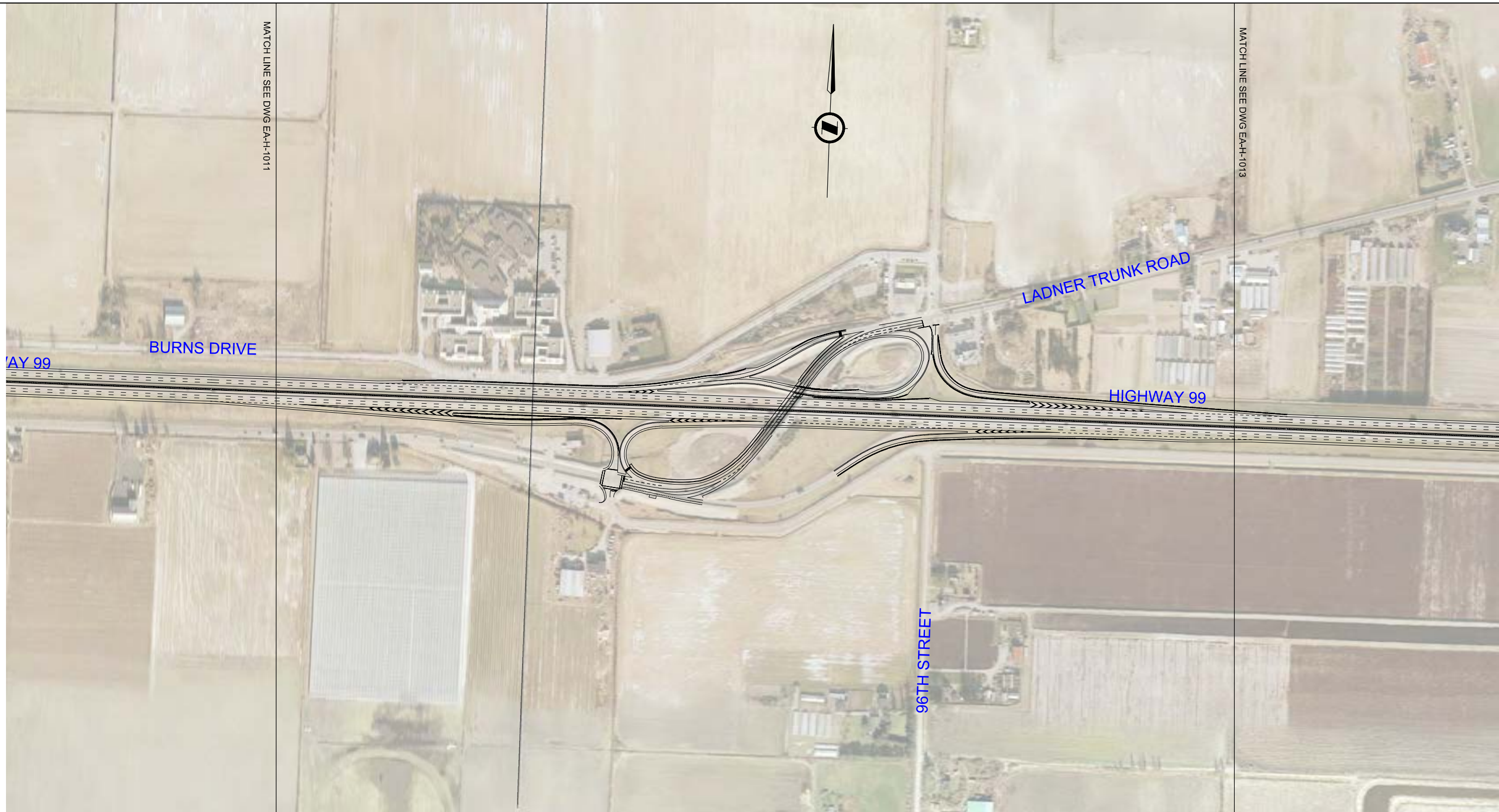


GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
PLAN

SCALE 0 25 1:5000 125m

CAD FILENAME GMITR-100RC.DWG
DATE 2016-05-19

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|-------------|----------------|-----|----------------|-----|
| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-1011 | |



MATCH LINE SEE DWG EA-H-1011

MATCH LINE SEE DWG EA-H-1013



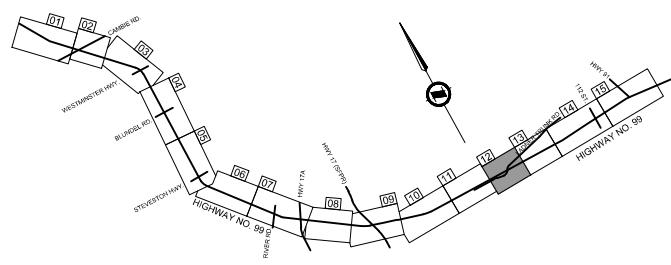
AY 99

BURNS DRIVE

LADNER TRUNK ROAD

HIGHWAY 99

96TH STREET



BRITISH COLUMBIA MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT PLAN

SCALE 0 25 1:5000 125m

CAD FILENAME: GMTR-100RC.DWG
DATE: 2016-05-19

| | | | | |
|-------------|----------------|-----|----------------|-----|
| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-1012 | |

MATCH LINE SEE DWG EA-H-1012

MATCH LINE SEE DWG EA-H-1014

LADNER TRUNK ROAD

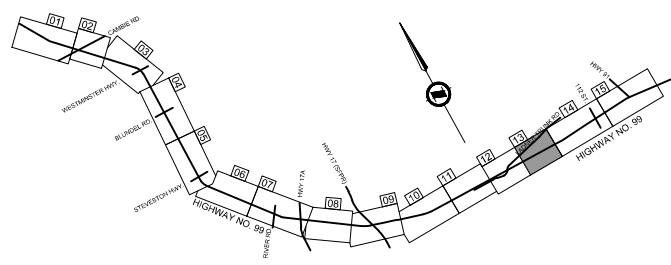
LADNER TRUNK ROAD

HIGHWAY 99

HIGHWAY 99

HORNBY DRIVE

104 STREET



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
PLAN

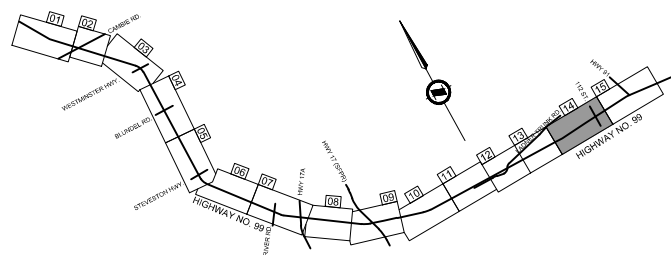
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CAD FILENAME GMITR-100RC.DWG
DATE 2016-05-19

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| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-1013 | |

MATCH LINE SEE DWG EA-H-1013

MATCH LINE SEE DWG EA-H-1015



May 19, 2016 - 11:13am P. 2016\14-137\00 - CAD File\Design\Drawings\20160509 Drawings for EA\GMTR-100RC.dwg



BRITISH COLUMBIA
 MINISTRY OF TRANSPORTATION
 AND INFRASTRUCTURE

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
 DRAFT CONCEPT
 PLAN

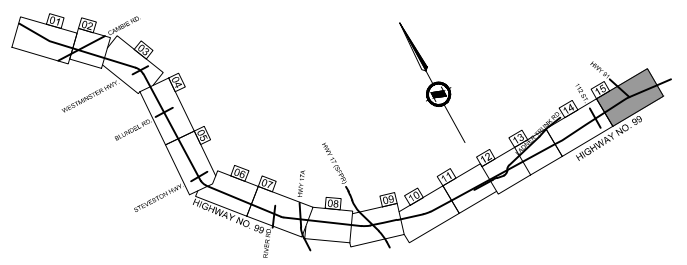
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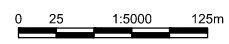
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 DATE 2016-05-19

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| | | | EA-H-1014 | |



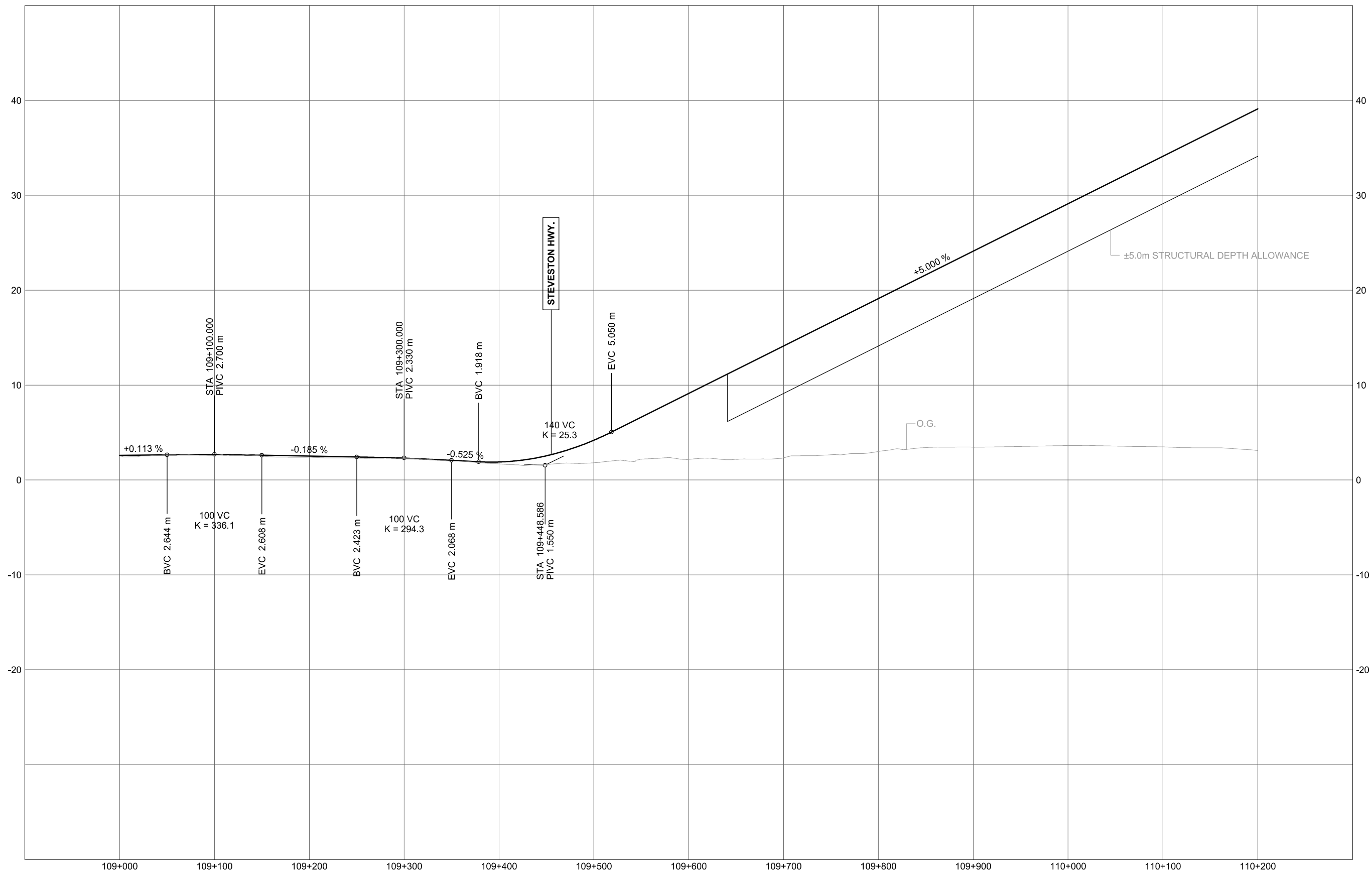
MATCH LINE SEE DWG EA-H-1014



SCALE 

CAD FILENAME: GMTR-100RC.DWG
DATE: 2016-05-19

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| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
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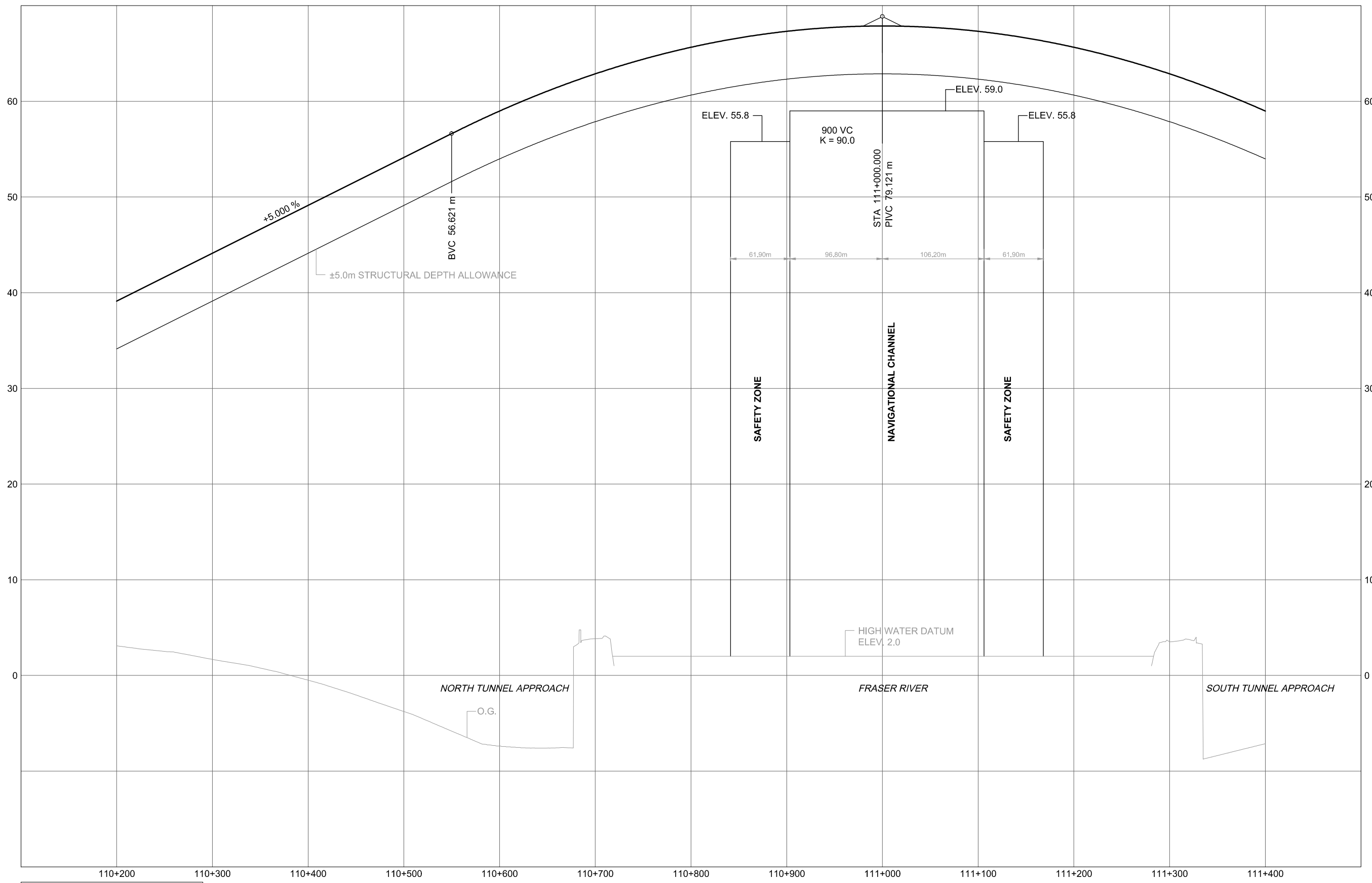
DESIGN SPEED 100 km/h

BRITISH COLUMBIA MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE

SCALE: 0 20 100m H 1:4000 V 1:400

CAD FILENAME: GMITR-200PR.DWG DATE: 2016-05-17

| | | | | |
|--|----------------|-----|----------------|-----|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | | | | |
| DRAFT CONCEPT | | | | |
| BRIDGE AND ROADWAY VERTICAL PROFILE | | | | |
| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-2007 | |



DESIGN SPEED 100 km/h



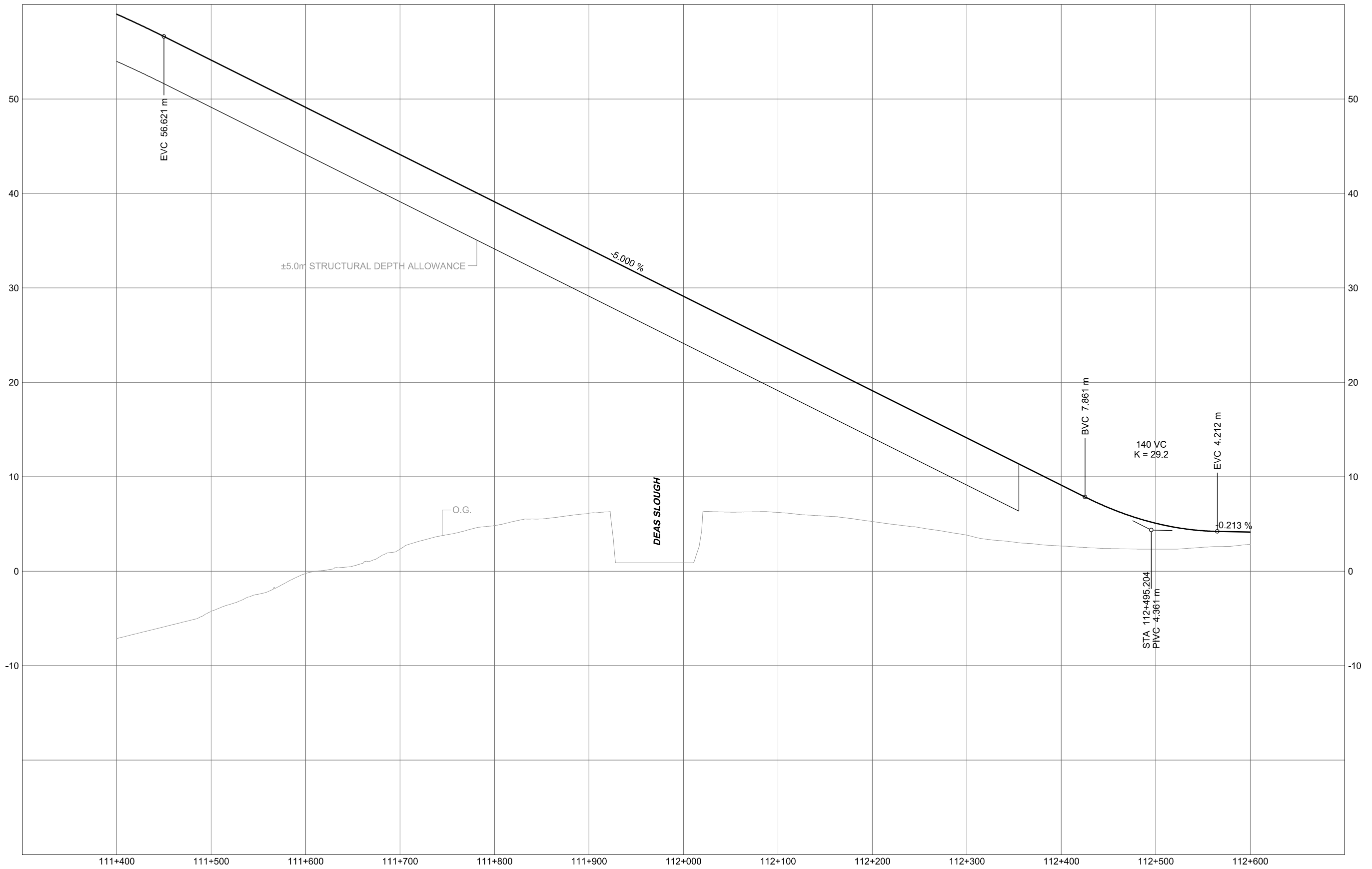
GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
BRIDGE AND ROADWAY VERTICAL PROFILE

SCALE 0 20 100m
0 2 V 1:400 10m

CAD FILENAME GMITR-200PR.DWG
DATE 2016-05-17

| | | | | |
|-------------|----------------|-----|----------------|-----|
| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-2008 | |

May 16, 2016 - 9:45am P:\2016\11-17\100 - CAD Files\Design\Drawings\20160509 Drawings for EA\GMTR-200PR.dwg



DESIGN SPEED 100 km/h



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
BRIDGE AND ROADWAY VERTICAL PROFILE

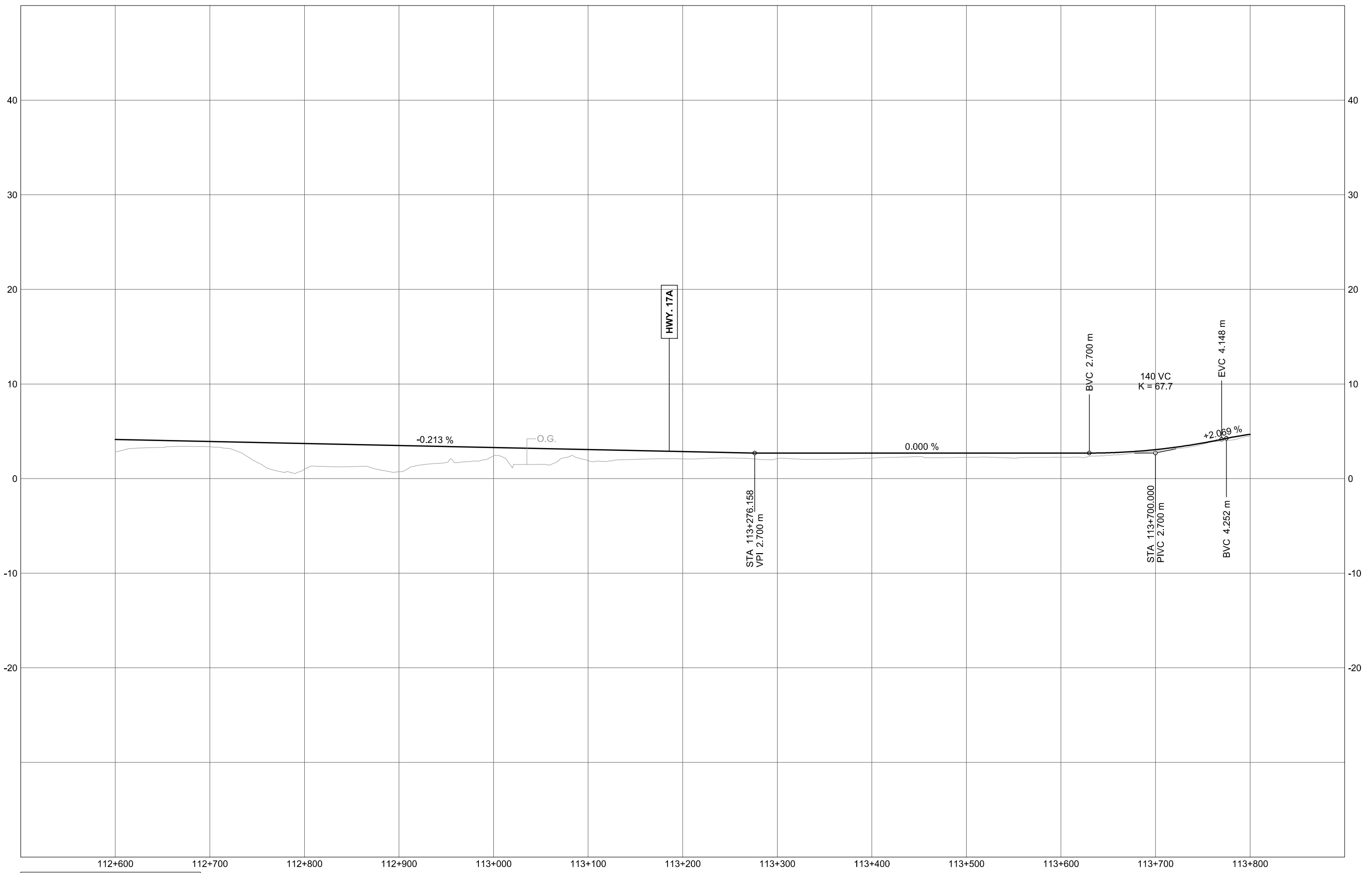
SCALE
0 20 100m
0 2 V 1:400 10m

CAD FILENAME GMITR-200PR.DWG
DATE 2016-05-17

| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
|-------------|----------------|-----|----------------|-----|
| | | | EA-H-2009 | |

May 16, 2016 - 9:45am P:\2016\11-17\10 - CAD Files\Design\Drawings\20160509 Drawings for EA\GMTR-200PR.dwg

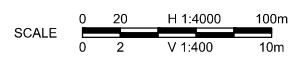
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DESIGN SPEED 100 km/h

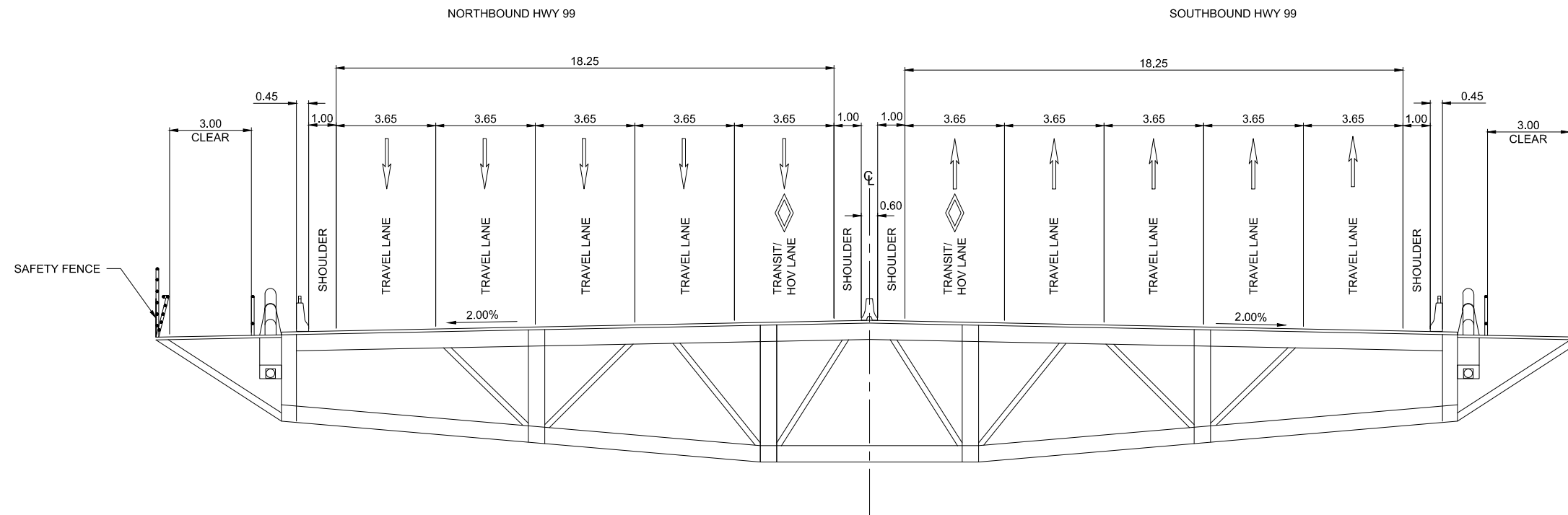


GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
 DRAFT CONCEPT
 BRIDGE AND ROADWAY VERTICAL PROFILE

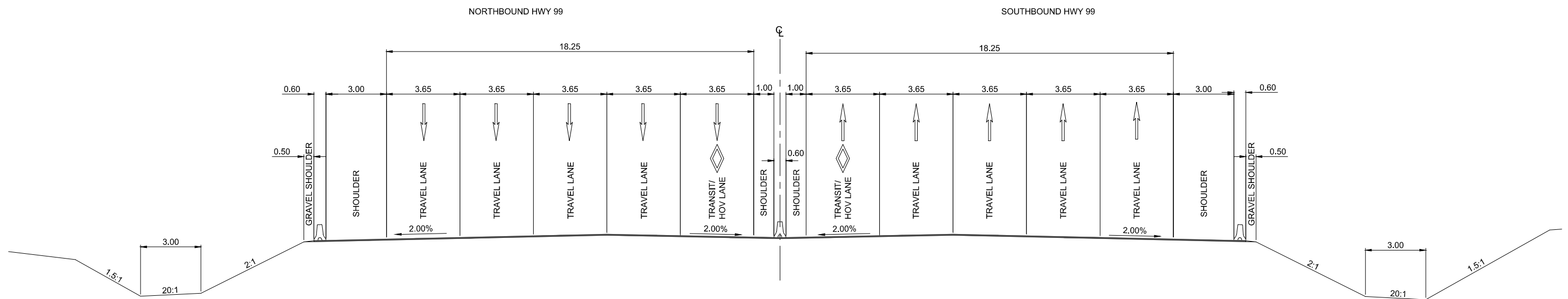


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 DATE: 2016-05-17

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| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
| | | | EA-H-2010 | |



TYPICAL SECTION - BRIDGE



TYPICAL 10 LANE SECTION - HIGHWAY

May 18, 2016 - 2:28pm P:\2014\1-17\00 - CAD Files\Design\Drawings\20160509 Drawings for EA\QMR-3001.dwg

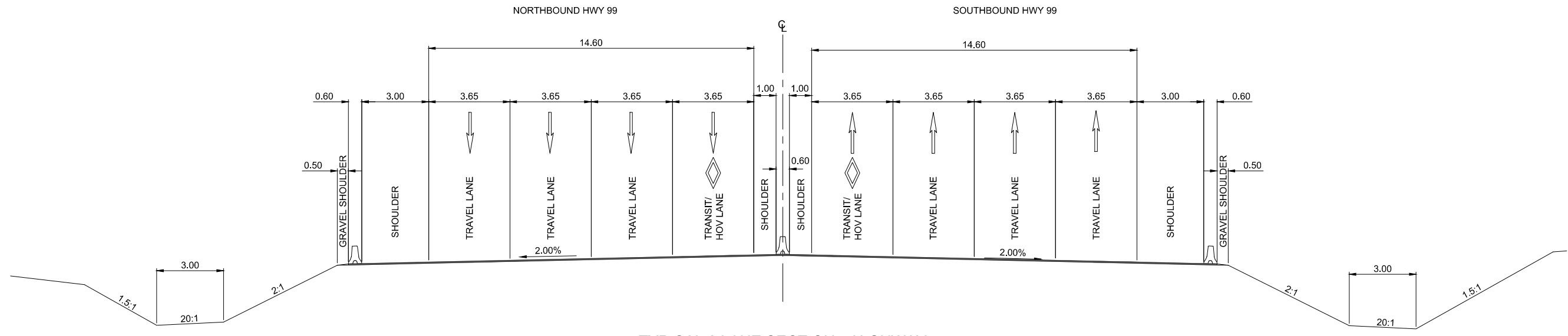


GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
DRAFT CONCEPT
TYPICAL SECTIONS

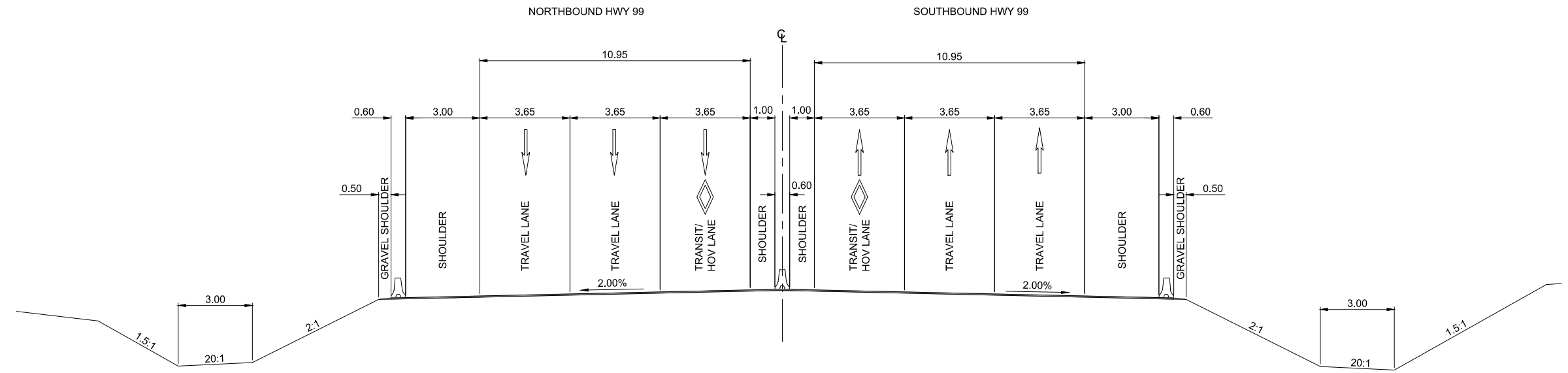
SCALE 0 1 1:100 5m

CAD FILENAME GMITR-3001S.DWG
DATE 2016-05-18

| FILE NUMBER | PROJECT NUMBER | REG | DRAWING NUMBER | REV |
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| | | | EA-H-3001 | |



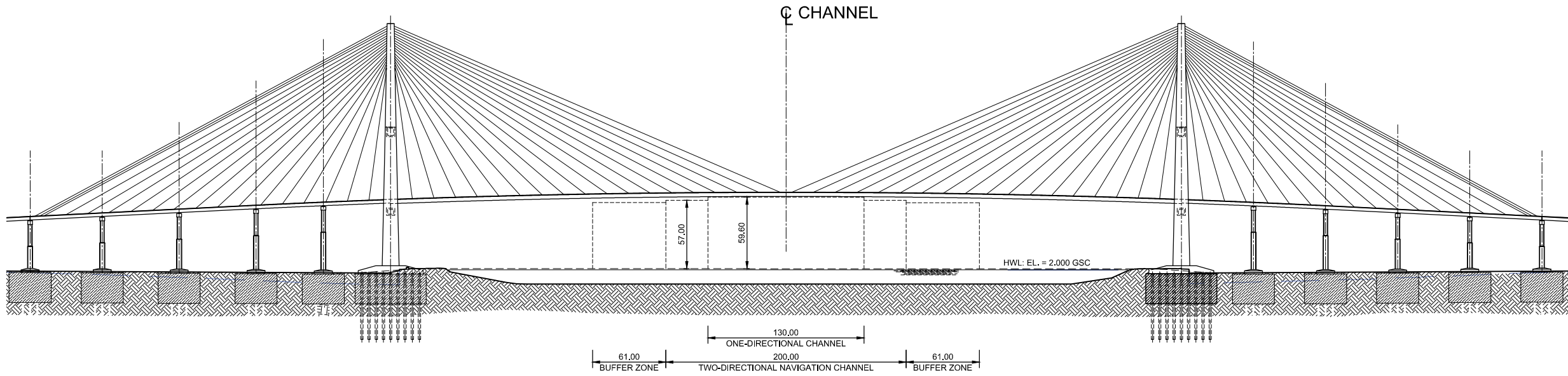
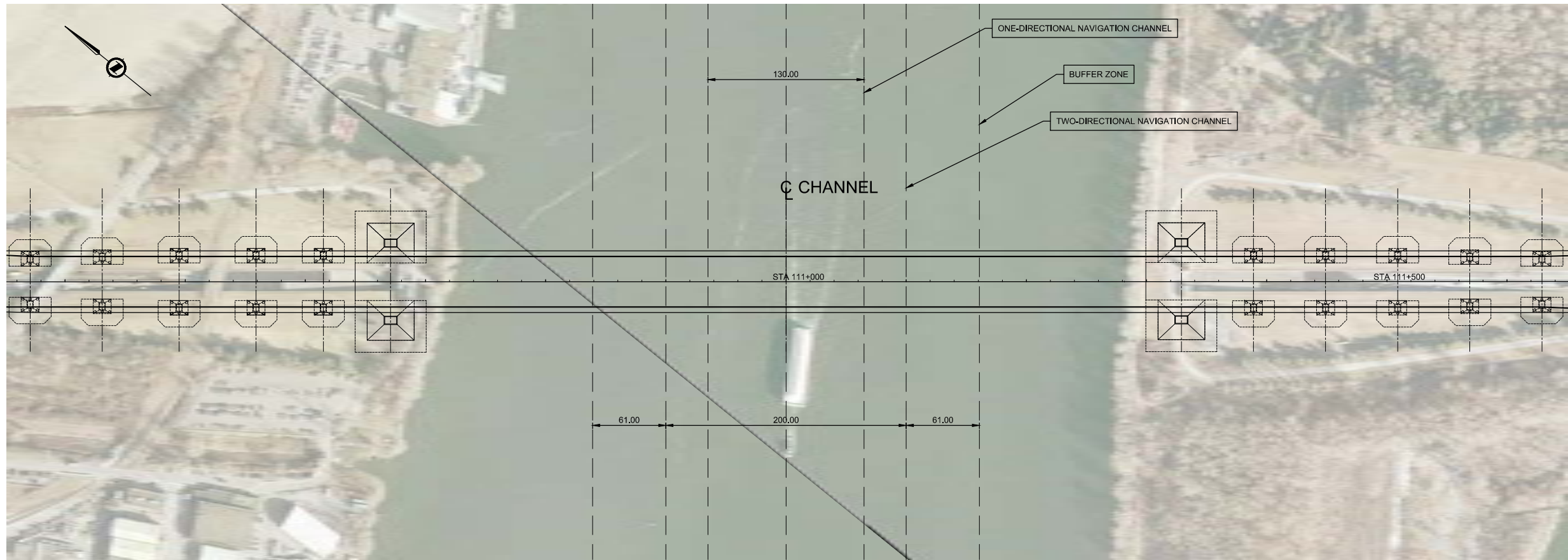
TYPICAL 8 LANE SECTION – HIGHWAY



TYPICAL 6 LANE SECTION – HIGHWAY

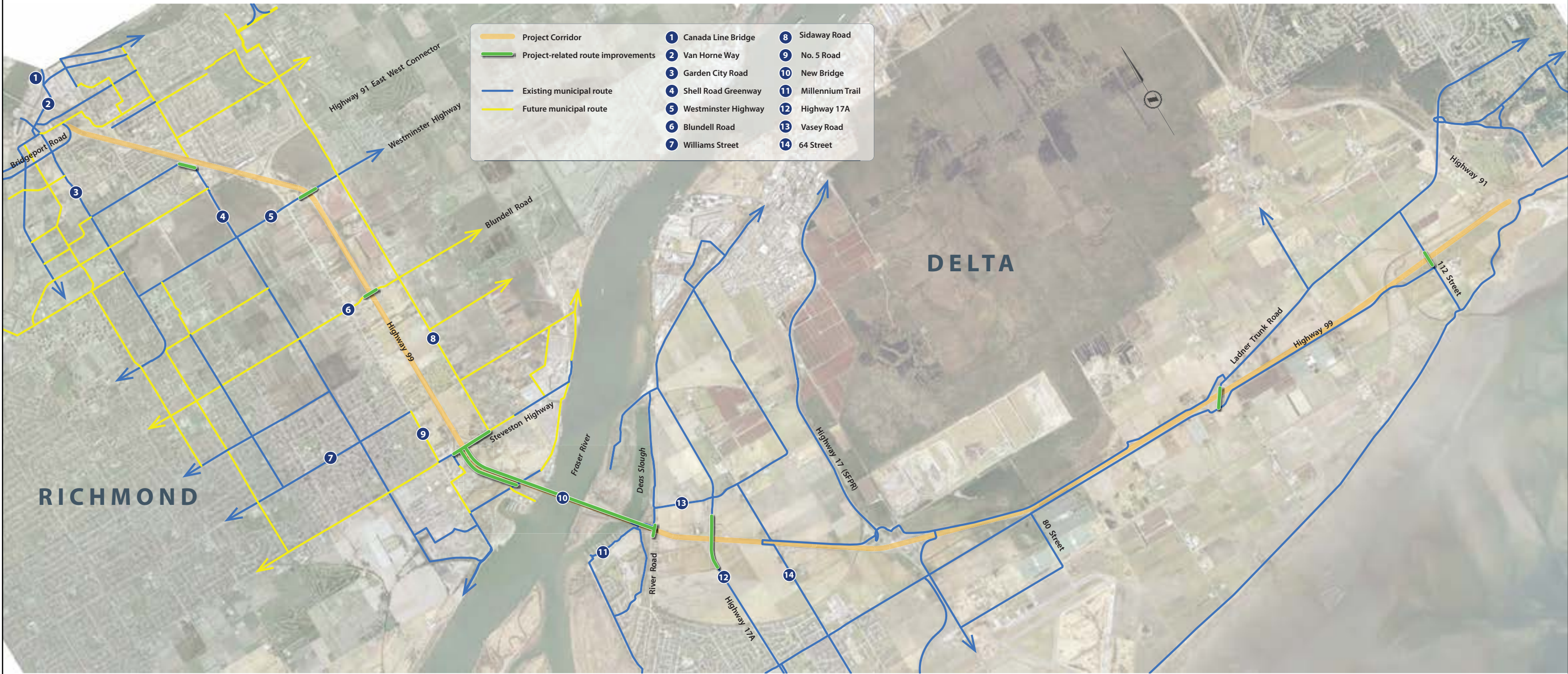
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| BRITISH COLUMBIA | | MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE | | | |
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT DRAFT CONCEPT TYPICAL SECTIONS | | | | | |
| SCALE | | CAD FILENAME: <u>GMTR-3001.DWG</u> DATE: <u>2016-05-18</u> | | FILE NUMBER | PROJECT NUMBER |
| | | | | REG | DRAWING NUMBER EA-H-3002 |



May 12, 2016 - 15:11pm D:\Temp\Asp\pub\ah...3200\B-GEN-1-FOR EA.dwg

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|-------------------------|--|--|--|-------------|----------------|-----|
| BRITISH COLUMBIA | MINISTRY OF TRANSPORTATION AND INFRASTRUCTURE | GEORGE MASSEY TUNNEL REPLACEMENT PROJECT DRAFT CONCEPT NAVIGATION CLEARANCE | | | | |
| | | SCALE 0 40m 1:4000 200m | CAD FILENAME B-GEN-1-FOR EA.DWG DATE 2016-05-12 | FILE NUMBER | PROJECT NUMBER | REG |



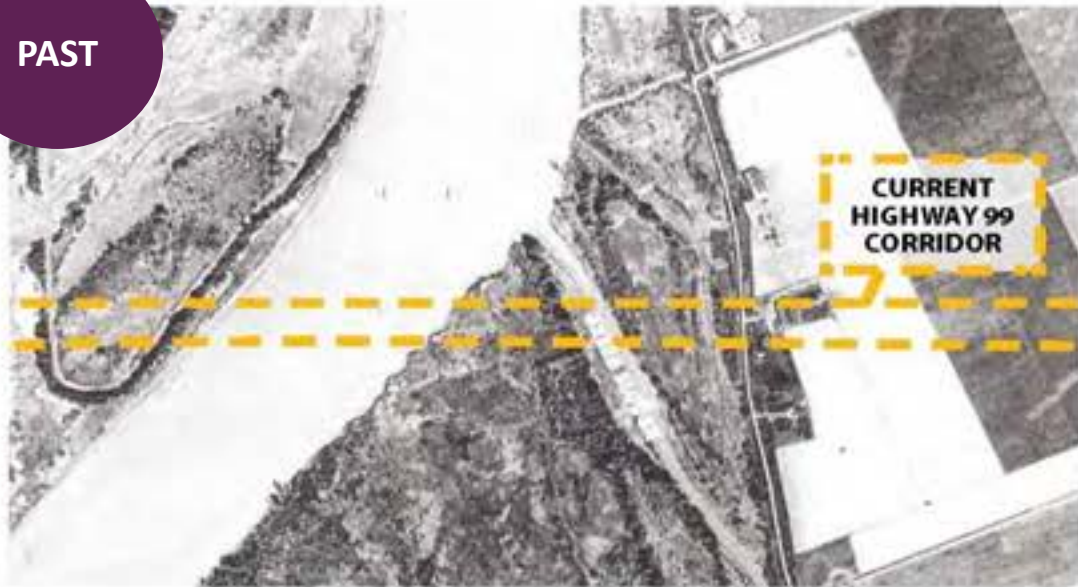
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| Project Corridor | 1 Canada Line Bridge | 8 Sidaway Road |
| Project-related route improvements | 2 Van Horne Way | 9 No. 5 Road |
| Existing municipal route | 3 Garden City Road | 10 New Bridge |
| Future municipal route | 4 Shell Road Greenway | 11 Millennium Trail |
| | 5 Westminster Highway | 12 Highway 17A |
| | 6 Blundell Road | 13 Vasey Road |
| | 7 Williams Street | 14 64 Street |

RICHMOND

DELTA

| | | | | | | | | |
|-------|--------------|--------------|-------------------|-------------|----------------|-----|----------------|-----|
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| | | DATE | 2015-05-12 | | | | H-SK-001 | |

PAST



1938

PRESENT

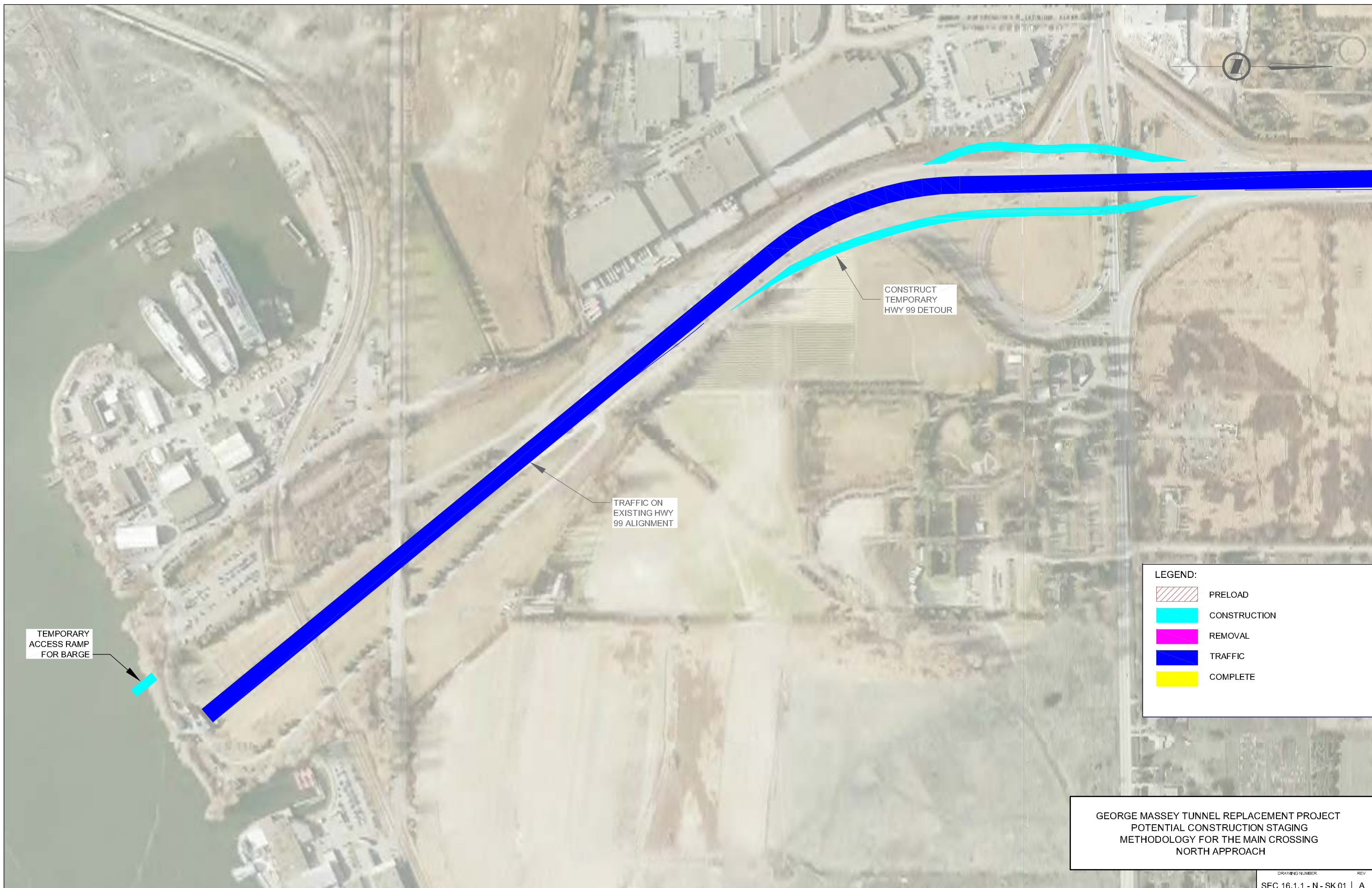


2014

FUTURE



The Project provides an opportunity to enhance the area under the new bridge, restore Green Slough to its original channel and improve the surrounding habitat








TEMPORARY
ACCESS RAMP
FOR BARGE

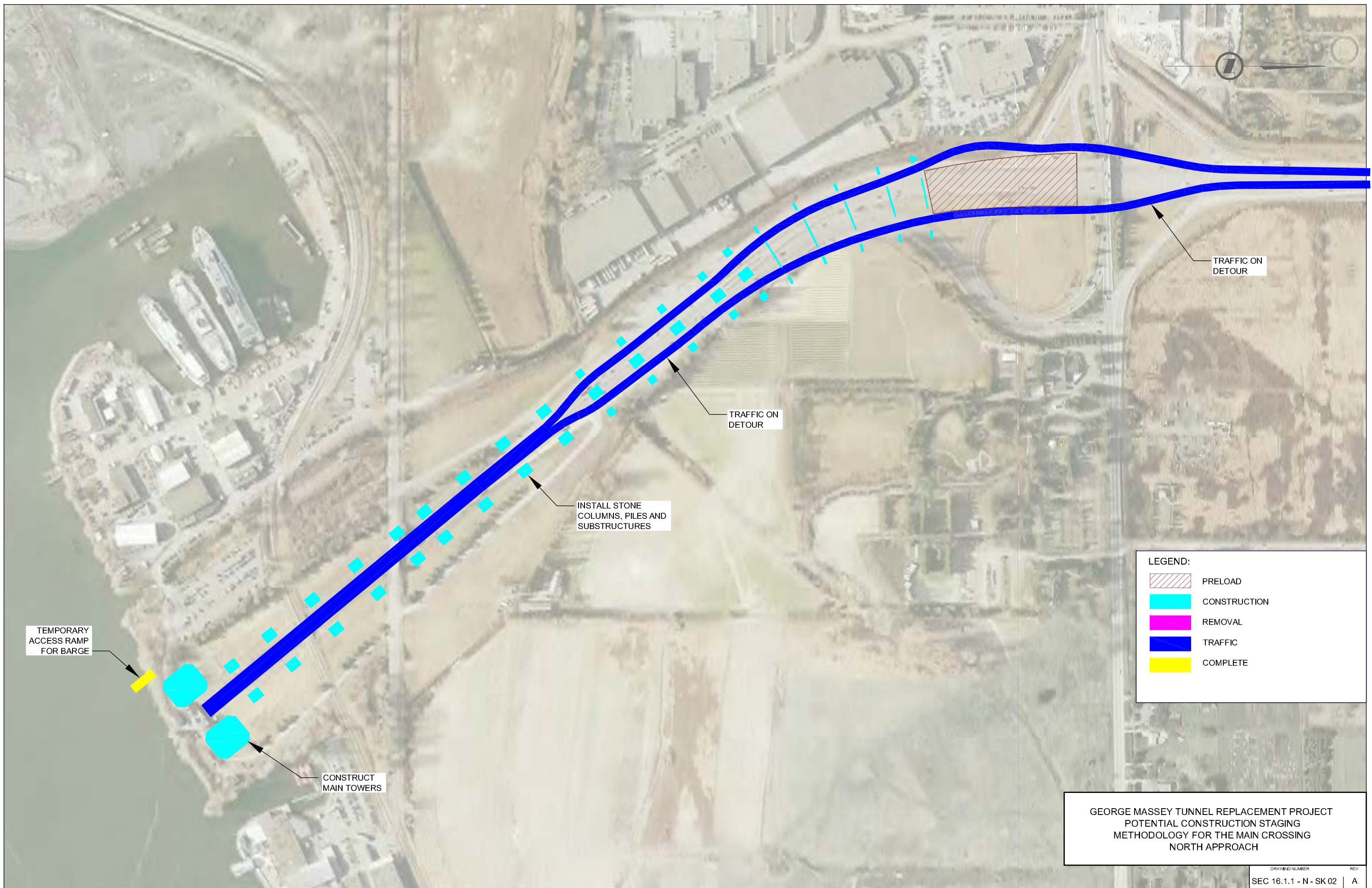
TRAFFIC ON
EXISTING HWY
99 ALIGNMENT

CONSTRUCT
TEMPORARY
HWY 99 DETOUR

LEGEND:

| | |
|---|--------------|
|  | PRELOAD |
|  | CONSTRUCTION |
|  | REMOVAL |
|  | TRAFFIC |
|  | COMPLETE |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
NORTH APPROACH



TEMPORARY
ACCESS RAMP
FOR BARGE






CONSTRUCT
MAIN TOWERS

INSTALL STONE
COLUMNS, PILES AND
SUBSTRUCTURES

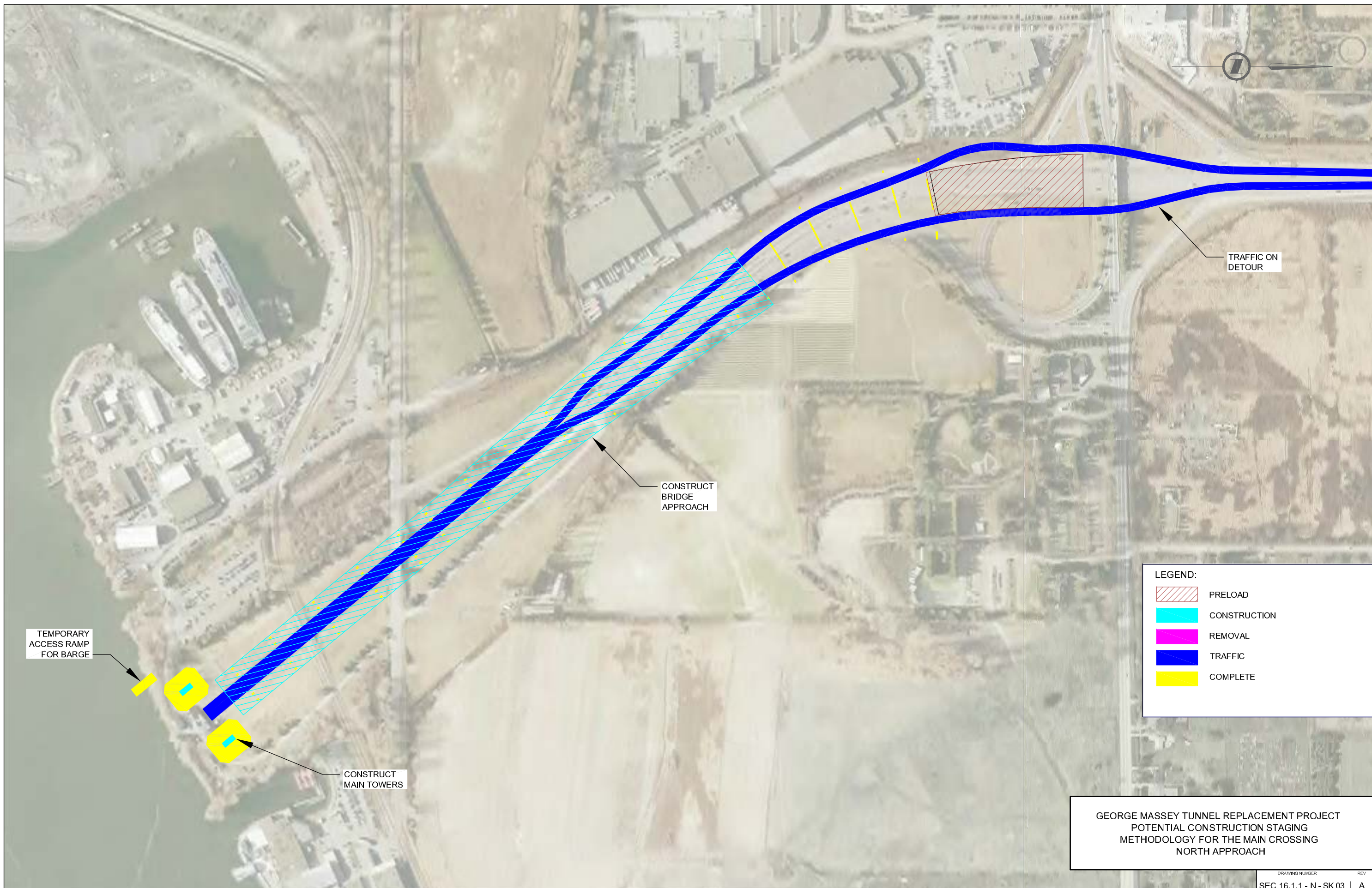
TRAFFIC ON
DETOUR

TRAFFIC ON
DETOUR

LEGEND:

| | |
|---|--------------|
|  | PRELOAD |
|  | CONSTRUCTION |
|  | REMOVAL |
|  | TRAFFIC |
|  | COMPLETE |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
NORTH APPROACH








TEMPORARY
ACCESS RAMP
FOR BARGE

CONSTRUCT
MAIN TOWERS

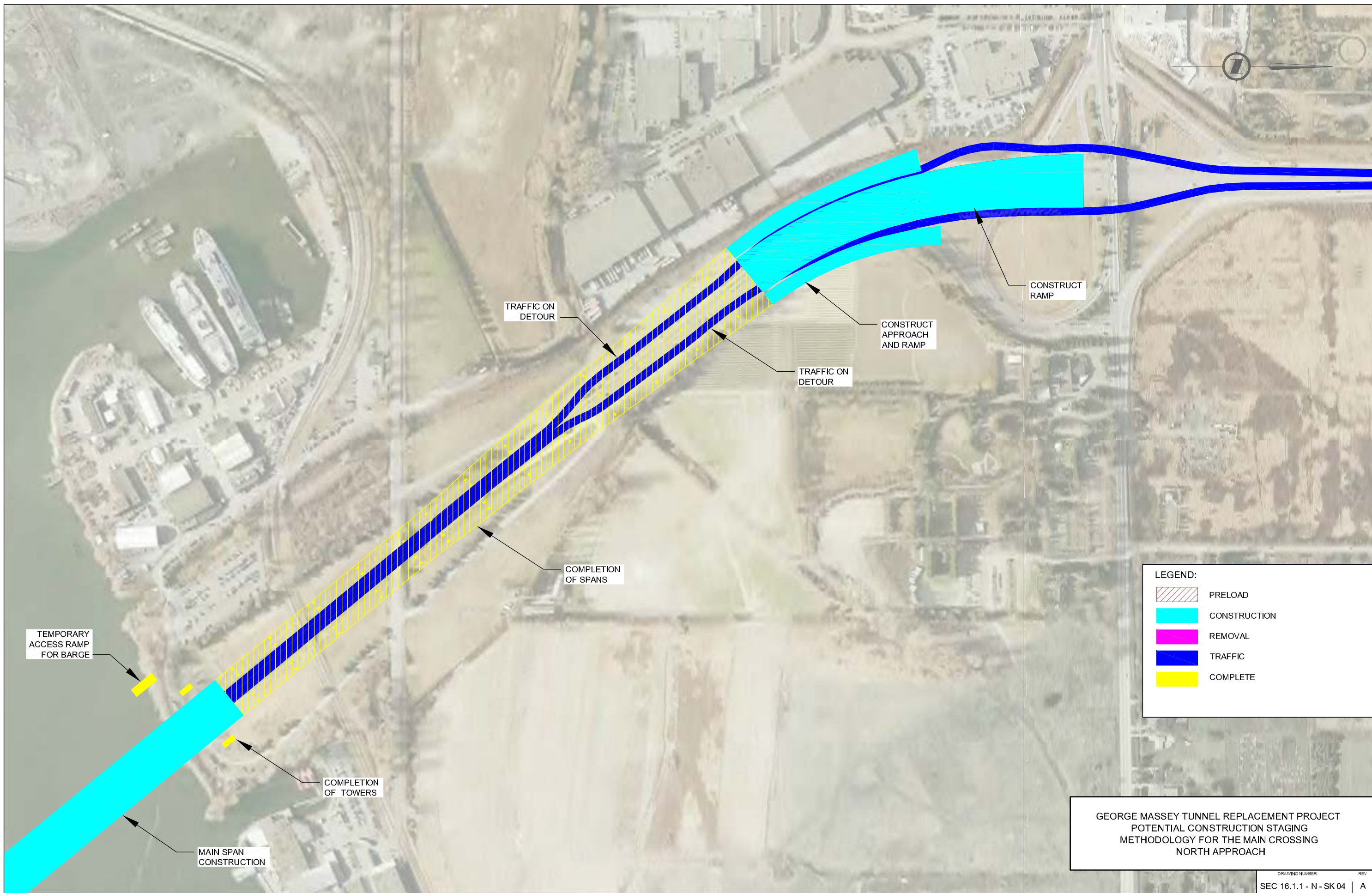
CONSTRUCT
BRIDGE
APPROACH

TRAFFIC ON
DETOUR

LEGEND:

-  PRELOAD
-  CONSTRUCTION
-  REMOVAL
-  TRAFFIC
-  COMPLETE

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
NORTH APPROACH



TEMPORARY
ACCESS RAMP
FOR BARGE

TRAFFIC ON
DETOUR

CONSTRUCT
APPROACH
AND RAMP

CONSTRUCT
RAMP






TRAFFIC ON
DETOUR

COMPLETION
OF SPANS

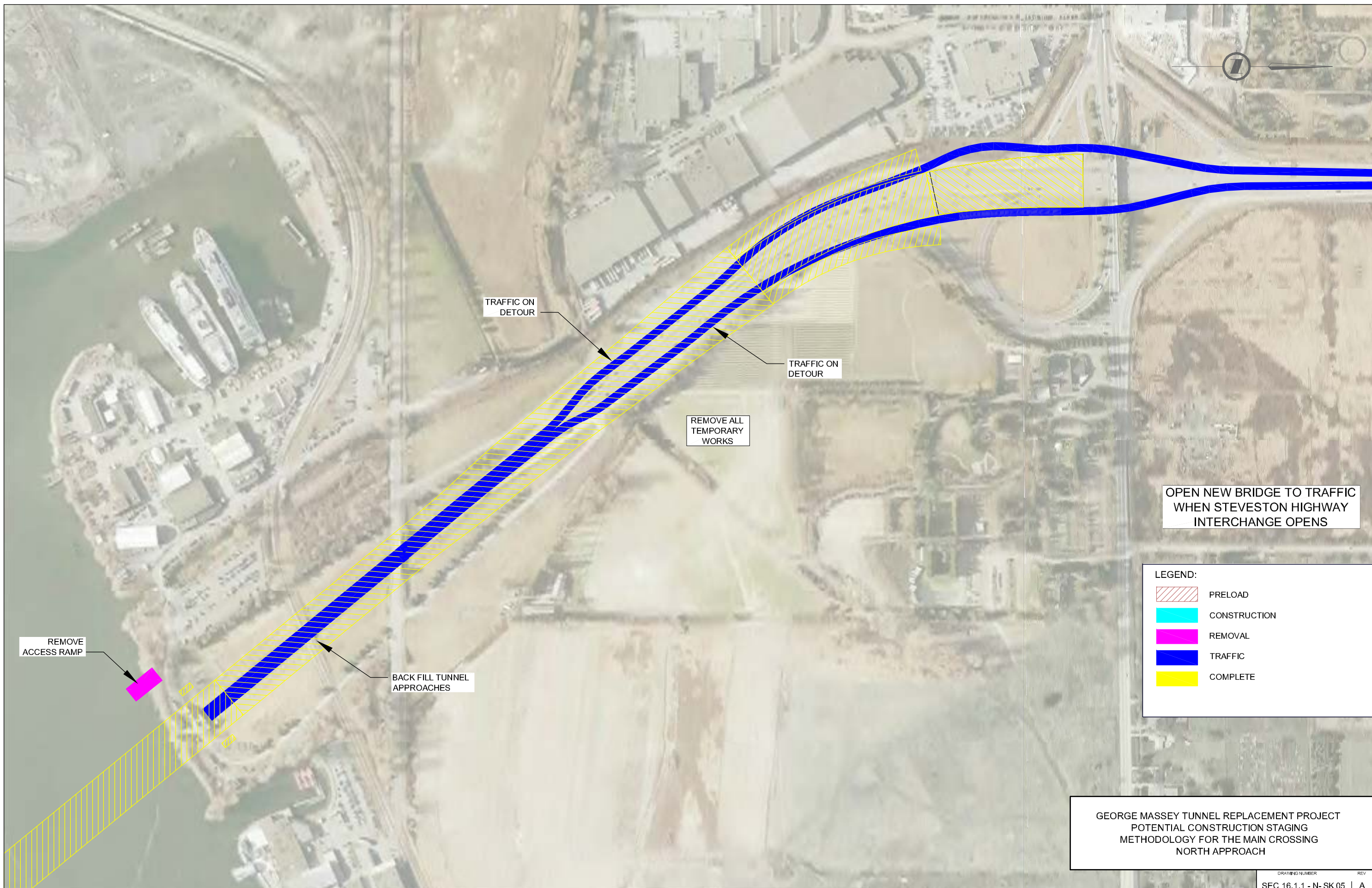
COMPLETION
OF TOWERS

MAIN SPAN
CONSTRUCTION

LEGEND:

| | |
|---|--------------|
|  | PRELOAD |
|  | CONSTRUCTION |
|  | REMOVAL |
|  | TRAFFIC |
|  | COMPLETE |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
NORTH APPROACH



TRAFFIC ON
DETOUR

TRAFFIC ON
DETOUR






REMOVE ALL
TEMPORARY
WORKS

BACK FILL TUNNEL
APPROACHES

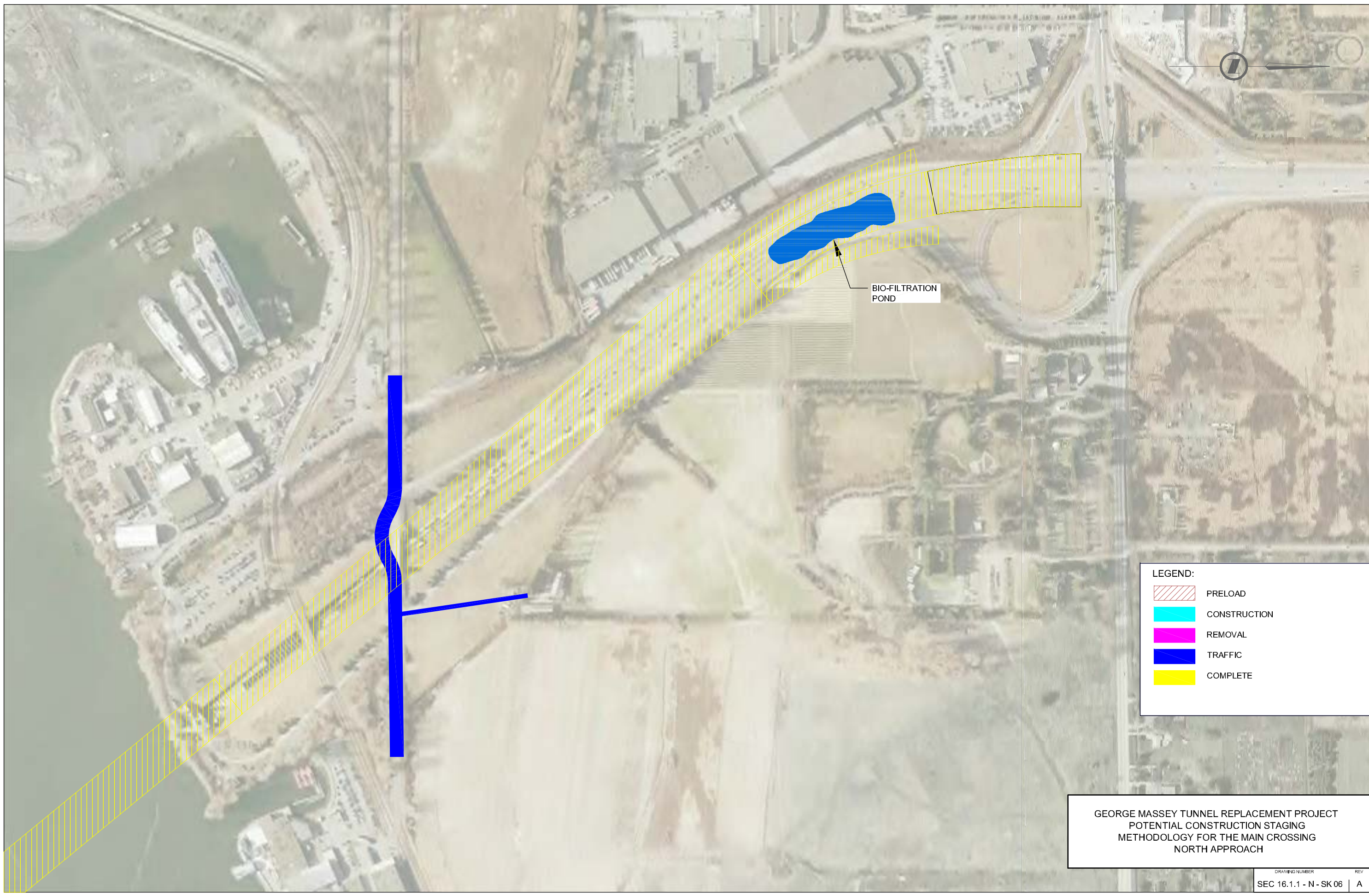
REMOVE
ACCESS RAMP

OPEN NEW BRIDGE TO TRAFFIC
WHEN STEVESTON HIGHWAY
INTERCHANGE OPENS

LEGEND:






| | |
|---|--------------|
|  | PRELOAD |
|  | CONSTRUCTION |
|  | REMOVAL |
|  | TRAFFIC |
|  | COMPLETE |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
NORTH APPROACH

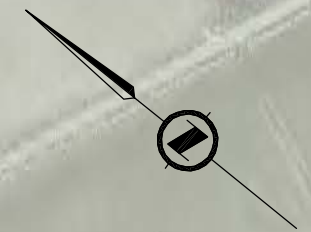


BIO-FILTRATION POND

LEGEND:

| | |
|---|--------------|
|  | PRELOAD |
|  | CONSTRUCTION |
|  | REMOVAL |
|  | TRAFFIC |
|  | COMPLETE |

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
NORTH APPROACH



- LEGEND:
- PRELOAD
 - CONSTRUCTION
 - REMOVAL
 - TRAFFIC
 - COMPLETE

TEMPORARY
ACCESS RAMP
FOR BARGE

TEMPORARY
BRIDGE

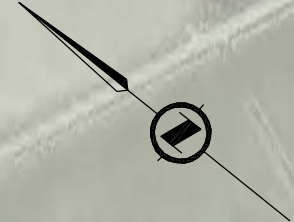
TRAFFIC ON EXISTING
HWY 99 ALIGNMENT

TEMPORARY
BRIDGE

GREEN SLOUGH

CONSTRUCT
HWY 99 DETOUR

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
SOUTH APPROACH

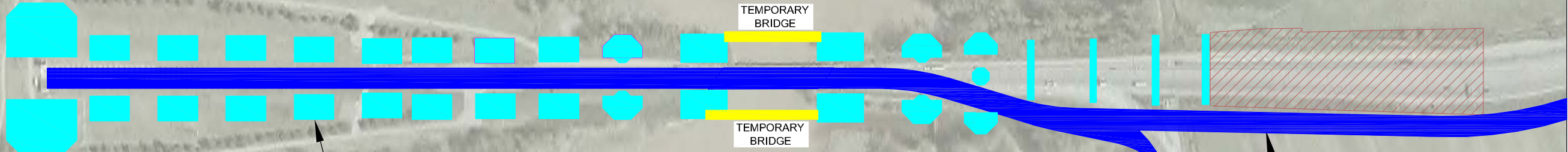


- LEGEND:
- PRELOAD
 - CONSTRUCTION
 - REMOVAL
 - TRAFFIC
 - COMPLETE

TEMPORARY
ACCESS RAMP
FOR BARGE

TEMPORARY
BRIDGE

TEMPORARY
BRIDGE

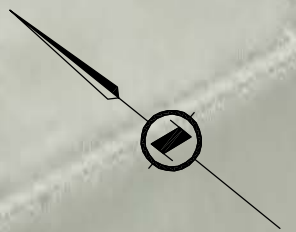


CONSTRUCT
MAIN TOWERS






INSTALL STONE
COLUMNS, PILES AND
SUBSTRUCTURES

TRAFFIC ON
DETOUR

GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
POTENTIAL CONSTRUCTION STAGING
METHODOLOGY FOR THE MAIN CROSSING
SOUTH APPROACH



LEGEND:

-  PRELOAD
-  CONSTRUCTION
-  REMOVAL
-  TRAFFIC
-  COMPLETE

TEMPORARY
ACCESS RAMP
FOR BARGE

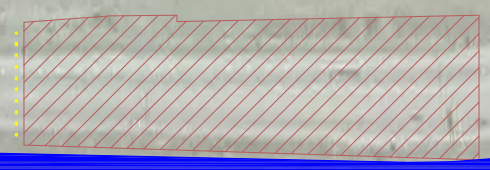


CONSTRUCT
MAIN TOWERS

CONSTRUCT
BRIDGE DECK

TEMPORARY
BRIDGE

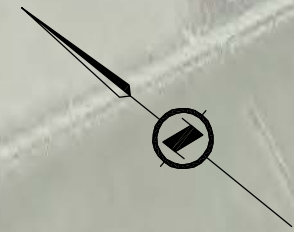
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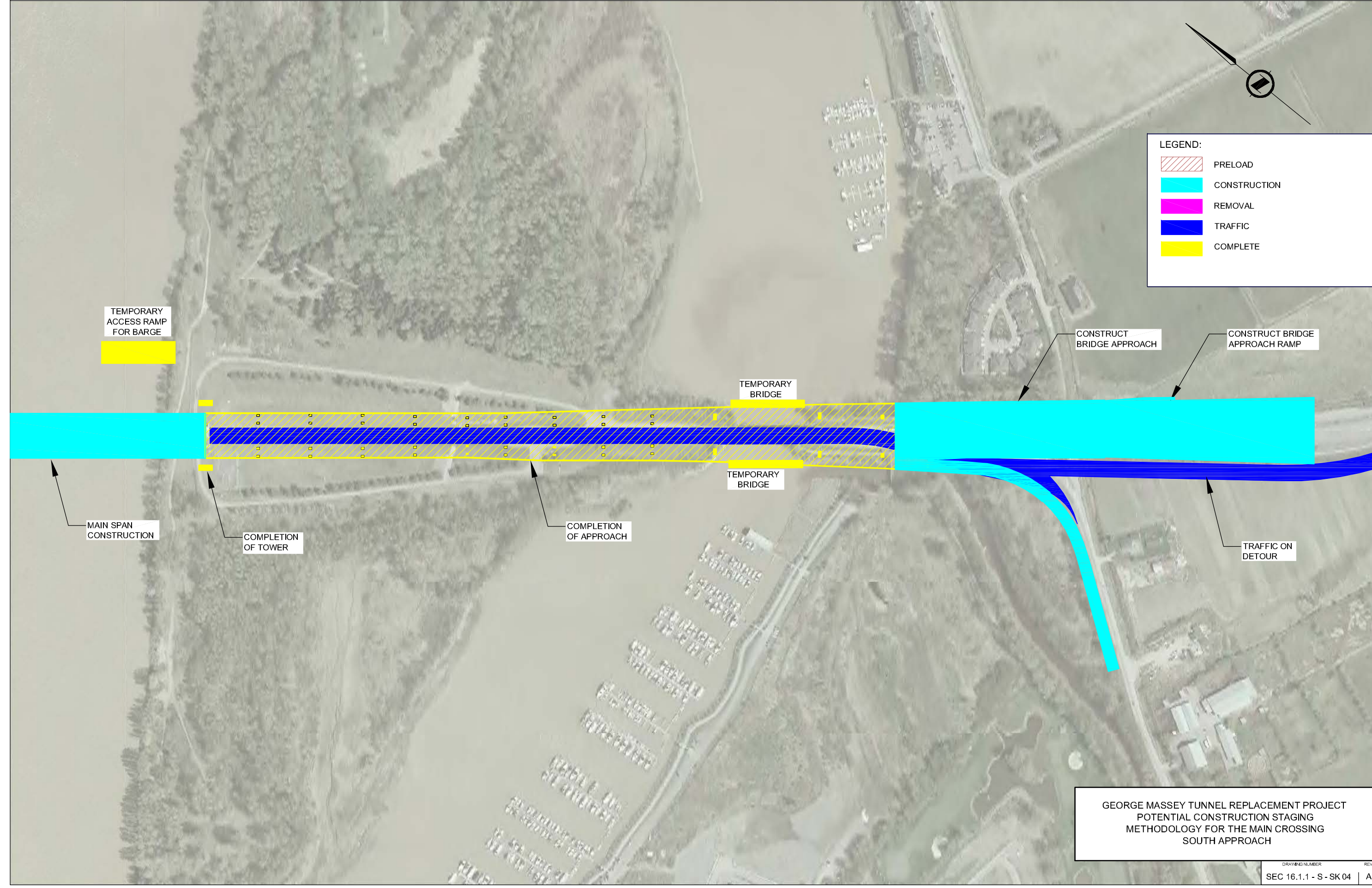


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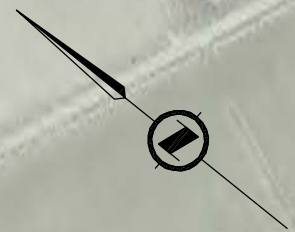


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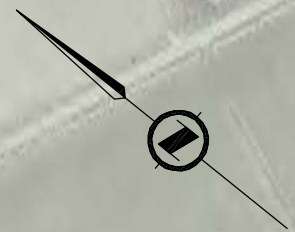
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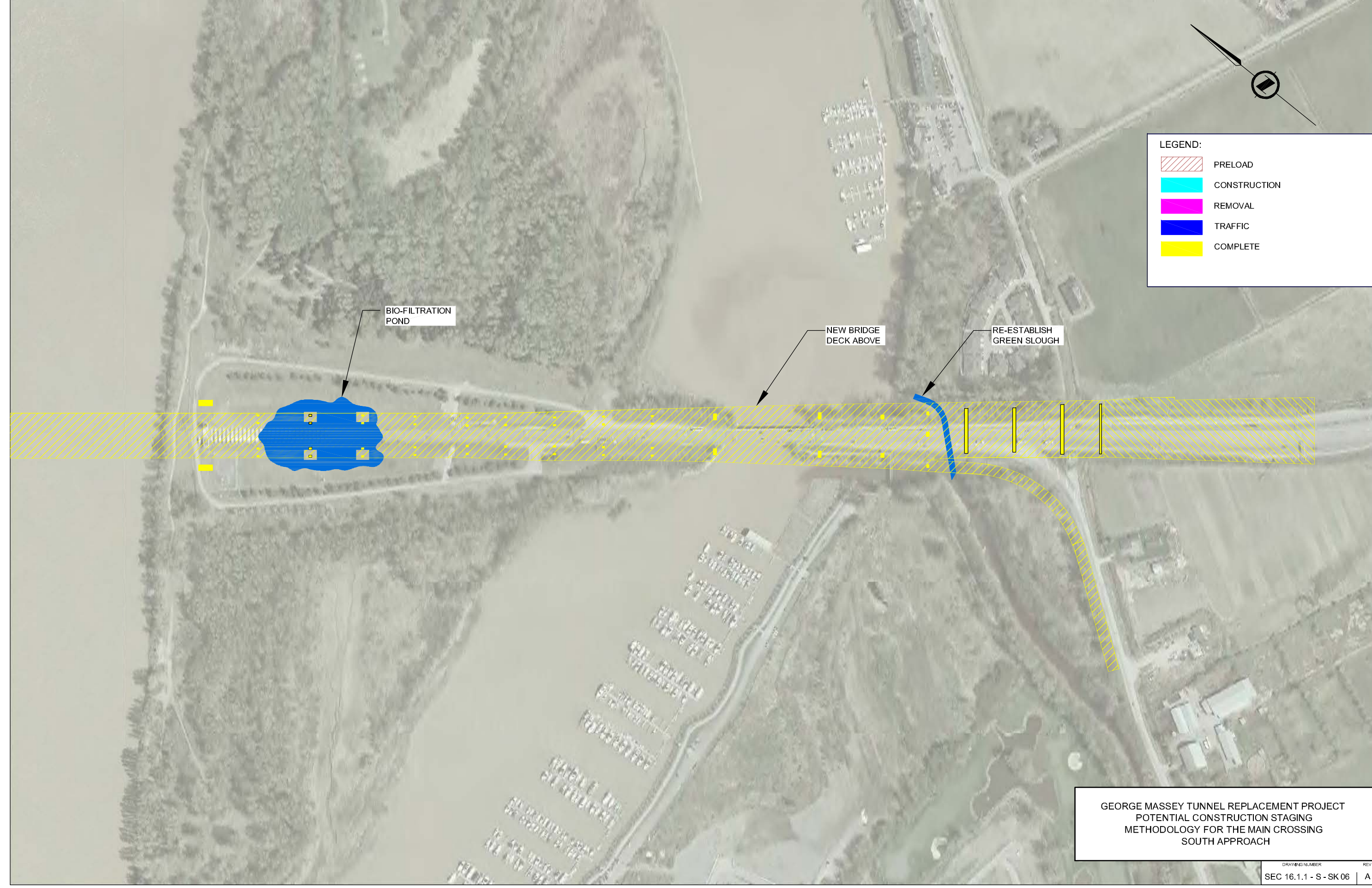


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GEORGE MASSEY TUNNEL REPLACEMENT PROJECT
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METHODOLOGY FOR THE MAIN CROSSING
SOUTH APPROACH

**George Massey Tunnel
Replacement Project**



**BC JOBS
PLAN**



Ministry of
Transportation
and Infrastructure

Section 16.2

RIVER HYDRAULICS AND RIVER MORPHOLOGY STUDY

Technical Volume

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- Attachment A As-built Drawings
- Attachment B Historical Aerial Photograph Mosaics
- Attachment C Model Development and Validation

Abbreviations and Acronyms

| Term | Definition |
|----------|--|
| ADCP | acoustic Doppler current profiler |
| AEP | annual exceedance probabilities |
| CAD | Computer aided design |
| CD | chart datum |
| DEM | digital elevation model |
| GD | geodetic datum |
| HWL | High Water Level |
| LiDAR | light detection and ranging |
| Ministry | Ministry of Transportation and Infrastructure |
| PWGSC | Public Works and Government Services of Canada |
| RMS | root mean square |
| SOG/LFR | Strait of Georgia/Lower Fraser River |
| Tunnel | George Massey Tunnel |

Glossary

| Term | Definition |
|---|---|
| acoustic Doppler current profiler (ADCP) | Technology that measures water current velocities using the Doppler effect of sound waves scattered back from particles within the water column. |
| anabranching | Describes a river with multiple channels separated by stable islands that are large relative to the size of the channels and which divide the flow at discharges up to and including bankfull. |
| bed load | Sediment particles moving in direct contact with the bed by rolling, sliding and saltating. On the lower Fraser River, bed load consists almost entirely of sand-sized sediments. |
| bedforms | Feature that develops on a river bed due to the action of fluid flow over a moveable bed. |
| bed-material load | The transport rate of sediments derived from entrainment and erosion of the bed material deposits in the channel; can be transported both as bed load and as suspended bed material, and has a major influence on the stability of the channel. Also, that part of the total sediment load of a river that is composed of particle sizes present in appreciable quantities in the shifting portions of the bed. |
| computer aided design (CAD) | Software used to assist in the creation, modification, analysis, or optimization of a design. |
| channel conveyance | A measure of the hydraulic carrying capacity of a channel, related only to the cross-sectional dimensions of the channel. |
| draft | Depth of water that is required to safely float a ship. |
| dunes | A bedform that occurs in sand bed rivers and consists of migrating undulations in the river bed surface. |
| element | In a finite element model, the unit of subdivision of the model mesh. |
| entrainment, or sediment entrainment | Process by which sediment is incorporated into river flow as part of the action of erosion. |
| exceedance probability, annual exceedance probability | The probability of an event being greater than or equal to a given value; annual exceedance probability is the probability of an event being greater than a given value once or more than once in a given year. |
| flow split | The distribution of flow among individual channels in a multi-channel stream. |

| Term | Definition |
|---|--|
| flume | An artificial channel or trough for conducting water, often used in hydraulic research. |
| headcutting | The process of riverbed erosion that is characterized by the upstream progression of a knickpoint. |
| hindcast | A way of testing a numerical model by simulating a past event and comparing results with known outcomes. |
| hydrodynamics | The branch of fluid dynamics that deals with liquids, including hydrostatics and hydrokinetics. |
| king tide | An especially high tide |
| knickpoint | The location along a river where there is a locally steepened slope between lower gradient sections, and an upstream-migrating wave of erosion can occur or has occurred. |
| left bank, right bank | As seen by an observer looking downstream. For the Fraser River, the left bank corresponds to the south bank; the right bank corresponds to the north bank. |
| LiDAR | Light detection and ranging remote sensing technology |
| mesh | In a finite element model, the model representation of the prototype domain, composed of elements. |
| morphodynamics | The study of riverbed changes due to erosion and sedimentation. |
| multibeam surveys | Bathymetric surveys conducted using a transducer that emits an acoustic pulse in a multi-directional cone of energy directed downward towards the bed to measure water depth below the ship. The high density of data collected provides a high resolution of features on the bed. |
| node | In a finite element model, a point common to two or more elements. |
| non-exceedance probability, annual non-exceedance probability | The probability that no event greater than a given value will occur; annual non-exceedance probability is the probability that an event having a given magnitude will not be exceeded in a given year. |
| planform | Channel shape as viewed from above |
| reach | Any specified length of a stream |
| river training | River engineering works intended to reduce hydraulic hazards by re-aligning and controlling flow patterns within the channel, (e.g., spurs, groynes, guide banks, etc.). |

| Term | Definition |
|---------------------|---|
| single-beam surveys | Bathymetric surveys conducted using a transducer that emits an acoustic pulse in a single, narrow cone of energy downward towards the bed to measure water depth directly beneath the ship. |
| suspended load | Sediment particles maintained in the water column by the turbulence of the flow, including fine material constantly maintained in suspension and sand temporarily entrained from the river bed (the suspended bed material load). |
| sill | A non-erodible or erosion resistant horizontal layer or structure protruding above the surrounding riverbed, usually forming a hydraulic control. |
| thalweg | The path along a river channel of maximum depth and usually velocity. |
| velocity | A vector quantity consisting of speed and direction; the speed of something in a given direction |
| velocity magnitude | The speed component of the velocity vector |
| washload | Fine sediment load that can be maintained in suspension by the turbulence of the flow and consequently is not found in appreciable quantities in the river channel bed material; in the lower Fraser River, wash load sediments consist of clay, silt and fine sand (less than 0.177 mm). |

1.0 Introduction

This technical volume presents the objectives, methods, and findings of the Fraser River hydraulics and morphology study undertaken to support the environmental assessment of the George Massey Tunnel Replacement Project (Project).

1.1 Project Background

The British Columbia Ministry of Transportation and Infrastructure (Ministry) is proposing the Project to address current safety and congestion challenges, meet forecast population and employment growth, and ensure Highway 99 continues to meet regional, provincial and national transportation needs. The Project involves replacing the George Massey Tunnel crossing (Tunnel) of the Fraser River South Arm with a new bridge within the existing Highway 99 right-of-way (ROW), replacing the Westminster Highway, Steveston Highway, and Highway 17A interchanges, widening Highway 99 between Bridgeport Road in Richmond and Highway 91 in Delta, and decommissioning the Tunnel. The Project's location is shown on **Figure 2-1**.

1.2 Study Overview and Objectives

The purpose of the study is to assess the potential changes in Fraser River hydraulics and morphology due to removal of the Tunnel. River hydraulics is the study of flow in rivers, and is most often related to flow patterns, water levels, and velocities. The study of river morphology (i.e., fluvial geomorphology) focuses on river forms and processes, and is primarily concerned with the interaction between fluid flow and the erodible materials in the channel bed and banks (Knighton 1998). This study reviews potential changes to water levels, velocities and flow patterns resulting from Tunnel removal, and their influence on sedimentation and erosion within the Fraser River. **Figure 2-1** shows locations of key interest in the study.

Potential changes due to the new bridge crossing are not discussed. The new bridge is proposed as a clear-span crossing, eliminating the potential for instream changes resulting from the structure. It has been assumed that the clear-span bridge will require no river-training structures (i.e., guide banks, spurs, etc.) or instream collision-protection structures, and that any upgrades to bank protection near the proposed bridge pylons will retain the shape and footprint of the existing bank protection works.

Table 1-1 River Hydraulics and River Morphology Study Components and Objectives

| Component | Objective | Scope |
|----------------------------|--|---|
| Interpretive geomorphology | <ul style="list-style-type: none"> • Supplement the numerical modelling results • Enhance understanding of lower Fraser River and estuary morphological evolution | <ul style="list-style-type: none"> • Literature review, interpretation of historical data and air photos, comparison with historical bathymetric data, site observations, and measurements |
| Numerical modelling | <ul style="list-style-type: none"> • Evaluate potential Project-related changes in river hydraulics (i.e., current distributions and water levels), and morphology (i.e., sedimentation patterns) | <ul style="list-style-type: none"> • Modelling conducted for two distinct scenarios: trench infilling and post-infilling • Regional (far-field) and local (near-field) |

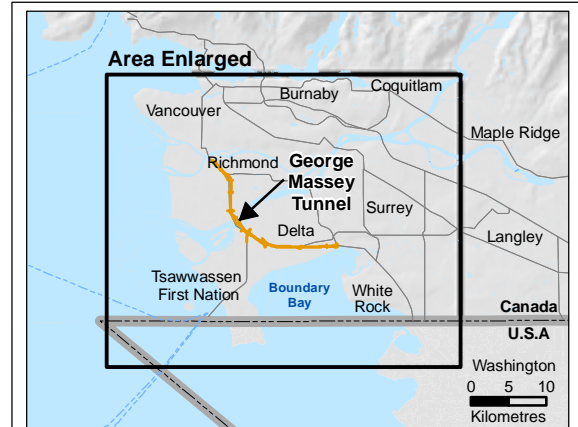
2.0 Methods

2.1 Assessment Area

The regional assessment area (RAA) includes the Fraser River South Arm from just upstream of Annacis Island to the Fraser River estuary, including Sturgeon Bank and Roberts Bank (**Figure 2-2**).

The local assessment area (LAA), where Project-related changes are likely to occur, extends from Fraser River South Arm from just upstream of Tilbury Island to the mouth of the River (**Figure 2-3**). Approximately 35 km upstream of the mouth, the Fraser River splits around Lulu Island and Annacis Island at the New Westminster Trifurcation. North of Lulu Island, flow enters the Fraser River North Arm. The Fraser River South Arm splits around Annacis Island to form Annieville Channel and Annacis Channel. Downstream of Tilbury Island, flow along the Fraser River South Arm is further dissected around islands in the area bounded by the main channel, Ladner Reach, and Sea Reach, and then around Westham Island, with a portion of the flow travelling down Canoe Passage. The water level in this lower reach is dominated by the tides (winter tides in particular), as opposed to Fraser River discharge.

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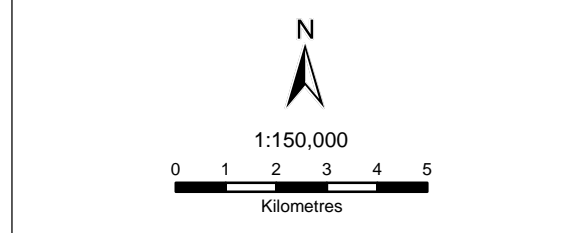


Legend

- Water Main
- Oil/Gas
- Cable
- Fraser River Centerline
- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.

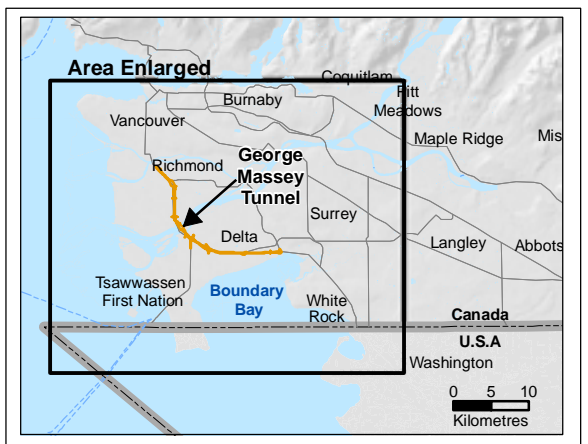


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

OVERVIEW MAP SHOWING LOCATIONS OF
INTEREST IN THE LOCAL ASSESSMENT AREA

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| Figure 2-1 | 13/05/2016 |
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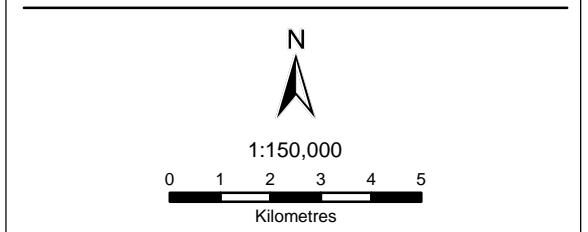
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- Legend**
- River Hydraulics and Morphology
 - Regional Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

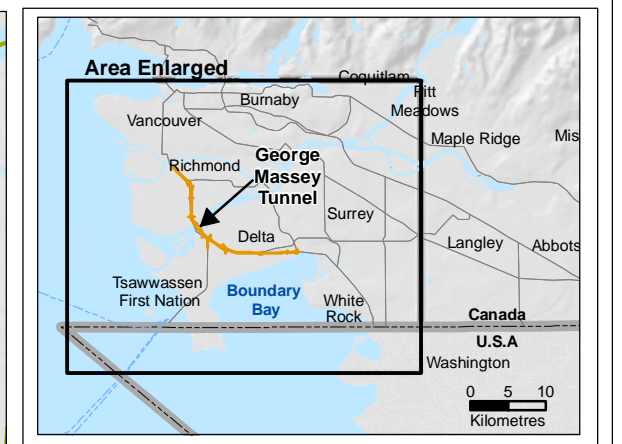
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| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| RIVER HYDRAULICS AND MORPHOLOGY REGIONAL ASSESSMENT AREA | |
| Figure 2-2 | 15/05/2016 |
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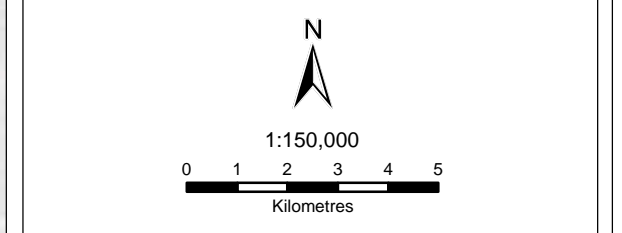
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- Legend**
- River Hydraulics and Morphology Local Assessment Area
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
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Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

RIVER HYDRAULICS AND MORPHOLOGY
LOCAL ASSESSMENT AREA

| | |
|------------|------------|
| Figure 2-3 | 15/05/2016 |
|------------|------------|

2.2 Temporal Scope

The three temporal cases in this assessment are identified as follows:

- Existing conditions
- Future conditions with the Project
- Future conditions without the Project

The characterisation of existing conditions was based on data from recent years. Model geometry was comprised of Fraser River bathymetry data from PWGSC, CRA Canada Surveys Inc. (CRA), and Northwest Hydraulic Consultants Ltd. (NHC) surveys completed in 2014. Wind, tide, and Fraser River flow data from 2012 were used as inputs to the numerical model. The year 2012 was typical in terms of storm frequency and intensity, but was above average for discharge from the Fraser River in the late spring and early summer. For the fall and winter periods, 2012 discharge corresponds with the mean.

Assessment of future conditions with the Project was based on the construction and operation phases of the Project as described in **Section 3.1** of the Application. Tunnel removal is anticipated to begin in August/September, and be undertaken within the least-risk timing window. Infilling of the trench feature expected to be left on the river bed by the removal of the Tunnel was simulated in the model based on data from August 16, 2012 to March 14, 2013. Longer-term changes in the river were assessed based on the post-infilling riverbed geometry. Post-infilling analysis in the model was carried out based on data from the freshet period of May 26 to July 27, 2012. The freshet period was selected for modelling because this is when the majority of sediment transport occurs in the Fraser River. The 2012 freshet in the Fraser River had a return period on the order of 20 years (B.C. FLNR 2014), and the high freshet flow scenario provided the condition for evaluating the upper end of potential changes to river hydraulics and sedimentation. Availability of data for the year 2012 facilitated model calibration.

The Fraser River is a dynamic environment with seasonal patterns and climatic influences. Climate change will have an impact on this natural variability in the long term. Changes to water levels as a result of sea level rise and to flows as a result of changes in precipitation are anticipated. For comparison purposes, a discussion of the influence of climate change on Fraser River hydraulics and morphology without the Project in place is provided.

2.3 Study Methods

Two methods were used to assess potential changes to river hydraulics and morphology due to the Project:

1. Interpretive geomorphic studies using historical data, site observations, and measurements
2. Numerical modelling of hydrodynamics and morphodynamics

2.3.1 Interpretive Geomorphology

An interpretive geomorphology approach was undertaken to supplement the numerical modelling results and enable a better understanding of the morphological evolution of the lower Fraser River and estuary. Tasks included the following:

- Literature review – Previous field, model, and theoretical studies were reviewed to understand the environment and driving forces at work near the Tunnel and interpret the results of the numerical modelling in this light.
- Aerial photograph interpretation – Aerial photographs of the local assessment area (LAA) spanning the years 1938 to 2009 were analyzed. They provide insight into the planform changes that have taken place on the lower Fraser River since 1938 and the role of natural or anthropogenic factors in driving these changes.
- Bathymetric surveys – Water main crossings on the Fraser River have been surveyed regularly by the Greater Vancouver Water District since 1962. Data were also obtained from bathymetric surveys of the lower Fraser River conducted in 1988/89, 2000/01, 2008/09 and 2014 by Public Works and Government Services of Canada (PWGSC).

2.3.2 Numerical Modelling

Potential Project-related changes to river hydraulics and morphology in the Fraser River were investigated using the TELEMAC-MASCARET modelling system. The hydrodynamic program TELEMAC-3D was applied to compute various physical processes of river hydraulics, and the SISYPHE program was used to compute sediment transport. The TELEMAC-3D program first computes hydraulic conditions in the lower Fraser River. Bed changes (scour and deposition) around the Tunnel were computed by coupling the sediment transport and morphodynamic model SISYPHE to TELEMAC-3D. SISYPHE uses the hydraulic information from TELEMAC-3D to compute scour and deposition of the riverbed. The new bed elevation computed by SISYPHE is fed back into TELEMAC-3D to re-compute the flow hydrodynamics (**Figure 2-4**).

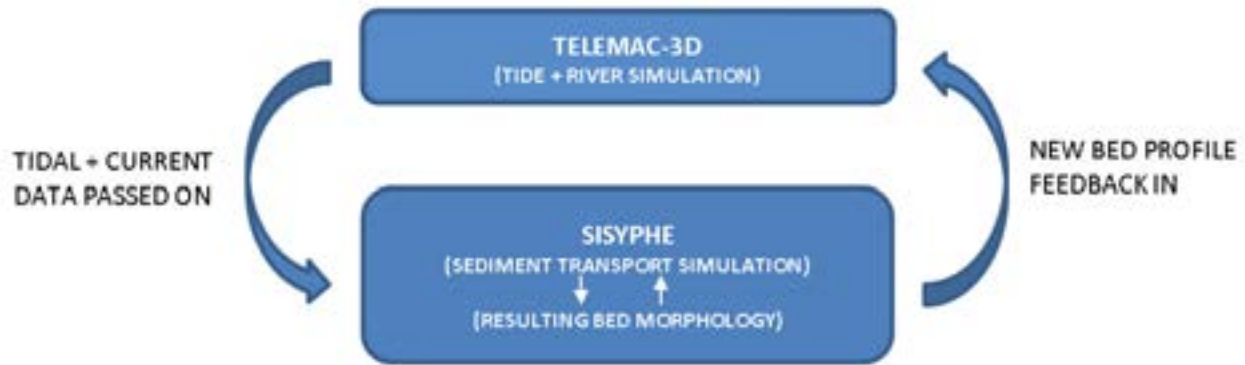


Figure 2-4 TELEMAC model coupling flow diagram

The resulting model serves as a tool for understanding the potential changes to river hydraulics and morphology due to Tunnel removal; however, it cannot be used to predict the long-term behaviour of the river. Future changes in physical inputs such as sea level rise, changes to hydrograph timing and shape, sediment supply, and alterations to the river channel (i.e., channel deepening, land reclamation) will influence future hydraulics and morphology in ways that cannot be predicted by the model. Rather, the model captures the most important physical processes in lower Fraser River and assists in predicting the consequences of a specific change to the system. As with all numerical models, it is subject to uncertainty due to reasonable limits on the collection and incorporation of input data, approximation of hydraulic and sediment transport processes, and natural variability. Model results must be understood in the context of known river behaviour and interpreted using professional judgement.

2.4 Tunnel Description

As discussed in **Section 1.2**, the river hydraulics and morphology study focussed on the potential changes due to Tunnel removal. Three options have been studied: existing conditions, full Tunnel removal, and partial Tunnel removal. These options are discussed further in **Section 3.1**.

3.0 Existing Tunnel Conditions

The Tunnel is located on the Fraser River South Arm between km 18 and 19 (**Figure 2-1**). As part of Tunnel construction, which was complete by 1959, concrete sections were floated into position and allowed to sink into a trench dredged out of the sandy river bottom. In the immediate vicinity of the Tunnel crossing lies Deas Dock, which was dredged and built in 1957, and is now used as a maintenance facility for BC Ferries. The Tunnel is 629 m long and consists of six concrete segments, each 105 m in length. The Tunnel is 23.8 m wide and 7.3 m high. Simplified schematics of the Tunnel are shown in **Figure 3-1** and **Figure 3-2**.

The Tunnel is protected from scour and erosion with riprap and flexible concrete mattresses. A rock apron composed of 680 kg (1,500 lb) rock covers the Tunnel. Beneath that is a layer of 227 kg (500 lb) rock. A 3.8 cm (1½”) flexible concrete mattress is keyed into the rock protection and extends upstream and downstream from the Tunnel with 227 kg (500 lb) rock overburden (**Figure 3-1**). The top of the scour protection layer was constructed to be flush with the riverbed in the central channel. As-built drawings of the Tunnel scour protection are included in **Attachment A**.

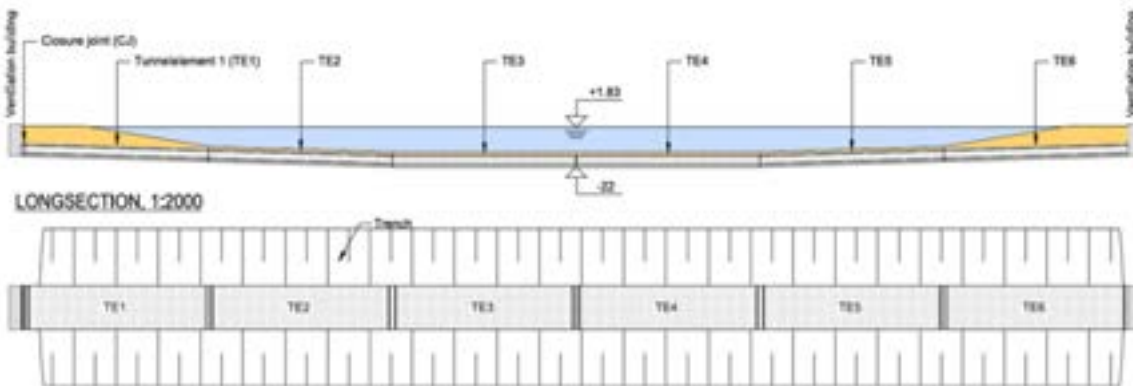


Figure 3-1 Schematic Longitudinal Section of the George Massey Tunnel (not to scale).

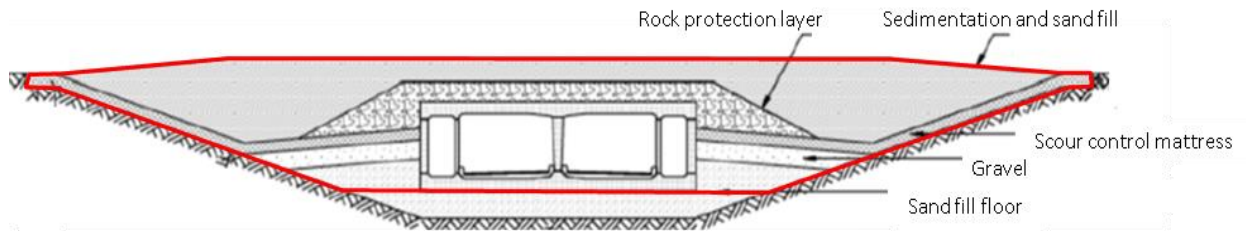


Figure 3-2 Schematic Cross-section of the Tunnel (not to scale). Red Polygon Indicates Assumed Extent of Excavation¹.

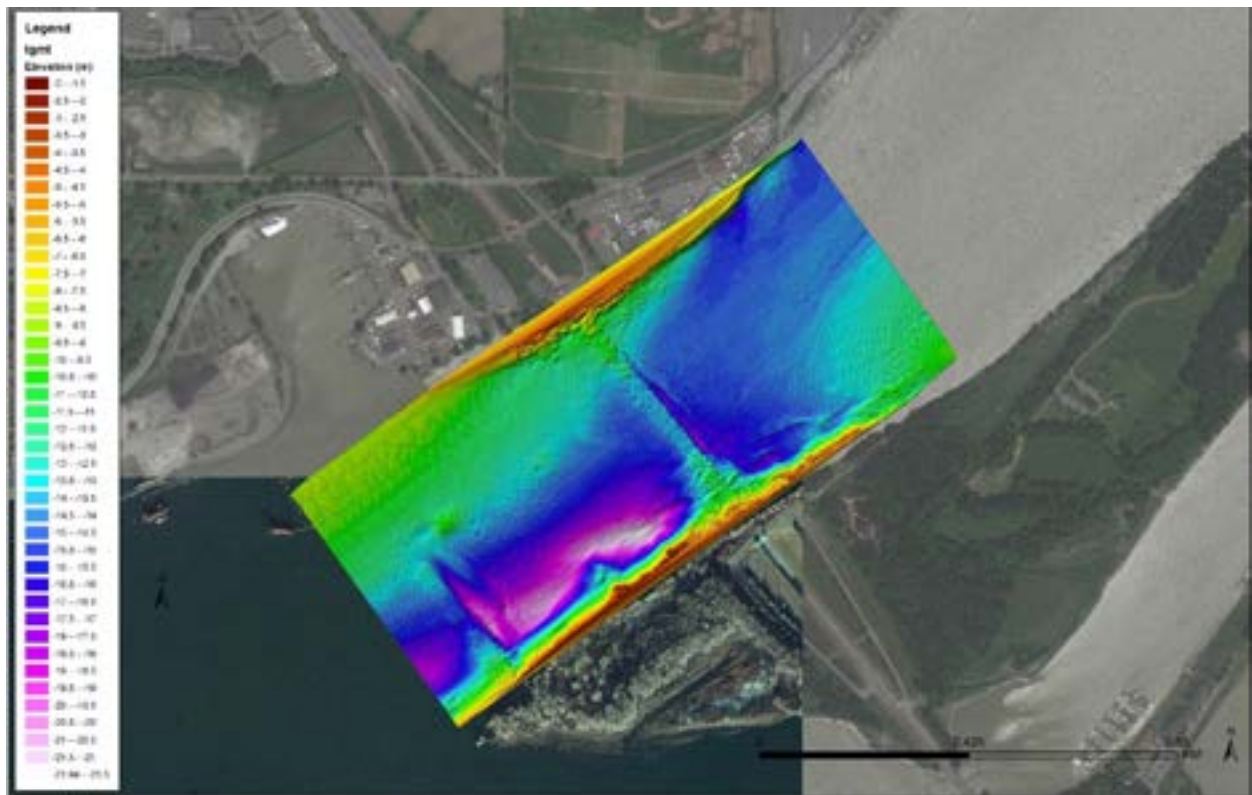


Figure 3-3 Riverbed Elevations from Bathymetric Survey Data Collected April 2, 2014

¹ Retrieved from MMM Group Ltd.

3.1 Proposed Tunnel Decommissioning Alternatives

The proposed Tunnel decommissioning is expected to occur once the new bridge is open to traffic. The assumed methodology involves removing the rock apron/ballast from the top of the structure, excavating beneath the Tunnel segments to break suction, and then floating the pre-cast concrete Tunnel segments to the surface. Tunnel decommissioning is assumed to take several months to complete. Two options for Tunnel removal are considered in this study: removal of six elements (full tunnel removal), and removal of four elements (partial tunnel removal).

3.1.1 Full Tunnel Removal

With the full Tunnel removal option, all six Tunnel segments, rock apron, and concrete mattress would be removed, leaving a trench of approximately 10 m in depth in the riverbed. The model assumes that both the north and south banks will be reconstructed to blend with adjacent banks and armoured with riprap where they have been disturbed by Tunnel removal.

3.1.2 Partial Tunnel Removal

With the partial Tunnel removal option, the two Tunnel segments located partially within the banks (TE1 and TE6 in **Figure 3-1**) would be left in place, and the four segments in the river channel would be removed, leaving an excavated trench. Since the end segments are mostly buried in the banks, channel conveyance at the crossing under this option is similar to that with the full Tunnel removal option. It has been assumed that rock would be placed around the nose of the two end segments at a 2H:1V slope to avoid adverse hydraulics and undermining of the Tunnel segments. The segments are expected to be filled with sand or gravel such that there would be no large voids within them.

4.0 Physical Setting

4.1 Fraser River Flows and Sediment Loads

4.1.1 Flows

The Fraser River drains a 232,000 km² area of southern B.C., making it the largest river on the west coast of Canada. Near the town of Mission, 85 km from the Strait of Georgia, the river changes abruptly from an anabranching gravel bed to a meandering sand-bed single channel. The reach from New Westminster to the Strait of Georgia represents the modern delta. At this location, 35 km from the river mouth, the main channel splits into the North Arm and South Arm. The North Arm further divides into the Middle Arm, and all three branches discharge into the Strait of Georgia.

The Fraser River has a snowmelt-dominated flow regime, with the discharge typically rising in April, peaking between May and July (the freshet period) and then receding during the autumn and winter months. **Figure 4-1** shows minimum, mean, maximum annual flow hydrographs for the Fraser River at Hope, 180 km upstream from the mouth. Flows in the lower Fraser River are often referenced to Hope since flows are free of tidal influence here, and the continuous gauge record extends back to 1912. The year 2012 is also shown because it was selected for the numerical modelling analyses (**Section 6.4**). Average peak flow of the Fraser River at Hope is about 7,000 m³/s in June; the average low flow is approximately 850 m³/s in March.

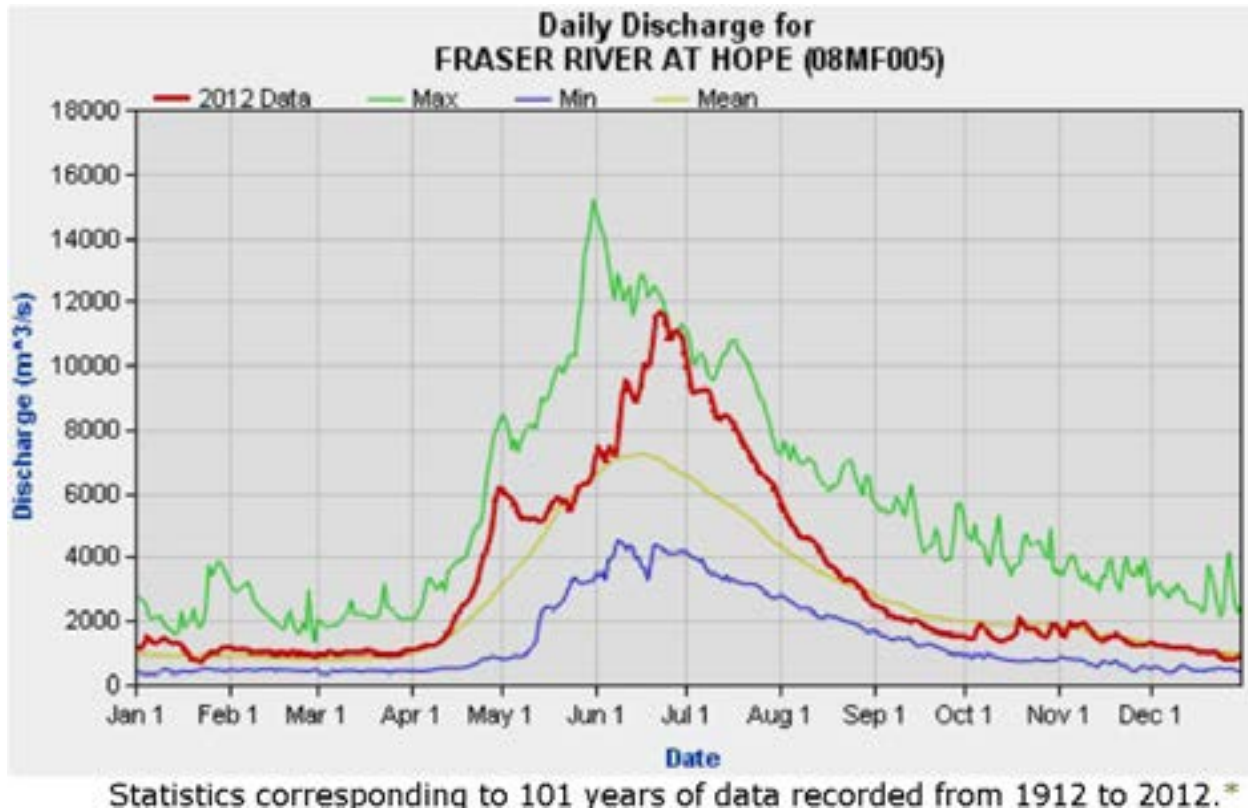


Figure 4-1 Annual Hydrographs of Fraser River at Hope (Retrieved from Government of Canada 2014).

4.1.2 Flow Patterns

The Fraser River South Arm divides just below Deas Island (18 km upstream from the Strait of Georgia) into Ladner Reach, and then again into Canoe Passage. Estimates of the flow splits in the various branches have changed over time due to the effects of river training and dredging; estimation is also complicated by the tidal influence on the flow. In May to June 2005, PWGSC conducted acoustic Doppler current profiler (ADCP) velocity-discharge measurements at several branches of the river in support of flood modelling investigations (NHC 2006). Those measurements indicated that the flow in the South Arm, upstream of Tilbury Island, was 90% of the flow at New Westminster; at the Kirkland Island bifurcation, the flow split is 81% in the Fraser River main channel (specifically, Woodward Reach) and 9% through Ladner Reach (**Attachment C: Tables 4, 5, and 6**).

Substantial effort has historically been devoted to maintaining a stable channel configuration through this reach of the river (Pretious and Thorne 1953), as discussed in **Section 5.1**. During the Tunnel planning stages, there was concern that the proposed Tunnel could alter flow patterns at the nose of Kirkland Island where Ladner Reach splits off, potentially resulting in scour and erosion in Ladner Reach (Pretious et al. 1957). Conversely, there are concerns about Tunnel removal altering flow patterns.

The Tunnel was expected to act like a weir, straightening flow near the riverbed. If this effect is indeed present, removing the Tunnel could allow flow to be directed more toward Ladner Reach. To address this issue, ADCP velocity measurements collected on March 27, 2014 near the bed and near the water surface along the centreline of the Tunnel (**Figure 4-2**) were examined. At the time, the river flow was approximately 6400 m³/s, and the water level was - 0.22 m Geodetic Datum (GD). The near-bed velocities were depth-averaged over the first metre above the bed, and the near-surface velocities were depth-averaged over the first metre below the water surface. The measurements show that the sill created by the top of the Tunnel does not appreciably change the direction of the flow near the bed. That is, the direction of flow near the bed is very close to the direction of flow near the water surface. This result suggests that the removal of the Tunnel will not change the velocity direction in its vicinity and is unlikely to change the flow splits in the surrounding area.

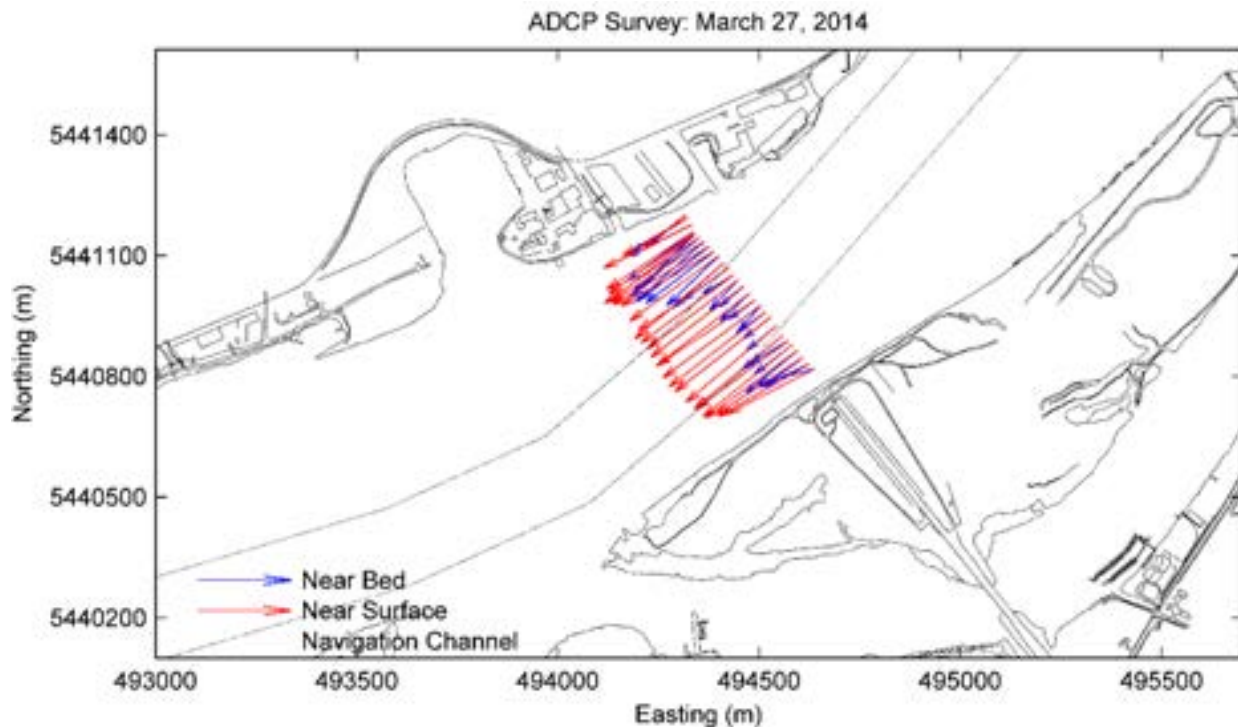


Figure 4-2 ADCP Velocity Measurements within 1 m Above the Bed (Blue) and within 1 m Below Water Surface (Red) for March 27, 2014 at 9:10 am.

4.1.3 Salt Wedge

Flow and sediment transport in the lower Fraser River are influenced by the presence of a salt water wedge, as is common in estuarine environments. The location of the salt wedge moves throughout each day in response to variations in tide height, as well as seasonally in response to variations in river discharge.

Stakeholder concerns have been raised regarding the potential changes to the extent of salt-wedge intrusion into the river as a result of Tunnel removal, specifically in the context of the influence of such changes on irrigation intake from the Fraser River South Arm. A separate study that involved hydrodynamic modelling was undertaken to investigate the behaviour of the salt wedge in the Fraser River and potential impact of Tunnel removal on its movement. A technical volume that provides further detail on the study is included as **Section 16.7**, and results of the study are discussed in **Section 5.4** (Agricultural Use) of the Application. A brief overview of the Fraser River salt wedge is provided below for context.

Ward (1976) found that during winter low flows, the wedge can extend up to 30 km upstream from Sand Heads (**Figure 2-1** and **Figure 4-3**). This observation contradicts the previously held hypothesis (Pretious 1972) that the sill formed by the Tunnel prevents the salt wedge from extending upstream of the Tunnel.

During freshet high flows, the maximum extent of salt water intrusion is less than 15 km. Therefore, the salt wedge is limited to downstream of the Tunnel during the freshet, and salt water is not present in the water column at the Tunnel during this period. Ward (1976) also found that stratification increases with increasing flow, and the wedge accordingly becomes better defined.

Patterns of sediment entrainment and deposition are affected by the salt wedge. As the salt wedge migrates upstream during flood tides, rapid deposition of suspended bed material occurs. This is presumably because of decreased turbulence in the upper non-saline layer and de-coupling of the river flow from the bed, preventing entrainment. During ebb tides, the salt wedge recedes and bed material re-suspension resumes due to increased turbulence as the tip of the salt wedge passes and is sustained by accelerating downstream flow (Kostaschuk, Luternauer, et al. 1989).

Kostaschuk et al. (1998) found that that sediment deposition during freshet occurs preferentially at the mouth of the river, where the tip of the salt wedge has been forced to retreat by high river flows. During periods of low flow, when the salt wedge has migrated upriver, bed-material transport from upstream is limited due to lower flows and weaker currents, and small amounts of bed material are deposited at the tip of the salt wedge.

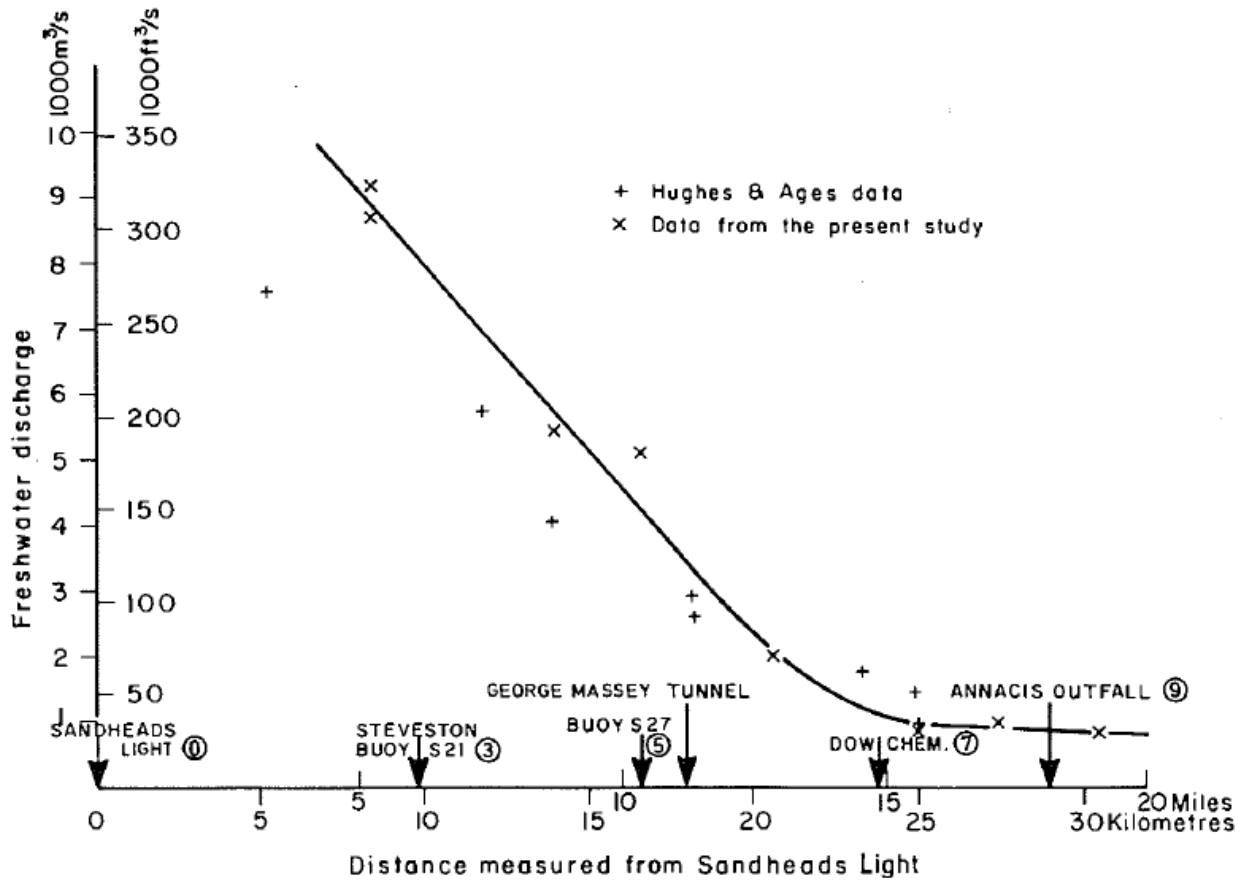


Figure 4-3 Distance of Tip of Fraser River Salt Wedge as a Function of Discharge (Retrieved from Ward 1976)

4.1.4 Sediment Loads

Sediment loads on the lower Fraser River were measured by Water Survey of Canada (WSC) at Hope, Agassiz, Mission, and Port Mann during the period 1965 to 1986. Based on that data, the total suspended load averaged 16.5 million tonnes/year, and ranged from 12.3 million to 31.0 million tonnes/year (Tywoniuk 1972, McLean and Tassone 1988, McLean et al. 1999, NHC 2002a). In the lower Fraser River, fine sediments (also called washload) generally remain in suspension and therefore have little effect on sedimentation patterns. Of primary importance is the bed-material load, which is the bed load and the fraction of sediment load capable of depositing in the river, and therefore exerts an influence on river morphology. The bed-material load averaged 2.9 million tonnes/year, and ranged from 1.2 million to 8.9 million tonnes/year (NHC 2002a).

4.2 Dunes

Dunes are river bedforms that are characteristic of sand-bed channels. Multibeam surveys by CRA from 2014 show that dunes occur within a 1.2 km span centered over the Tunnel crossing. Large dunes have been observed from Port Mann (NHC 2009) to the mouth of the Fraser River. Dune height typically varies from 0.5 to 2.0 m in channels of approximately 12 m in depth, although individual dunes can be considerably larger (Church and McLean 1994).

Near Steveston, dune bedforms of up to four metres in height were measured in the channel. The morphology of dunes in the lower Fraser River varies with discharge (Kostaschuk, Church, et al. 1989); dunes are largest during freshet, then wash out and rebuild over the rest of the year. Results from multibeam surveys (Kostaschuk and MacDonald 1988) show that bedforms in the Sand Heads area have a curved, concave-downstream planform, and crests were continuous for at least 300 m across the river channel. The major bedforms are essentially two-dimensional, transverse dunes migrating directly downchannel. At the river mouth, migration rates were found to be at their maximum during the freshet period with an average migration rate of 14.8 m/day (Kostaschuk, Church, et al. 1989). Field observations by Pretious and Blench (1951) determined that migration occurred at rates of up to 50 to 75 m/day. The dunes produce periodic scour and fill as they migrate along the channel and can considerably increase total scour depths, damaging existing scour protection aprons and rock protection, and potentially exposing existing pipe crossings.

4.3 Water Levels

The Fraser River is tidally affected as far upstream as Mission. Tides in the Strait of Georgia are mixed semi-diurnal, generally having two highs and two lows of unequal height in each 24-hour day. The tidal range at Point Atkinson (**Figure 2-2**) located 23 km north of the mouth at Fraser River South Arm, is up to 5.2 m, and the mean tidal height is +3.1 m Chart Datum (CD). The fluctuations in water level at Fraser River at Deas Island (WSC gauge 08MH053) are shown in **Figure 4-4**, based on differences in hourly water levels for 2013. As at Point Atkinson, there is a seasonal variation, with the greatest amplitudes (the difference between high and low tide level) occurring during the months of April to July and October to January; values exceed 3.5 m during most of the months in these two periods. However, the tide signal is moderated by the influence of Fraser River flow at Deas Island. Nonetheless, extreme water levels in the lower estuary of the Fraser River are governed by the occurrence of high tides and storm surge in the winter season, rather than high discharges during the freshet.

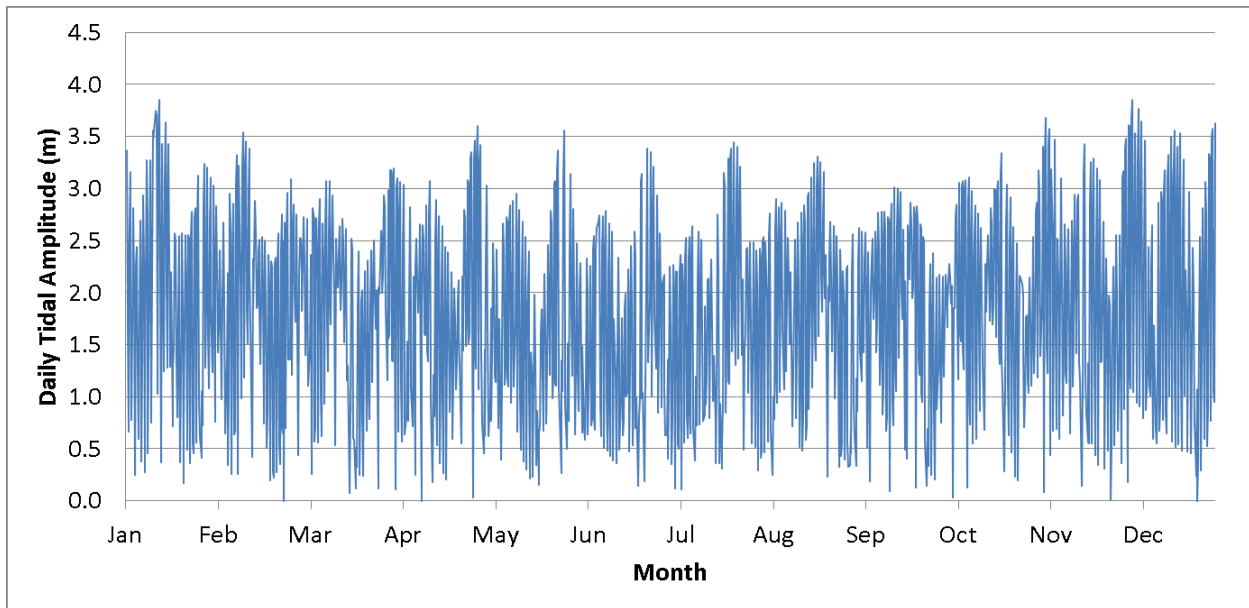


Figure 4-4 Fluctuations in Daily Tidal Water Levels Calculated at Fraser River at Deas Island, WSC Gauge 08MH053².

Hourly water levels at the Fraser River at Deas Island gauge from 1969 - 1984³ were analyzed. Elevations in this gauge record are relative to Sand Heads datum (-2.603 m); therefore, data were corrected to GD prior to the analysis. Water levels ranged from -2.02 to +2.64 m. Corrected water levels were ranked, and annual probabilities of water level exceedence and non-exceedence were calculated (**Figure 4-5**). Exceedence and non-exceedence probabilities of a number of relevant water levels are listed in **Table 4-1**.

NHC assumed a preliminary design high water level of 2.0 m GD, which corresponds to the Canadian Hydrographic Service (CHS) high water datum at Deas Island. The HWL had an exceedence probability of 0.24% (i.e., in any hour there is a 0.24% chance that the water level will be higher than 2.0 m). The preliminary high water level was exceeded 298 times in the period of record (1969 – 1984).

² Data tabulated from Water Survey of Canada

³ The record was 88.2% complete within the period 1969 to 1984. Records are also available from May 2007 onward, but the gauge was relocated 200 m downstream from the original location, resulting in a shift in the record. The post-shift data were not included in the analysis.

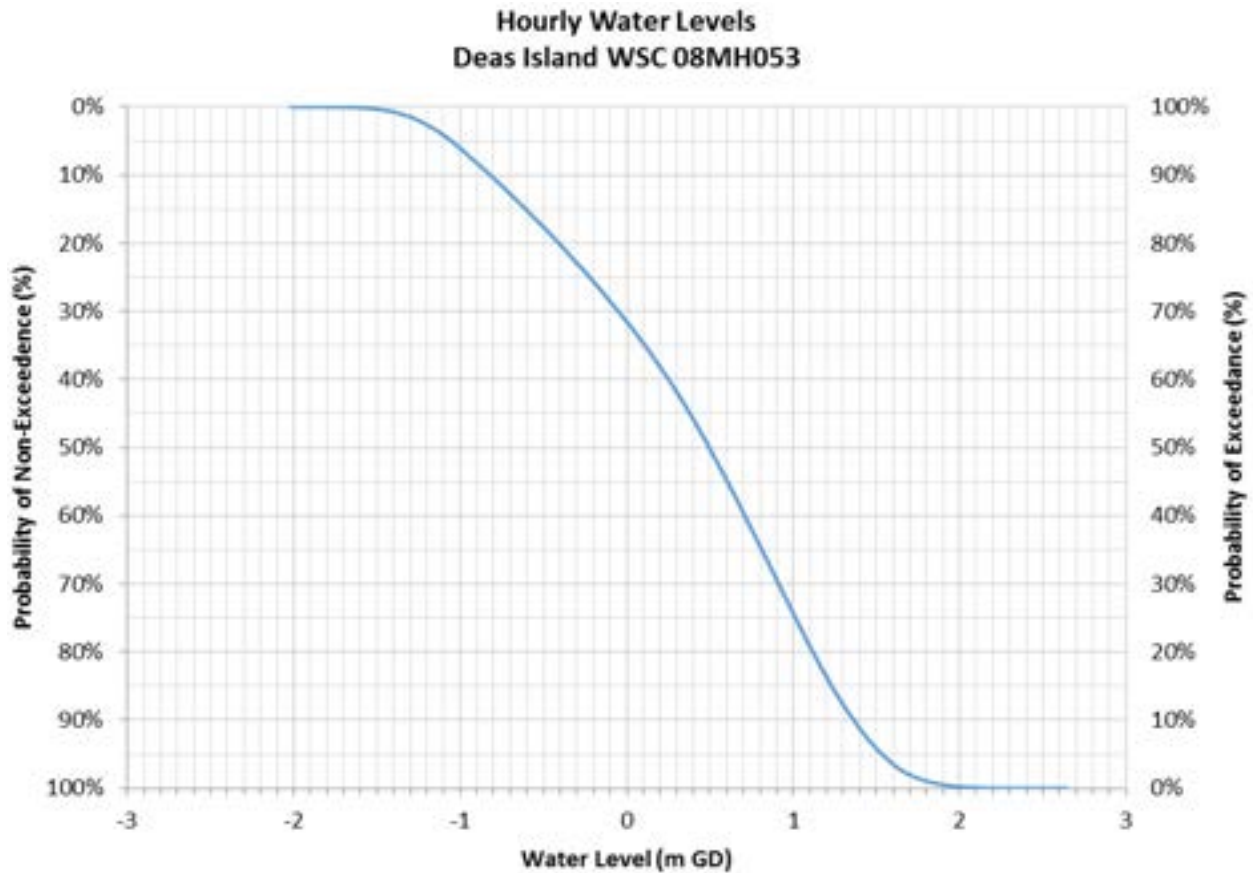


Figure 4-5 Hourly Exceedence and Non-exceedence Probabilities for Fraser River Water Levels at Deas Island (WSC 08MH053, 1969 – 1984)

Canadian Hydrographic Service chart datum at Deas Island is -1.8 m, and had a non-exceedence probability of 0.02% (i.e., in any hour there is a 0.02% chance that the water level will be lower than -1.8 m). Water levels dropped below this level 19 times in the period of record.

It should be noted that the hourly probabilities referred to in this analysis do not account for seasonal variation. High water levels are clustered during the periods of largest tidal swings around the summer and winter solstices.

Table 4-1 Hourly Exceedence and Non-exceedence Probabilities for Fraser River Water Levels at Deas Island (WSC 08MH053, 1969 – 1984)

| Parameter | Description | Water Level (m GD) | Exceedence Probability (%) | Non-Exceedence Probability (%) |
|------------------|----------------------|--------------------|----------------------------|--------------------------------|
| Maximum | Highest recorded | 2.64 | 0.0008 | 99.9992 |
| | | 2.34 | 0.01 | 99.99 |
| | | 2.11 | 0.10 | 99.90 |
| High Water Level | CHS High Water Datum | 2.00 | 0.24 | 99.76 |
| | | 1.81 | 1.00 | 99.00 |
| | | 1.37 | 10.00 | 90.00 |
| Median | | 0.50 | 50.00 | 50.00 |
| | | -0.82 | 90.00 | 10.00 |
| | | -1.36 | 99.00 | 1.00 |
| Low Water Level | CHS Chart Datum | -1.62 | 99.90 | 0.10 |
| | | -1.80 | 99.98 | 0.02 |
| | | -1.87 | 99.99 | 0.01 |
| Minimum | Lowest recorded | -2.02 | 99.9992 | 0.0008 |

4.3.1 Water Level Changes

Water levels from three WSC hydrometric stations and two CHS tide gauges were analysed for long-term trends. Data from 1969 onwards were available from Mission (WSC 08MH024), Port Mann Pumping Station (WSC 08MH016), Deas Island (WSC 08MH053), New Westminster (#7654), and Point Atkinson (#7795). Minimum water levels were plotted for each year to highlight degradation and aggradation, since low water levels are sensitive to bed elevation changes.

The water level record upstream at Mission exhibits a subtle declining trend in minimum water levels between 1969 and the late 1980s, and levelling since then. The limited data available at Port Mann supports this observation with declining minimum water levels in the 2000s. The data record for New Westminster is the most complete, and follows a similar pattern as at Mission where minimum water level elevations clearly declined up to the late 1980s, after which the trend is flat (**Figure 4-6**). Similar to New Westminster, water levels at Deas Island decreased in the period from 1969 to 1984 and, even after the gauge was re-located, there has been a subtle downward trend.

The downward trend in minimum water levels is most likely a response to lowering of the riverbed, assuming that there have been no significant changes in discharge over this time period. Further discussion on riverbed lowering is provided in **Section 5.2**. Changes in low tide elevations could also affect the reported minimum water level; however, as shown in **Figure 4-6**, no corresponding downward trend in tide levels is apparent at Point Atkinson.

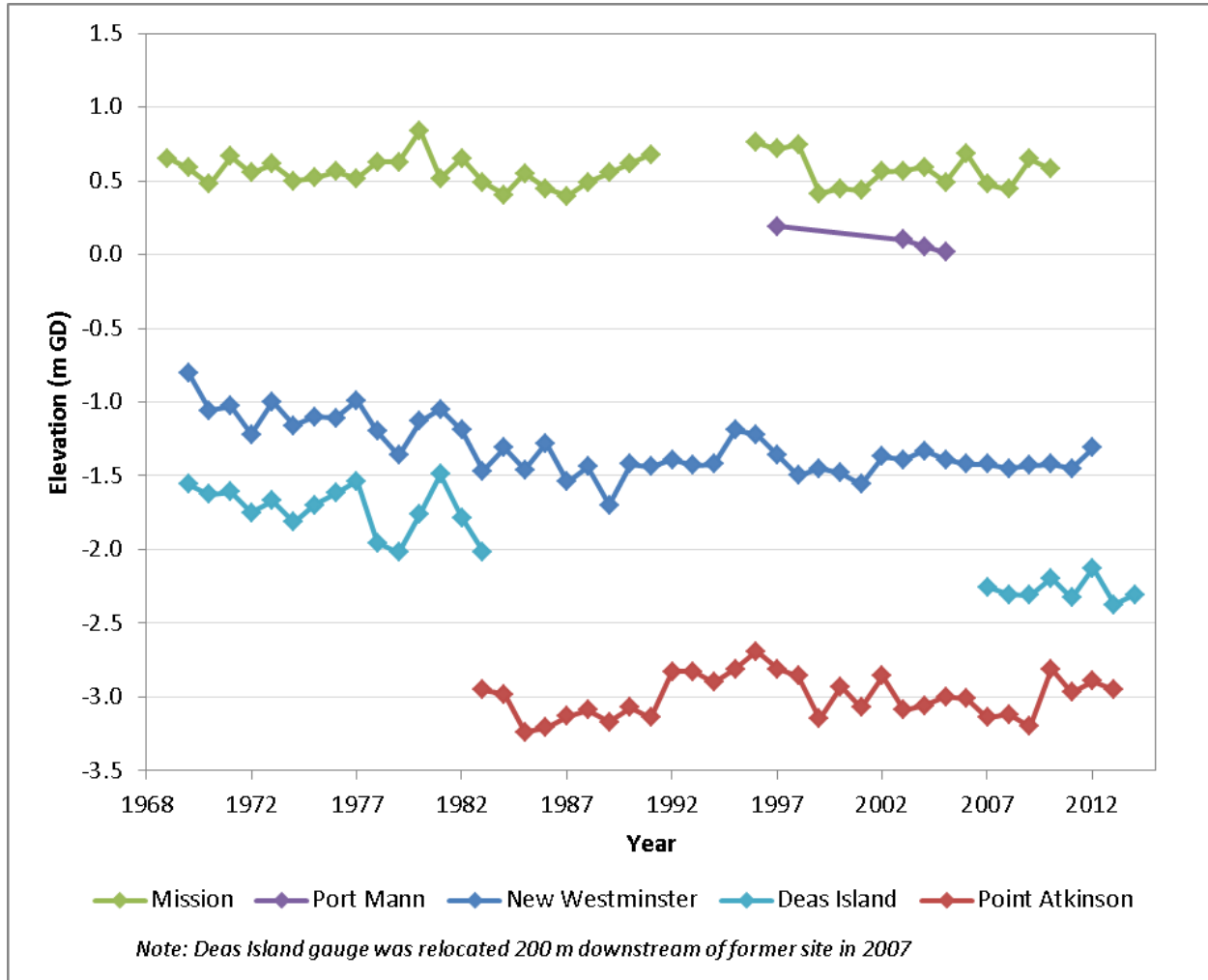


Figure 4-6 Minimum Water Levels Over Time at Gauges in the Assessment Area

4.4 River Infrastructure

4.4.1 Water Mains and Pipelines

Six water main crossings are present on the Fraser River downstream of New Westminster (**Figure 2-1**): Port Mann Main, Annacis Main No. 2 (Annieville Channel crossing), Annacis Main No. 3 (Annieville Channel crossing), Annacis Main No. 4 (Annacis Channel crossing), Tilbury Main, and Lulu Island–Delta Main.

The Lulu Island–Delta Main is nearest to the Project, situated approximately 600 m downstream of the Tunnel. Survey data indicate that scour occurs upstream of the water main, primarily in the left (south) part of the channel. **Section 8.2.2** discusses potential changes at the water main due to Tunnel removal.

There are nine other submerged pipeline crossings in the RAA (**Figure 2-1**) including three natural gas pipelines owned by Fortis (two at Tilbury Island and one downstream of the Port Mann Bridge); a gas pipeline located in Annacis Channel; an oil pipeline downstream of the Port Mann Fortis pipeline; and four submarine cables or cable areas downstream of the Tunnel.

There are scour protection aprons at several of these submerged pipeline crossings that create grade controls which affect river bed elevations upstream and downstream. The Lulu Island–Delta Main has a scour protection apron over its southern half that imparts a variable cross-channel elevation, but it is two metres lower than the Tunnel along the thalweg.

4.4.2 Bridge Crossings

Bridge crossings in the RAA include the Pattullo Bridge, built in 1936-37; the Alex Fraser Bridge, built in 1983-86 **Figure 2-1**; and the TransLink Advanced Light Rapid Transit bridge, situated just downstream of the Pattullo Bridge and constructed from 1987 to 1989. The Port Mann Bridge, 5 km upstream of the RAA boundary, was re-built in 2012.

4.4.3 River Training

With the growth of population and industry in the Lower Mainland, industrial use of the Fraser River estuary has increased, bringing with it an incentive for improving shipping access and protecting property and infrastructure on the river's banks. Extensive efforts to control the alignment of the river mouth started in 1910. The general locations of river training works described are shown in **Figure 4-7**.

The Steveston North Jetty was built in stages from 1911 to 1932, and the South Jetty was constructed between 1930 and 1932. The first Albion Jetty was constructed in 1935 (Morton 1949). The Woodward Island training wall and dam were constructed between 1922 and 1936 to further concentrate the main channel flow. Three pile dykes were constructed at Steveston (Shady) Island between 1925 and 1927 to train flow in the main channel; two on the southern bank and one upstream of the island. As a result of river training and bank protection, the channel in the estuary was significantly narrowed and deepened in comparison to conditions that existed in 1894 (McLean et al. 2007). The channelized section of river was also extended approximately nine kilometres seaward, mainly as a result of the Steveston North Jetty (**Figure 4-7**).

Two training structures, both completed in 1949, are in close proximity to the existing Tunnel: Deas Dam and the nose of Kirkland Island at the bifurcation. Deas Dam connects the upstream tip of Deas Island to the mainland, forcing flow down the main channel and closing off Deas Slough. The upstream tip of Kirkland Island was protected with a closed-pile bulkhead in 1949. Poor placement of the bulkhead had the unintended consequence of diverting excess flow into Ladner Reach (Pretious and Thorne 1953). The bulkhead was damaged in the 1952 freshet, and presumably not replaced or repaired. Currently, a rock training spur extends upstream from Kirkland Island's nose on the main channel side of the bifurcation, and what is believed to be the southern flank of the pile bulkhead remains in the Ladner Reach side.

4.4.4 Bank Hardening

Banks of the lower Fraser River have been hardened over the years by extensive riprap protection. Between 1927 and 1941, Woodward Island was riprapped on the main channel side. By 1953, the majority of the right bank had been protected with riprap from Steveston to upstream of the Tunnel (Pretious and Thorne 1953). The main channel bank of Deas Island has also been protected with riprap, although the time of construction is not known.



Figure 4-7 Known River Training Structures in the Fraser River Estuary, from the Mouth to Tilbury Island.

4.5 Dredging

The annual dredging effort along the Fraser River South Arm since 1960 has been extensive, with most of the sediment removals occurring downstream of New Westminster. Dredging volumes were greatest in the period between 1976 and 1990 and have declined in more recent years. Since 1999, 65% of the total dredging effort has taken place in the lower 11 km of the river, between Steveston and Sand Heads (McLean et al. 2006). In 1999, the Fraser River Estuary Management Program (FREMP) began to manage dredging on the lower Fraser River to ensure that the rate of dredging was approximately in proportion to the incoming bed material load (FREMP 2005).

According to FREMP (2006), frequent maintenance dredging of the navigation channel occurs at the mouth of the river, especially in Steveston Cut. There is also infrequent dredging of secondary channels in Ladner Reach and Sea Reach to maintain depths for navigation of small vessels. Further upstream, between the New Westminster trifurcation (where the North Arm and South Arm diverge) and Deas Island, annual maintenance dredging occurs at St. Mungo's Bend and Annieville Channel (**Figure 2-1**) near the Fraser-Surrey Docks to allow access for large ship traffic. Transfer pits are also present near Tilbury Island, from which sand is pumped to upland sites. Infrequent (no more than once every five years) localized dredging for boat access to small craft harbours in Ladner and Steveston also takes place.

During the height of dredging activity from 1976 to 1990, about 15% of the total annual sediment removal was from the reaches adjacent to the Tunnel: Gravesend Reach upstream and Woodward Reach downstream (**Figure 4-8**). At Gravesend Reach, large-scale borrow dredging had a noticeable effect on bed levels. Bed levels remained relatively constant when the dredging quantities remained in the order of 200,000 m³/year, but when navigation and borrow dredging reached up to 700,000 m³/year during the 1980s, the bed at Gravesend lowered at a rate of about 25 cm/year (NHC 2002a). Although total removals have rebounded since 2001, less than one per cent of total dredging has been extracted from Gravesend Reach annually.

Since 2004, the maximum vessel draft in the reaches downstream of Deas Island (Woodward Reach, Ladner Reach, Sea Reach, Canoe Passage, Steveston Cut, and Sand Heads Reach) has been increased from 10.7 m, which had been in place since 1976, to 11.5 m.

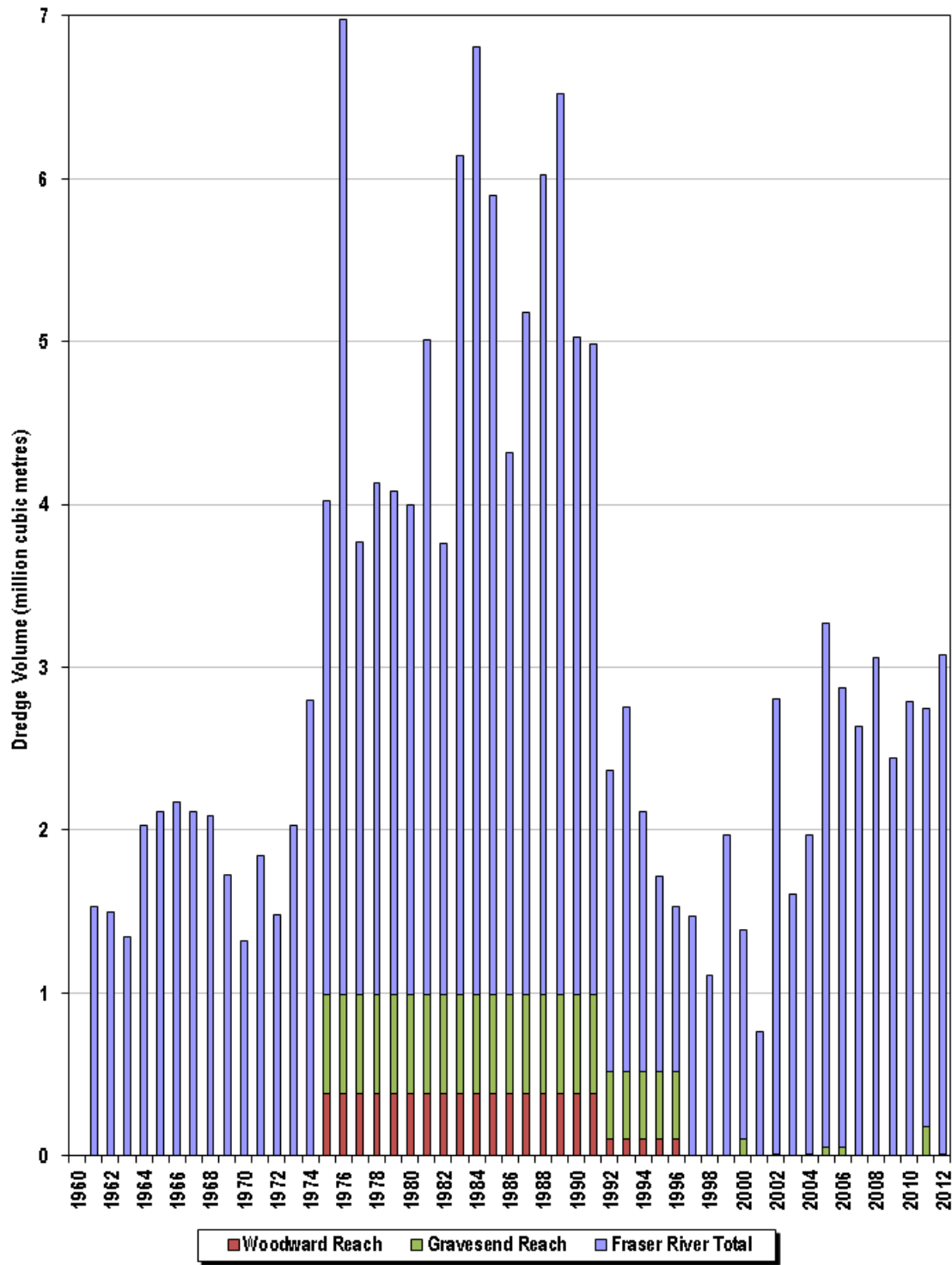


Figure 4-8 Annual Dredging Effort on the Lower Fraser River from 1960 to 2012.

5.0 Fluvial Processes and Morphology

5.1 Long-Term Lateral Changes

The Fraser River estuary has historically been morphologically active. The river transports large volumes of sand downstream of Mission, at which point patterns of deposition, mobilization and transport become heavily influenced by the tides. As a result, the configuration of channels at the mouth of the river is complex and, in the absence of human intervention, would be in constant flux.

As late as 1898, Ladner Reach was considerably larger than its current size. Around 1827, the main channel occupied Ladner Reach, and continued along Sea Reach to the mouth. Prior to this, the main flow path may have been down Canoe Passage via Ladner Reach. The Ladner Reach entrance was observed to have widened (see **Section 5.1**), and the thalweg migrated from the right (north) to left (south) bank⁴ at Deas Island (see **Section 5.2**) in the years prior to Tunnel construction (Pretious and Thorne 1953).

Historical aerial photographs were acquired of the LAA from the University of British Columbia (UBC) aerial photograph library for nine years to represent the period from 1938 to 2009 (i.e., 1938, 1949, 1954, 1963, 1974, 1984, 1991, 2002, and 2009). Photos of the vicinity of the Tunnel (two kilometres upstream and downstream) for these years were scanned and rectified (**Attachment B**). In the broader reach extending from Tilbury Island to the mouth of the river, photos from 1949, 1974, and 2009 were scanned and rectified (**Attachment B**).

The photos reflect increasing anthropogenic development in the lower Fraser River over time, both within the river itself and on its floodplain. Banklines of the main channel were digitized from the 1974 photos and displayed on orthorectified photos from 1949 and 2009 for comparison (**Figure 5-1**). Varying tides and Fraser River flows at the time of photo collection can confound interpretation and make quantitative assessments of bank changes difficult. However, the results indicate that there has been no major shifting in the bankline position over the 60-year period. The only distinguishable changes are attributed to the dredging of the Deas Dock and some expansion of industrial water lots in the Steveston area. Banklines are generally stable, due in large part to bank hardening and river training works fixing their position.

⁴ From the perspective of an observer looking downstream.

Banklines of mid-channel islands, particularly those in the area bounded by the main channel, Ladner Reach and Sea Reach, are largely unprotected, and therefore more likely to change over time. Although they could not be reliably digitized due to the tidal variations between photos (1949 photos were collected at higher tide than 2009 photos), a visual comparison of the photos in **Figure 5-1** suggests that existing islands have expanded since 1949. In particular, Little Hart Island developed between 1949 and 1974 and has been attributed to dredge spoil dumping and subsequent transport by currents (Hay & Company Consultants Inc. 2010). Little Hart Island's growth appears to have forced the flow at the elbow of Ladner Reach north, into Barber Island. The main channel of the reach has since shifted north of Little Hart and Big Hart islands, while the south channel has become constricted.

Downstream in Sea Reach, the width of the southern portion of the channel has not changed appreciably, but the reach downstream of the confluence with Woodward Slough appears to have widened between 1949 and 2009.

A sand bar located approximately 1.5 km upstream of the Tunnel, at the downstream end of Tilbury Island, was first observed in the 1954 air photo. Favourable tides allowed observation of it again in the 1984 photoset, by which time it had started to become colonized by vegetation. Known as Tilbury Marsh, the bar is still present and is roughly three-quarters colonized by marsh vegetation. Nonetheless it represents a relatively young geomorphologic feature.

Archived UBC reports for the Fraser River model show that between 1898 and 1953, the upstream end of the Kirkland Island was subject to considerable erosion (Pretious and Thorne 1953). The bankline at the downstream end of Deas Island also receded, with the majority of the change occurring between 1948 and 1953. Air photos from this year onwards suggest that the banklines of upstream Kirkland Island Deas Marsh have largely stabilized.

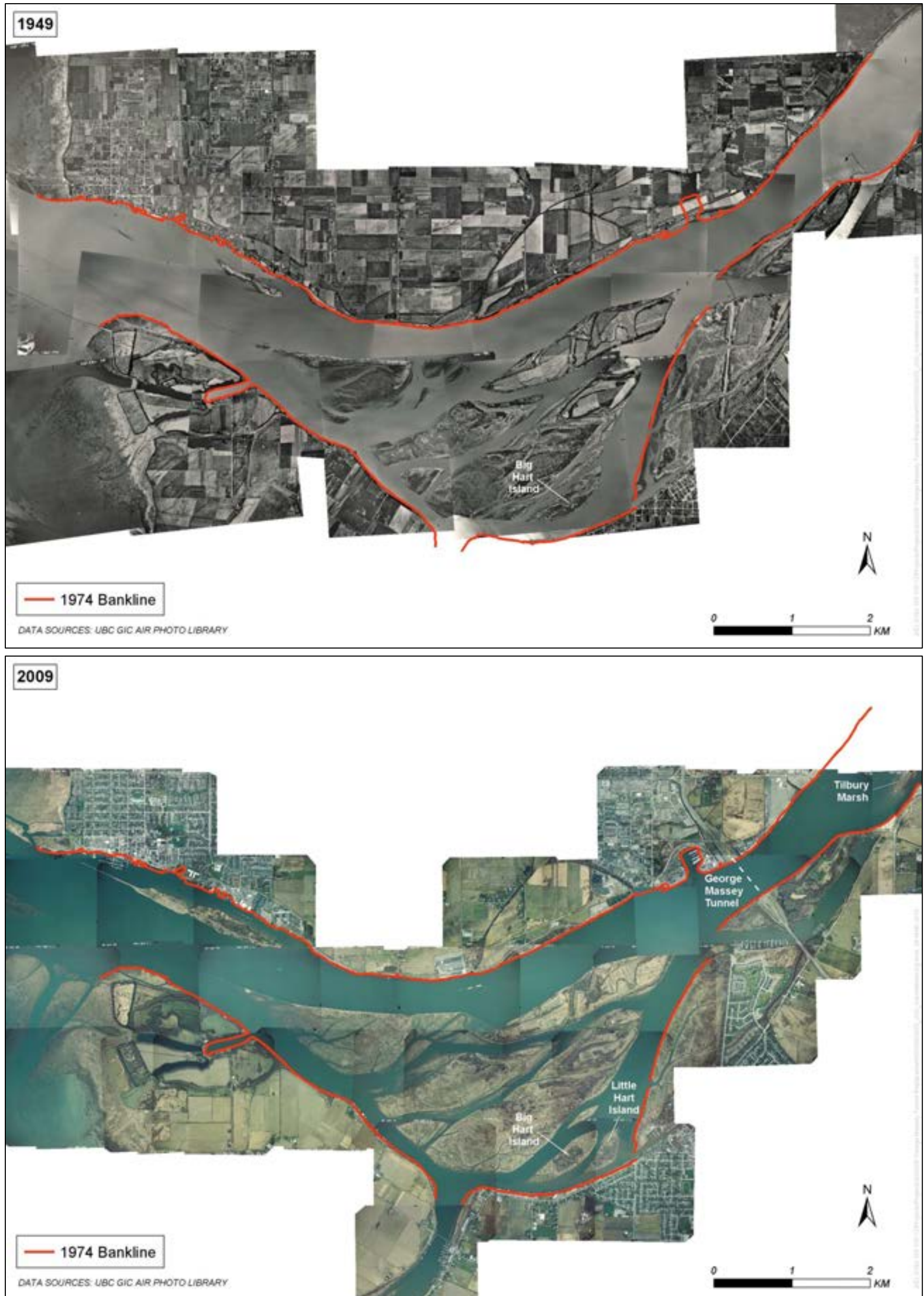


Figure 5-1 Historical aerial photographs comparison of the study reach between 1949 and 2009. Red line represents the digitized banklines from 1974. Tide heights during photo collection: 1949 = 0.6 m, 1974 = 0.0 m, 2009 = 0.0 m.

5.2 Long-Term Vertical Changes

Changes in riverbed elevations along the study reach were assessed using historical bathymetry from PWGSC. Annual datasets were available from 1988/89 through 2014 and from a more recent period than the air photos. To assess changes in bed elevations, survey data collected during the winter low-flow period for the years 1988/89, 2000/01, 2008/09 and 2014 were reviewed. Whereas the data from 1988/89 consist of surveyed cross-sections collected every 100 m, data from the 2000s consist of multibeam surveys (data point every metre) with some supplementary single-beam survey transects. Coverage along the study reach is very good, with some small gaps in in 1988/89⁵ and 2014⁶. Triangulated Irregular Network (TIN) surfaces were generated for each year using the point data. Longitudinal profiles along the thalweg between the Port Mann Bridge and the river mouth were extracted from each of the surfaces as well as cross-section profiles in the same reach.

The longitudinal profile downstream of the Port Mann Bridge is characterized by deep pools separated by shallower reaches (**Figure 5-2**). The pools occur at channel bends, narrower sections, and at instream structures such as bridge piers and pipeline and water main crossings where channel morphology has been constrained. Notably, a 15-m scour hole has developed in the long profile downstream of the Alex Fraser Bridge since 1988/89. The Tunnel is higher than the adjacent channel within about two kilometres upstream and downstream (**Figure 5-3**), but remains lower in elevation than Woodward Reach and Steveston Cut, which are further downstream.

Cross-sections from three well-spaced locations (**Figure 2-1**) along the lower 35 km length of the river (upstream of the New Westminster trifurcation, at Tilbury Island, and at Woodward Reach) are shown in **Figure 5-4 a, b, and c**. A review of these cross-sections suggest that the highest bed elevations were in 1988/89, with the bed lowering by 1.5 to 3.5 m as of 2014. At Tilbury Island, where there is a bend in the channel, scour has been greater along the outer right bank. About seven kilometres downstream from the bend, where there are a number of training works (**Figure 4-7**), concentrated flow at Woodward reach has deepened the channel near the right bank, and deposition has taken place at the opposite bank.

⁵ Missing data include the upstream portion of Ladner Reach and a section between Annacis Island and Tilbury Island.

⁶ Survey data from Ladner Reach were not available at the time of analysis.

The long profile in **Figure 5-2** also shows there has been a trend towards general bed lowering over much of the 45-km river profile downstream of Port Mann Bridge. The amount of lowering between 1988/89 and 2014 is consistent with that observed at individual cross-sections and corresponds to an average annual rate of approximately 10 cm/year. These changes are more recent but the trend toward bed lowering is consistent with previous findings of long-term riverbed degradation downstream of New Westminster. Between 1951 and 1988, the channel bed lowered by two to three metres (NHC 2002*b*). McLean et al. (2006) noted that the greatest lowering occurred in the 1980s, which corresponds to the period during which sediment removal volumes were consistently greater than incoming bed material load. They further observed that, since the 1990s, this trend has slowed with the reduction in dredging volumes, but anticipated that the river would continue to undergo changes resulting from earlier intensive dredging for at least the subsequent two decades. Since 2004, dredging volumes have increased in the lower reaches to facilitate an increase in vessel draft. It is expected that progressive degradation migrating up to New Westminster will resume in response to the increased dredging.

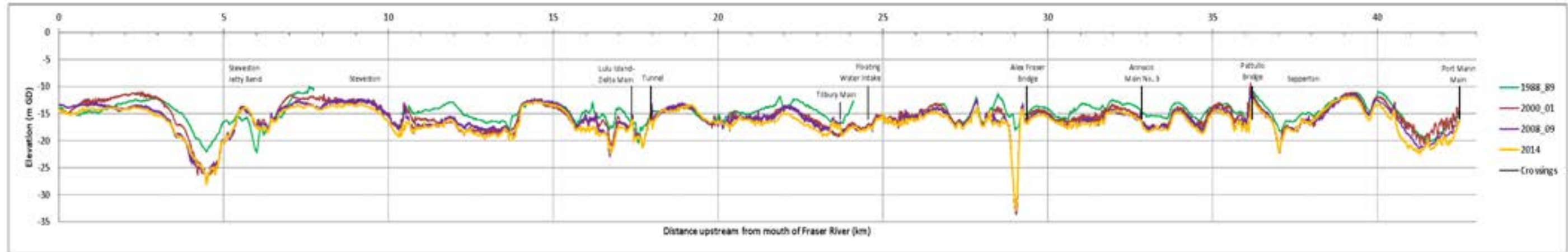


Figure 5-2 Historical Longitudinal Profiles for the Lower Fraser River (Data Source: Public Works and Government Services Canada 2014)

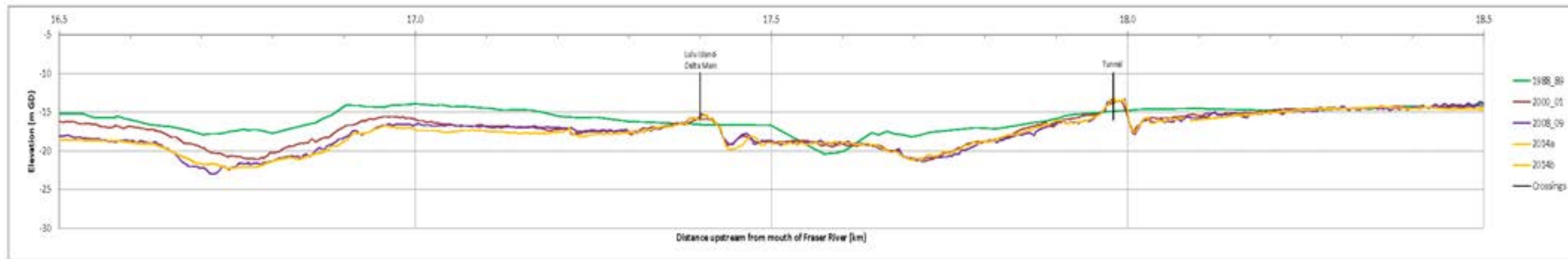
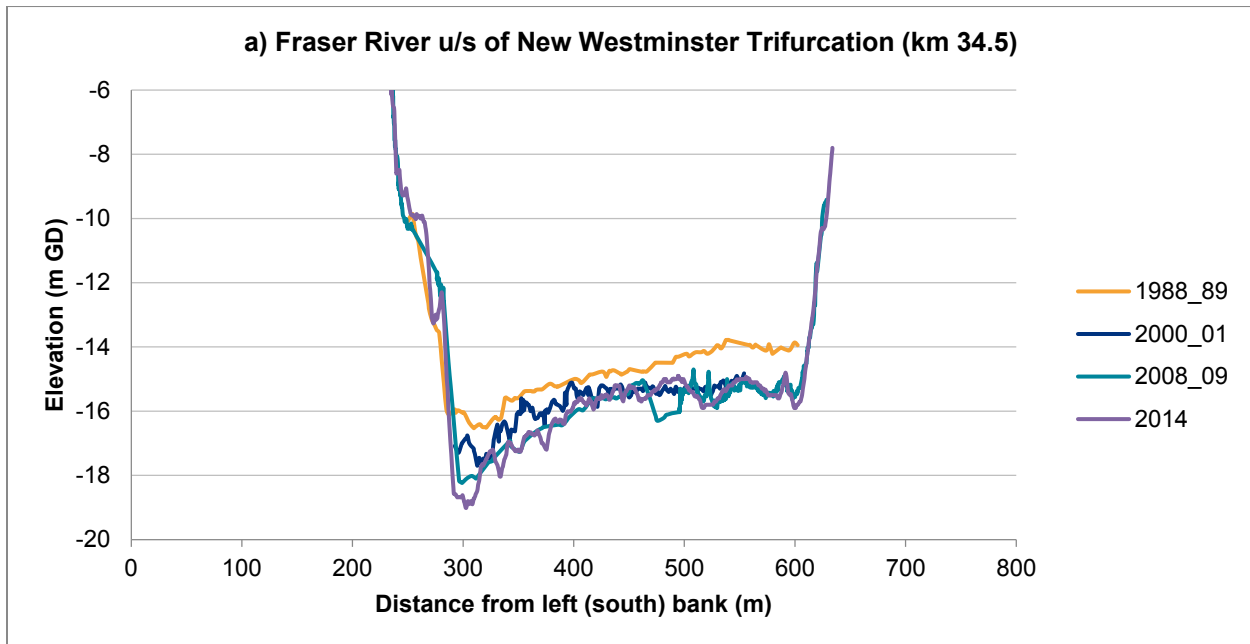


Figure 5-3 Historical Longitudinal Profiles for the Lower Fraser River in the Vicinity of the Tunnel (Data Source: Public Works and Government Services Canada 2014)

A comparison of historic cross-section bathymetry surveyed over time at Tilbury water main and Lulu Island–Delta water main (**Figure 5-5**), located upstream and downstream of the Tunnel respectively, provide further validation of the bed lowering trend. At the Lulu Island–Delta water main crossing, the bed scoured by as much as 2.5 m between 1981 and 1997. Scour protection was added in 2000, and the bed is noticeably higher in the 2011 profile. Scour of 0.5 to 1.0 m occurred again between 2011 and 2013. Prior to construction of the Tunnel, cross-sections surveyed near the water main between 1947 to 1952 indicate that there was approximately 2.5 to 3.5 m of bed elevation change there, largely attributed to shifting of the thalweg from the right to left bank by a strong shoal that formed on the right side of the channel during the 1950 freshet (Pretious and Thorne 1953).

At the Tilbury water main crossing, the bed scoured down by 2.5 to 3 m between 1990 and 1997. As a result of scour protection being added in 2001/2002, the profile is higher in 2008 than in 1997. From 2002 to 2008, only about 0.5 m of scour is observed at this crossing.



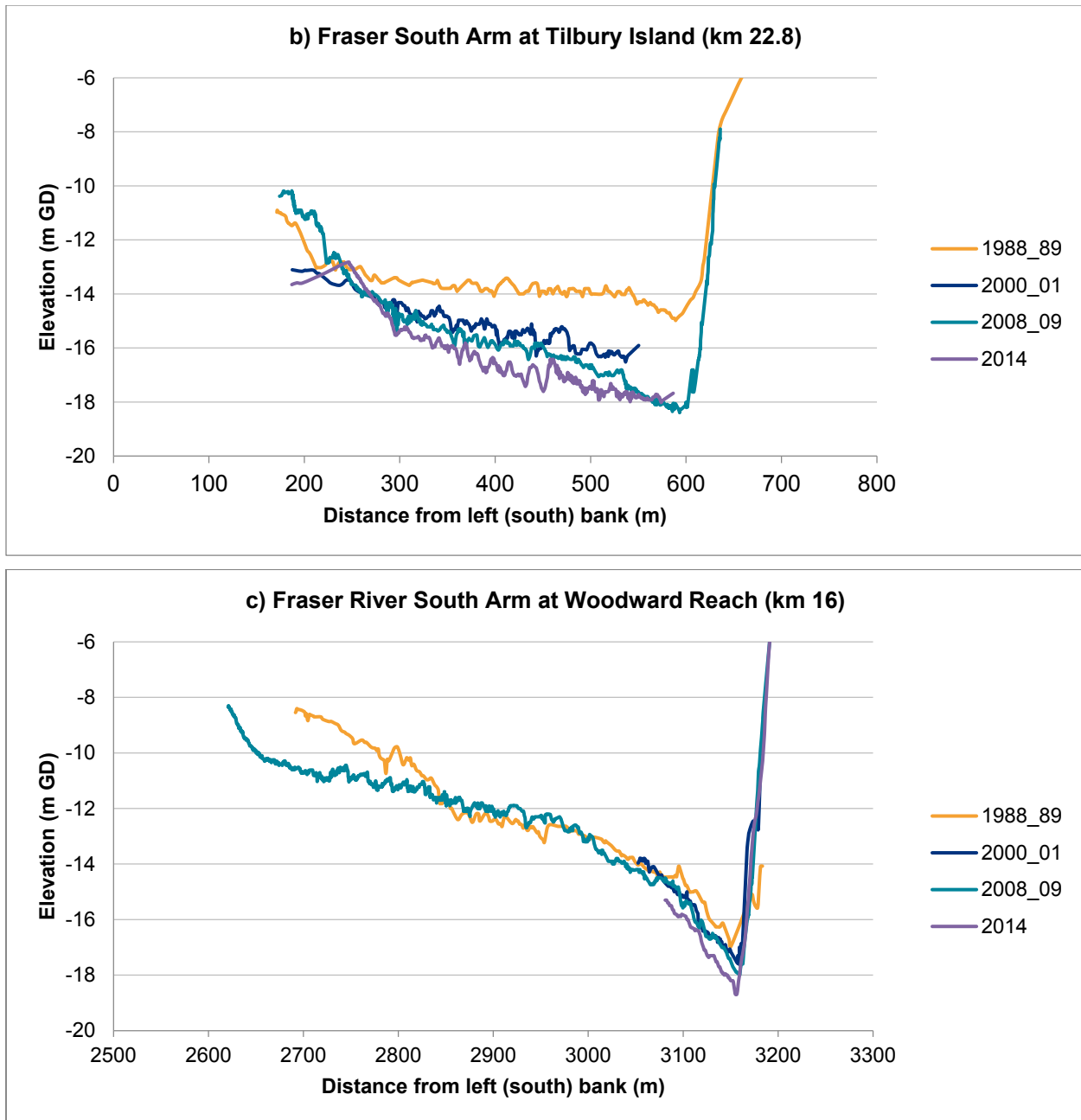


Figure 5-4 Comparison of River Cross-sections (a) Upstream of New Westminster Trifurcation (km 34.5), (b) Tilbury Island (km 22.8), and (c) Woodward Reach (km 16) Extracted from Historical Bathymetric Surveys

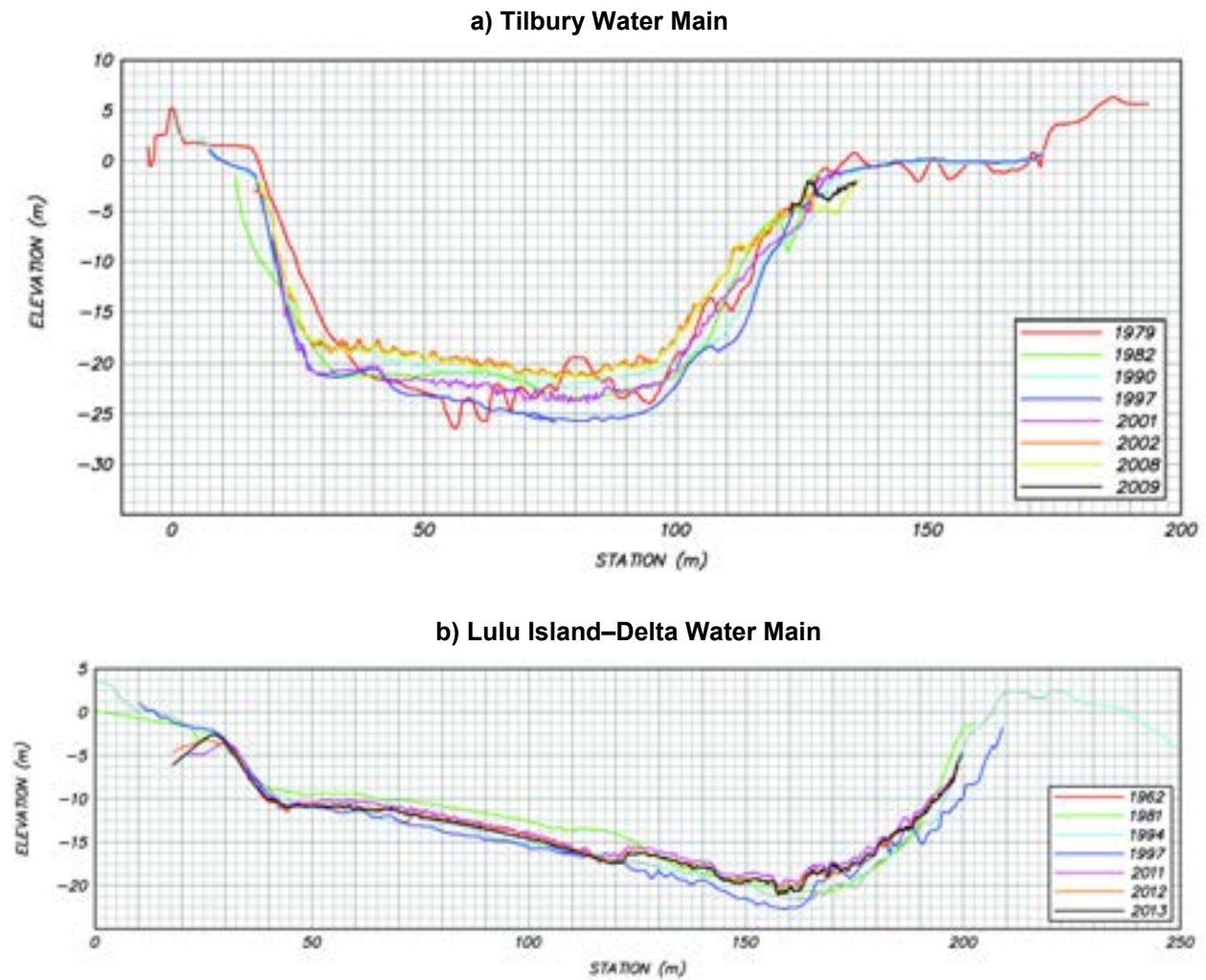


Figure 5-5 Comparison of Cross-sections Profiles from Historical Surveys at a) Tilbury Water Main and b) Lulu Island–Delta Water Main

Figure 5-6 shows the bed level changes in the vicinity of the Tunnel over three time periods: (a) 1988/89 to 2000/01, (b) 2000/01 to 2008/09, and (c) 2008/09 to 2014. The 1988/89 to 2000/01 period overlaps with peak dredging activity, with the post-2001/02 period corresponds to minimal dredging. Nonetheless, the observed trends inherently comprise both natural scour and deposition, and dredging, as the river responds over time to this disturbance.

The greatest bed level changes seem to have occurred in the 11-year period between 1988/89 and 2000/01. Upstream of the Tunnel, the main channel side of Deas Dam underwent about two to four metres of local deposition over that period. On the main channel side of Deas Island, a zone of significant scour (more than three to four metres) developed during the same time frame, with half that amount of bed lowering from 2000/01 to 2008/09. For both these areas, there is inadequate information for a 2008 to 2014 comparison.

Downstream of the Tunnel, the thalweg impinges on the left bank to the upstream third of Kirkland Island and there is evidence of scour along this bank. Between the Tunnel and the Lulu Island–Delta water main, there is a hole at the left bank that was scoured by four metres between 1988 and 2000, and lesser amounts in subsequent intervals; corresponding deposition occurred immediately downstream of the scour hole.

Further downstream at the Kirkland Island bifurcation, local erosion and deposition of greater than three metres has taken place in all three periods, likely due to how the rock spur divides flow into the two channels differently with varying seasonal discharges. An accumulation of sediment deposited in the mid-channel off Kirkland Island in the 1988/89 to 2008/09 period was presumably sourced from sediment eroding along the left bank upstream of the Tunnel. A summary comparison of bed elevation changes between 1988/89 and 2008 is provided in **Figure 5-7**. There is inadequate survey data to allow a 2008 to 2014 comparison.

Due to sparse survey coverage within the side channels, Ladner Reach could only be assessed for two time periods, from 1988/89 to 2000/01 for lower Ladner Reach, and from 2000/01 to 2008/09 for the entire reach. Bed level changes in Ladner Reach appear to be modest, with less than one metre of scour along the thalweg, and deposition of the same magnitude near adjacent banks. Detection of changes may, however, be confounded by dredging activity. There are localized areas of greater scour at the upstream and downstream ends of the islands, and where the thalweg impinges on the bank. Local deposition of two to three metres between 2000/01 and 2008/09 was also observed in Ladner Harbour, which was slated for dredging in 2014.

Historical bathymetric charts from the Department of Public Works (the predecessor of PWGSC) supplement the understanding of more recent bed changes—specifically, those from 1950, 1967, and 1983. The shift in primary flow to north of Big Hart Island (**Figure 5-1**) deepened the channel there from a shoal in 1950 to five to seven metres in 1967, and increased sedimentation south of Big and Little Hart islands reduced depths from seven to eight metres in 1967 to 2.5 to 5.5 metres in 1983. The bed in the reach between Kirkland Island and Big and Little Hart islands did not change appreciably between 1950 and 1983. Further downstream, in Sea Reach, sedimentation has occurred downstream of the Woodward Slough confluence, with bathymetric charts showing maximum depths of nine metres in 1967 and seven metres in 1983.

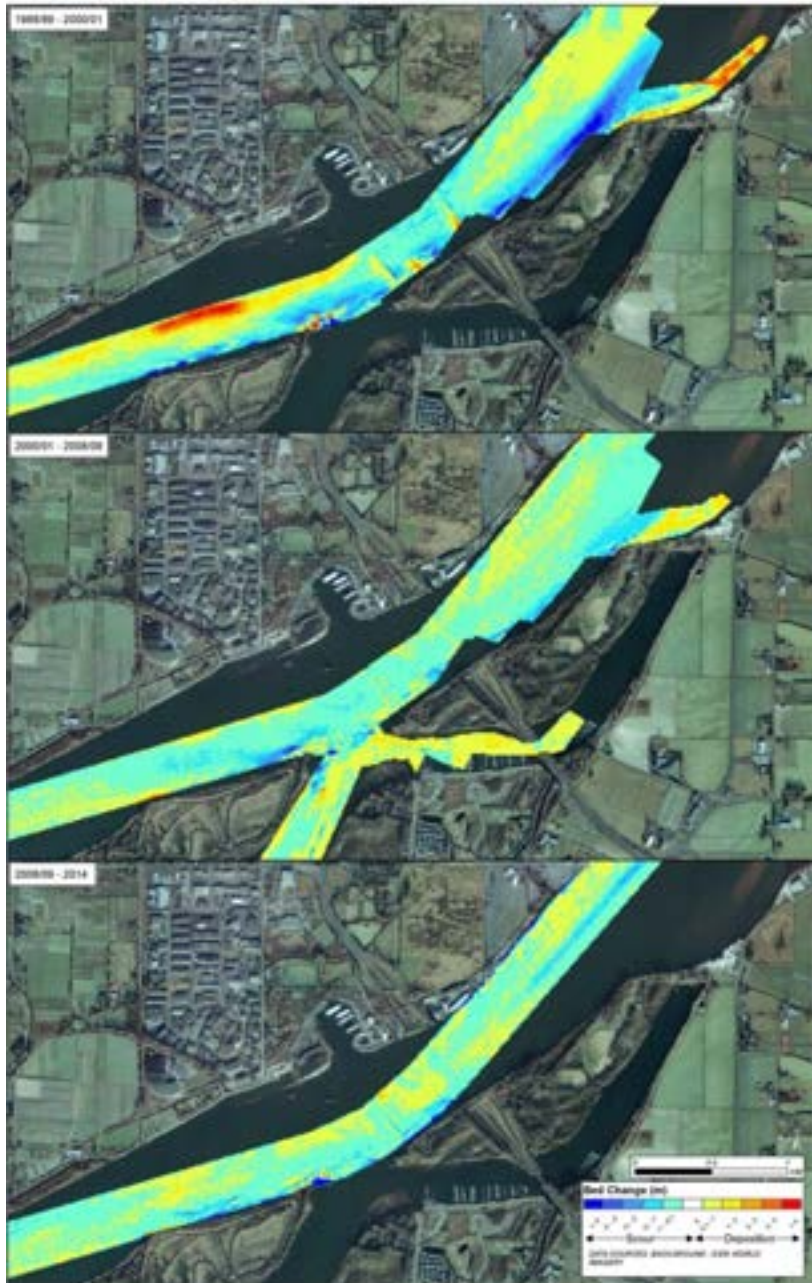


Figure 5-6 Change in Fraser River Bed Elevations in the Vicinity of George Massey Tunnel Between Survey Periods (a) 1988/89 – 2000/01, (b) 2000/01 – 2008/09, and (c) 2008/09 - 2014.⁷

⁷ Some Gaps Occur in the Survey Datasets in Secondary Channels.

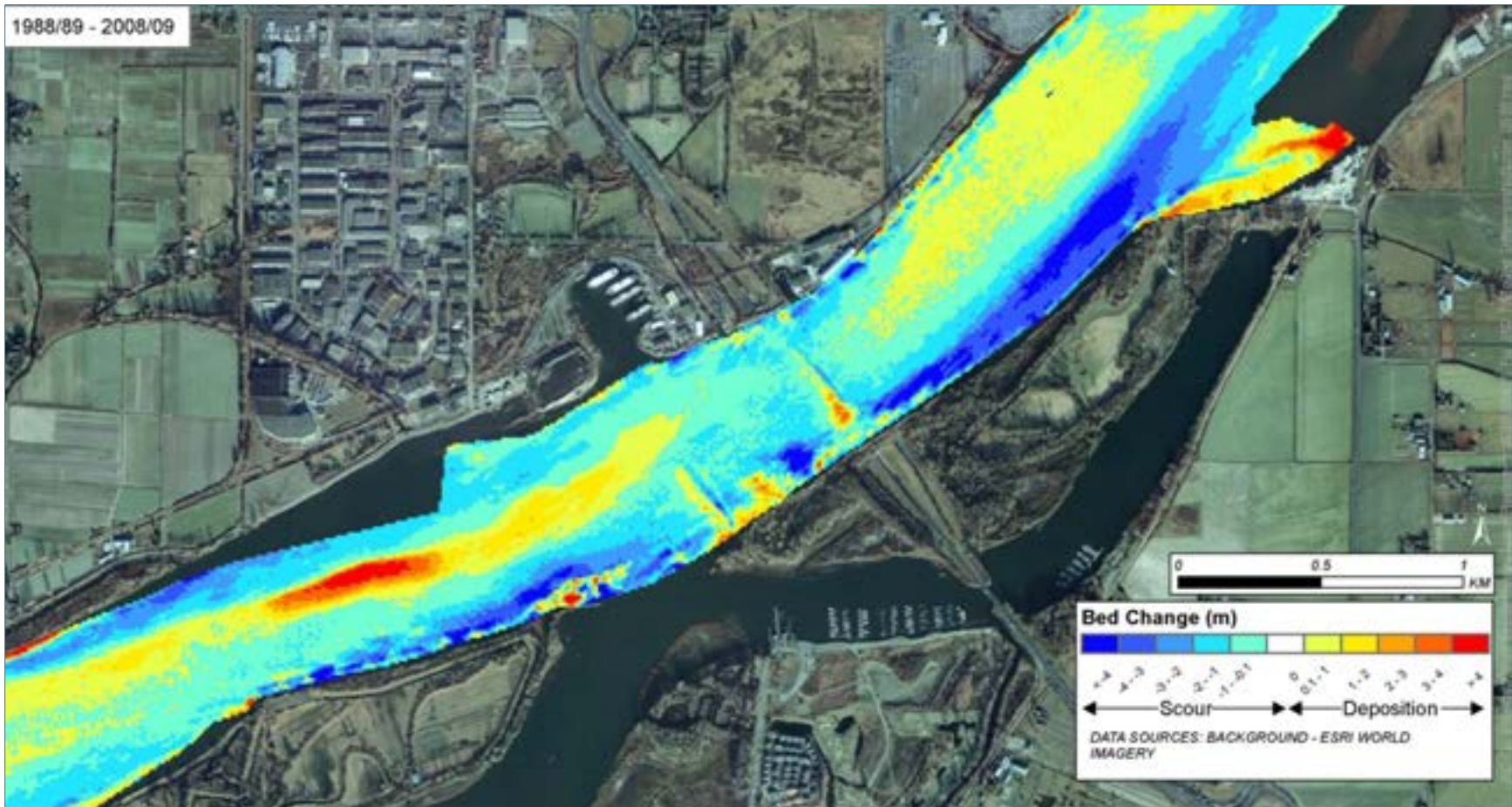


Figure 5-7 Trench Morphology and Evolution

5.3 Project Considerations

The study assumes at least four of six Tunnel segments are to be removed (**Section 3.1**). Tunnel removal will result in a trench feature in the river bed. It is particularly instructive to review trench evolution in comparison with the evolution of a dredge cut, since dredge cuts are common in the reaches of interest in this study, and their effects are relatively well known.

Whereas a dredge cut typically spans a number of kilometres, a trench tends to be more confined, extending for a few hundred metres along the river profile. The larger footprint of a dredge cut has the ability to locally lower the water surface profile. The water draft at the edges in particular is reduced and flow velocities increase locally as a consequence. The knickpoint created in the profile can therefore headcut upstream and deposit the eroded material immediately downstream at the toe of the slope. A similar knickpoint migration occurs at the downstream end, except that it travels downstream and there is no deposition at the toe of the slope. The transition between the cut slopes and the bottom become more gradual over time, thereby altering the overall morphology.

In contrast, the narrower trench feature proposed for the Project of approximately 95 m wide and 8 m deep (**Attachment A** and **Figure 3-2**), would not have as considerable an effect on the height of the water surface profile. For a river slope of 0.00005 (similar to the lower Fraser River near the Tunnel), a 100-m wide trench would result in an approximate 0.5% change in water level. This minimal water level change translates to less acceleration of flow; therefore, no erosion of the upstream knickpoint would occur and the trench would fill. However, the downstream knickpoint, would erode and propagate downstream.

Walstra et al. (1999) modelled the morphological development of trench geometries over 50 years and found that narrow, relatively deep trenches, such as anticipated for the Project, are preferable over wide, relatively shallow ones if stability (i.e., minimum migration rate) is desirable. That study did show, however, that deep trenches have a longer morphological lifespan (time to fill) than wide trenches (Walstra et al. 1999). The volume required to fill a trench with dimensions for the full Tunnel removal option is on the order of 260,000 m³, which represents about nine per cent of the average annual bed material load of the Fraser River (2.9 million m³). In addition, compared with the seven million cubic metres (or more) dredged from the Fraser River in a single year at the height of dredging activity, or the one million cubic metres removed in the local reaches annually, the excavated trench volume of 260,000 m³ constitutes a small fraction.

Trenches have been excavated for other river infrastructure developments on the Fraser River. In 2009, a 200-m-wide by 5-m-deep by 300-m-long trench was excavated to allow barge access for construction of the Port Mann Bridge. Numerical modelling (NHC 2009) indicated that the 100,000 m³ trench would infill by 45% in about a year, with complete filling in three years. Subsequent monitoring verified that filling has occurred, although the actual time required for infilling is not known. In another example, an excavation site on the Fraser River at Bedford Channel was dredged in early 2006. The trench had similar characteristics to the excavated area at Port Mann, and underwent about 100,000 m³ of sediment infilling after two freshets.

6.0 Modelling Methodology

Hydraulic and morphodynamic numerical modelling analyses were conducted to evaluate potential changes in river hydraulics (i.e., current distributions and water levels), and morphology (i.e., sedimentation patterns) associated with the full Tunnel removal and partial Tunnel removal proposed options. Modelling used the TELEMAC system, a suite of finite element computer programs developed by the Laboratoire National d'Hydraulique et Environnement (LNHE). The TELEMAC system is a modelling tool recognized throughout the world, having more than 4,000 registered users including BC Hydro, Hydro-Québec, and Canadian Coast Guard, as well as universities, engineering schools and research centres. TELEMAC programs utilized for this study include the following:

- TELEMAC3D – A three-dimensional hydrodynamic model that solves the time-dependent Navier-Stokes equations with an evolving free surface, under the assumption of hydrostatic or non-hydrostatic pressure distribution using the finite element method.
- SISYPHE – A sediment transport and morphodynamic model that computes bed-load and suspended load separately, and the resulting bed changes using the Exner equation.

The modelling methodology and results are presented in the sections below. Further details on the development, calibration, and validation of the numerical models can be found in **Attachment C**.

6.1 Far-Field and Near-Field Models

As described in **Section 2.1** and shown in **Figure 2-3**, the RAA for this study extends from the mouth of the Fraser River to New Westminster. Modelling this extent of the river while providing a useful level of detail at the Project site required careful consideration of model size and computational time. To yield the desired combination of model precision and efficiency, two TELEMAC models were developed for the study:

Far-Field: the Strait of Georgia/Lower Fraser River (SOG/LFR) model extends from Ballenas Island at its northern boundary, to Port Renfrew at its western boundary (**Figure 6-1**). This model mesh also includes the Fraser River up to km 42, downstream of Port Mann Bridge. The SOG/LFR model was used to evaluate far-field changes to hydraulics and sedimentation associated with the proposed Tunnel removal options.

Near-Field: the No.5 Road model extends from 1,300 m upstream of the Tunnel to 700 m downstream of the Tunnel (**Figure 6-2**). The No.5 Road model was used to evaluate near-field hydraulic and sedimentation associated with the proposed Tunnel removal options. This spatial resolution was employed to better define Tunnel geometry, and hence, better identify features in the flow field that could result in changes to the local deposition pattern.

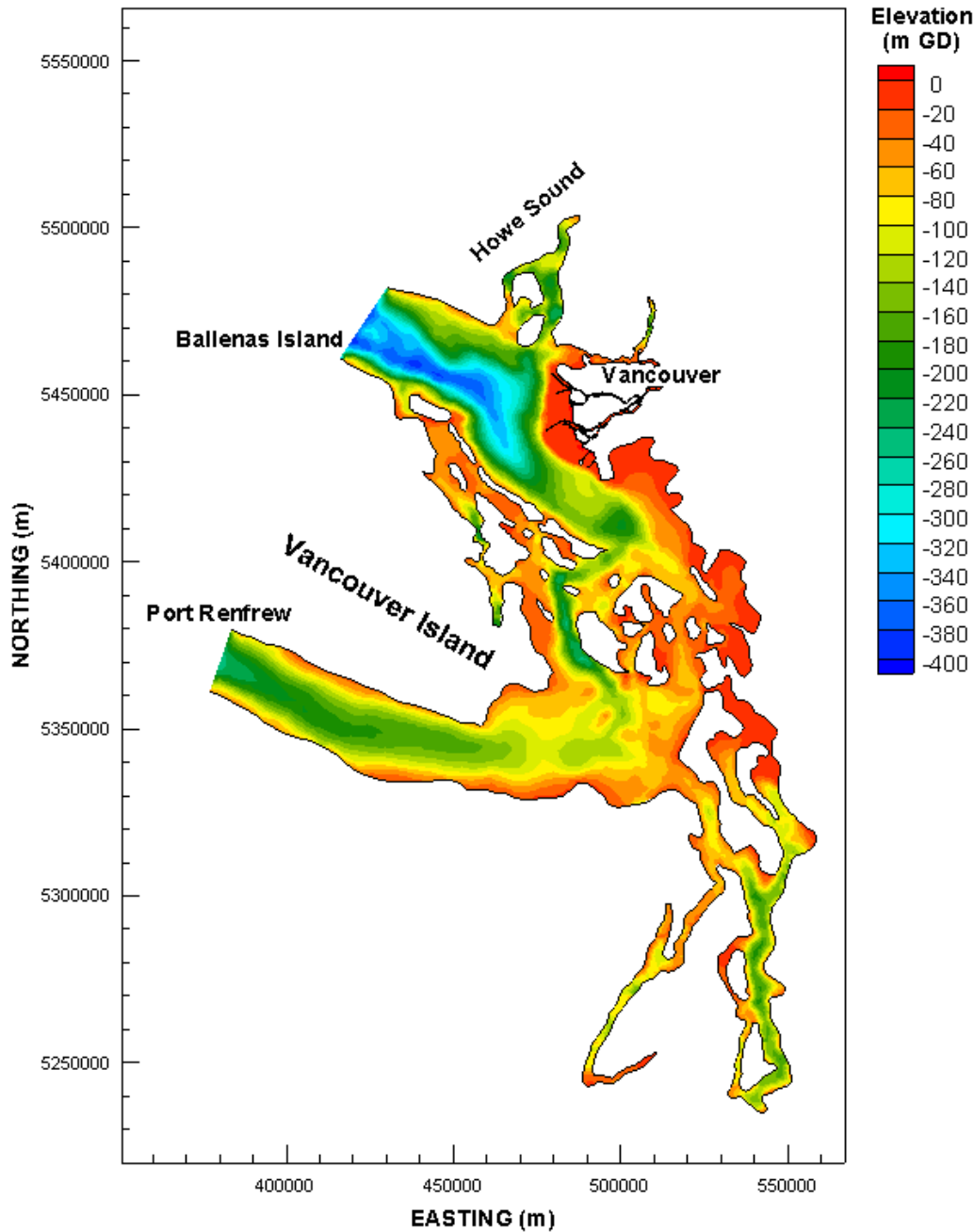


Figure 6-1 TELEMAC Strait of Georgia/Lower Fraser River (Far-Field) Model Extent

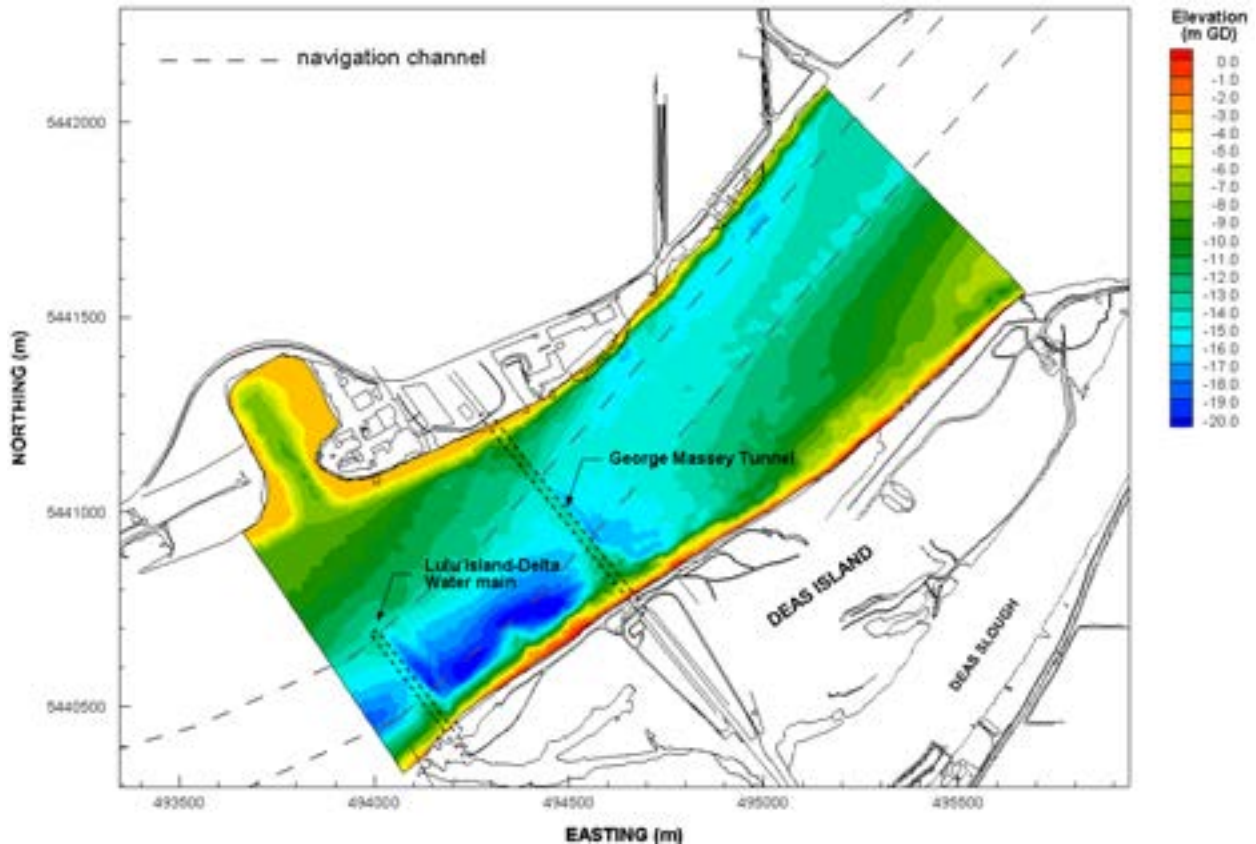


Figure 6-2 TELEMAC No.5 Road (Near-Field) Model Extent

The SOG/LFR model is used to evaluate far-field hydraulic effects and sedimentation associated with the proposed Tunnel removal options. The TELEMAC model uses a computational mesh as a mathematical representation of the physical environment under study. A mesh typically includes information on the shoreline geometry, the bathymetric features, and the bottom-type characteristics of the area involved. The SOG/LFR model mesh comprises approximately 35,000 nodes, 63,000 elements, and 10 levels in the vertical. The element lengths vary from approximately 3,000 m in the Strait of Georgia to about 50 m in the lower Fraser River. In the river reach near the Tunnel, the element lengths were further refined to about 30 m.

The No.5 Road model is used to evaluate near-field hydraulic and sedimentation associated with the proposed Tunnel removal options. This model mesh comprises approximately 11,000 nodes, 21,000 elements, and 10 levels in the vertical. The element lengths vary from approximately 20 m in the upstream to about 5 m in the vicinity of the Tunnel. This spatial resolution was employed to better define Tunnel geometry, and hence, better identify features in the flow field that could result in changes to the local deposition pattern.

To ensure that both models were subjected to the same hydraulic conditions, the modelled flow and water levels from the SOG/LFR model at km 18 and km 19 (near the Tunnel) of the Fraser River were compared against the same values in the No.5 Road model and found to have good agreement (**Figure 6-3**).

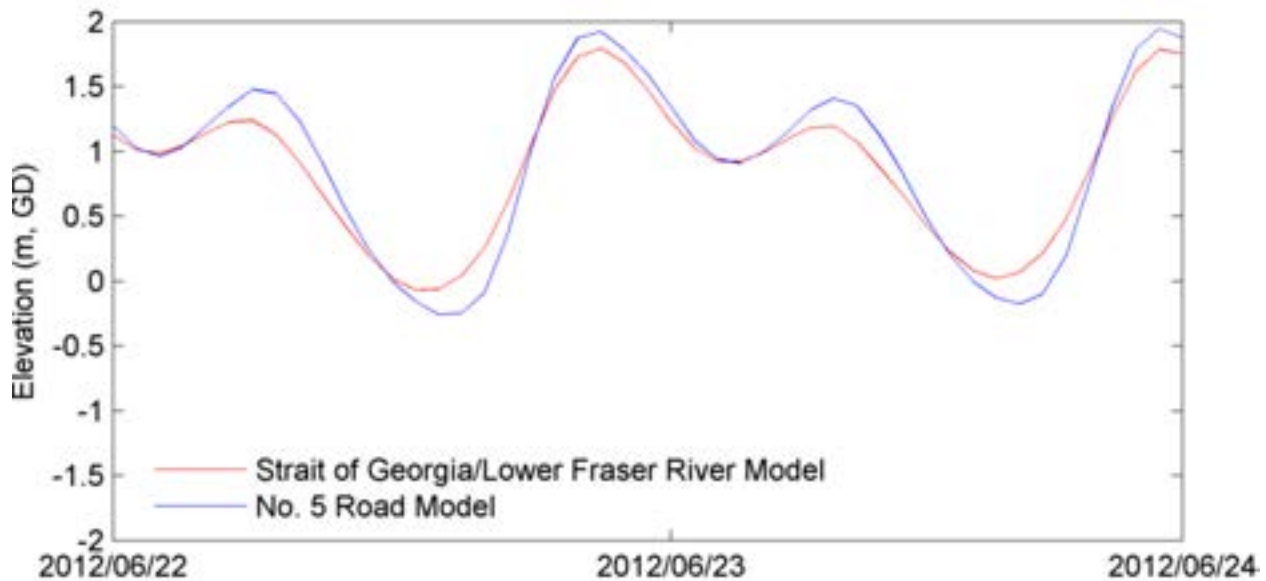


Figure 6-3 Comparison of Modelled Water Levels at Deas Island for the Strait of Georgia/Lower Fraser River and No.5 Road Model Meshes During Peak of 2012 Freshet

6.2 Modelled Scenarios

The model analysis was conducted for two distinct scenarios:

1. The trench infilling scenario examines the short-term channel response to the removal of the Tunnel, particularly trench migration and infilling. Key processes analyzed include: (a) trench migration and infilling as a result of Tunnel removal, and (b) the potential changes on nearby infrastructure and habitat due to the trench.
2. The post-infilling scenario examines the potential changes to the river hydraulics and sedimentation patterns as a result of Tunnel removal, after the trench has been filled in by deposition of river sediments. To reduce computation time and more clearly delineate the short-term and long-term analyses, river bathymetry at the Tunnel alignment was modified to blend with upstream and downstream bed elevations, rather than beginning with the final bed configuration of the trench infilling model.

6.3 Model Geometry

Five model geometries were developed for the analysis:

- Existing conditions
- Full Tunnel removal trench infilling
- Full Tunnel removal post-infilling
- Partial Tunnel removal trench infilling
- Partial Tunnel removal post-infilling

These geometries represent the initial bed profile for each model simulation. Each of these is described below.

6.3.1 Existing Conditions

Existing channel geometry for both the SOG/LFR and No.5 Road models was derived using the following datasets:

- Bathymetric survey data collected by CRA Canada Survey Ltd. on April 2, 2014. The survey extended approximately 500 m upstream and downstream of the Tunnel (**Figure 3-3**).
- For the Fraser River, data from the 2014 PWGSC bathymetric surveys and 2005 Fraser Basin Council LiDAR acquisitions
- For Puget Sound, the Strait of Georgia and Juan de Fuca Strait, CHS bathymetry data

No.5 Road model geometry for existing conditions (with the Tunnel) is shown in **Figure 6-4**.

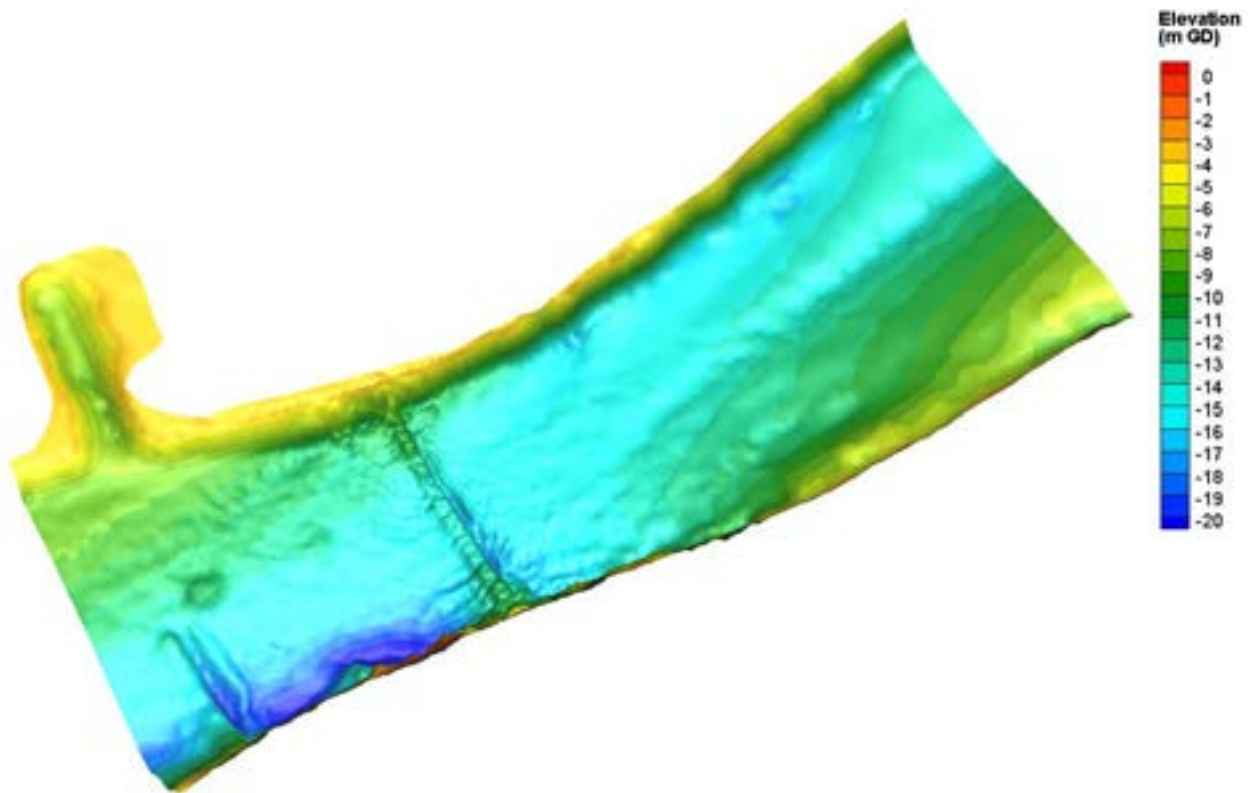


Figure 6-4 No.5 Road Model Geometry for Existing Conditions (with the Tunnel)

6.3.2 Full Tunnel and Partial Tunnel Removal Geometries

To determine the extent of excavation for the full Tunnel and partial Tunnel removal geometries, the as-built drawings prepared for the B.C. Toll Highways and Bridges Authority (**Attachment A**) were reviewed and a three-dimensional model of the Tunnel and surrounding erosion protection was developed using computer-aided design (CAD). The CAD model was then used to develop localized digital elevation models (DEMs) within the extents of the excavation for the Tunnel removal options. Beyond the extents of the excavation, the localized DEMs were merged with the existing conditions DEM so that all three DEMs were identical outside of the excavation area. To avoid discontinuities at the border of the merged DEMs, the extents of excavation were extended up to existing ground at a 2H:1V slope.

6.3.2.1 Full Tunnel Removal Trench Infilling

For full Tunnel removal trench infilling scenario, it was assumed that all six precast concrete segments of the Tunnel were to be removed. The two sections (TE1 and TE6) closest to the river banks are located partially under existing ground, as shown in **Figure 3-1**. Banks at the Tunnel crossing were assumed to be re-constructed and protected with riprap to match the adjacent upstream and downstream banklines. **Figure 6-5** shows the No.5 Road DEM used for the full Tunnel removal option in the trench infilling scenario. The DEM used for the SOG/LFR trench infilling scenario was identical to this in the Tunnel reach.

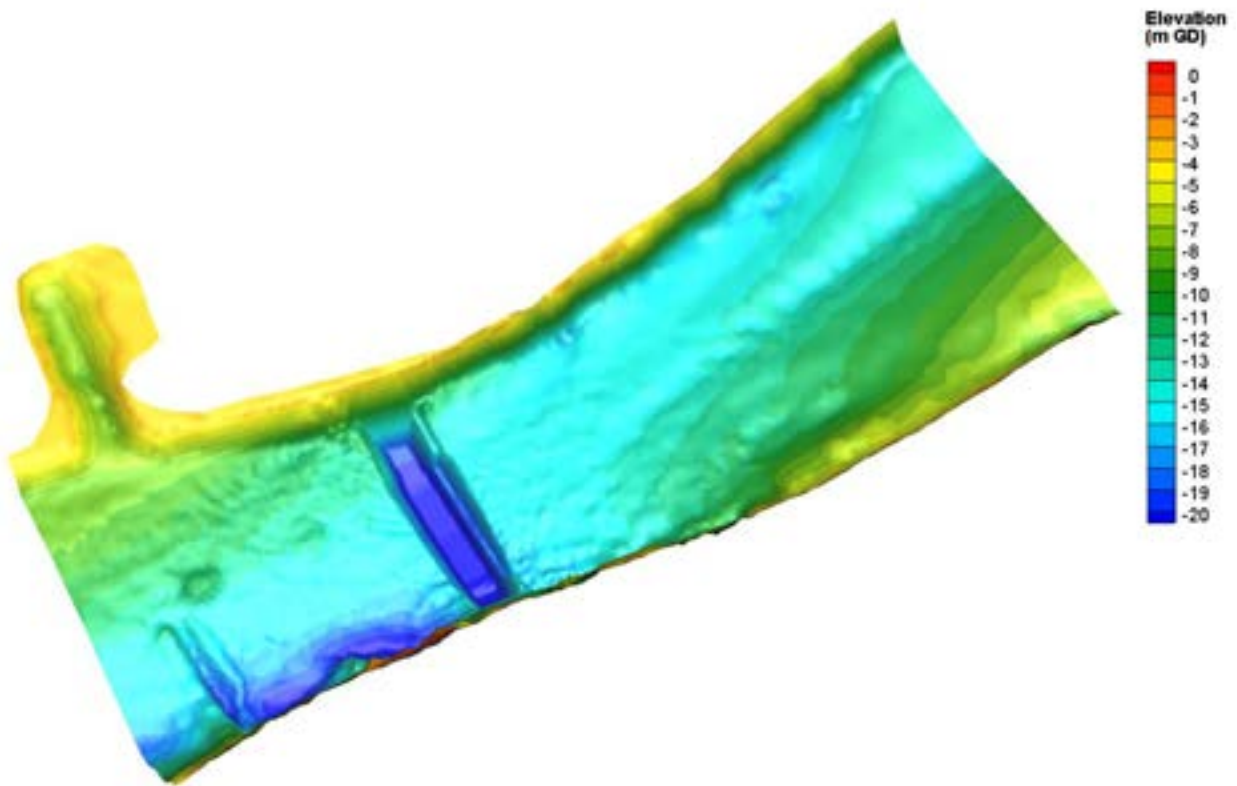


Figure 6-5 No.5 Road Model Geometry for Trench Infilling Scenario Modelling of the Full Tunnel Removal Option

6.3.2.2 Full Tunnel Removal Post-Infilling

The full Tunnel removal post-infilling scenario examines potential effects of Tunnel removal after sediment has filled in the trench. The DEM used for the SOG/LFR trench infilling scenario was identical to the No.5 Road DEM used for the full Tunnel removal option in the trench infilling scenario as shown in **Figure 6-6**.

6.3.2.3 Partial Tunnel Removal Trench Infilling

For the partial Tunnel removal trench infilling model, it was assumed that the four middle precast concrete segments of the Tunnel were removed, while the two end segments closest to the river banks (TE1 and TE6) and the existing banks were left intact. It was assumed that a riprap “nose” with a 2H:1V slope would be placed around the end of each end segment to avoid abrupt transitions leading to adverse hydraulics. The DEM used for the SOG/LFR model was identical to the No.5 Road model bathymetries used for partial Tunnel removal in the trench infilling model as shown in **Figure 6-7**.

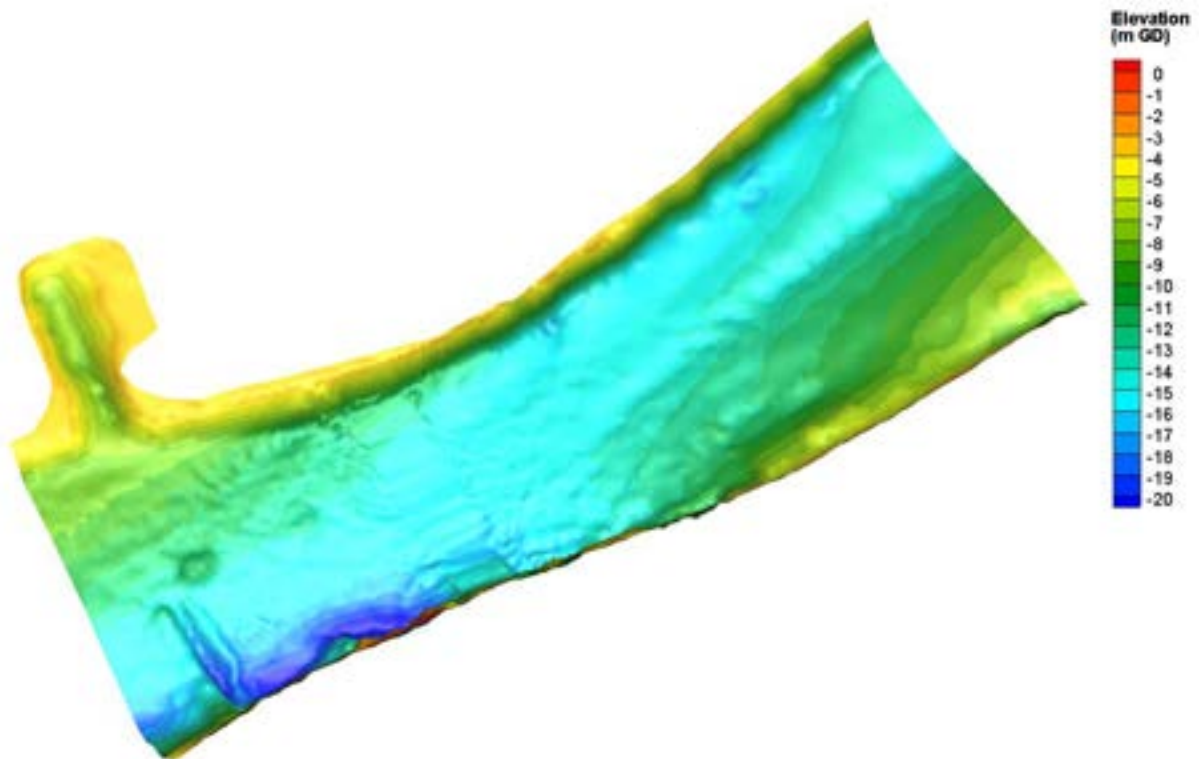


Figure 6-6 No.5 Road Model Geometry for Post-infilling Scenario Modelling of the Full Tunnel Removal Option

6.3.2.4 Partial Tunnel Removal Post-Infilling

For the partial Tunnel removal post-infilling model, river bathymetry at the Tunnel alignment was modified to blend with upstream and downstream bed elevations. **Figure 6-8** shows the No.5 Road model bathymetry used for partial Tunnel removal in the post-infilling model. The DEM used for the SOG/LFR model was identical to this in the Tunnel reach.

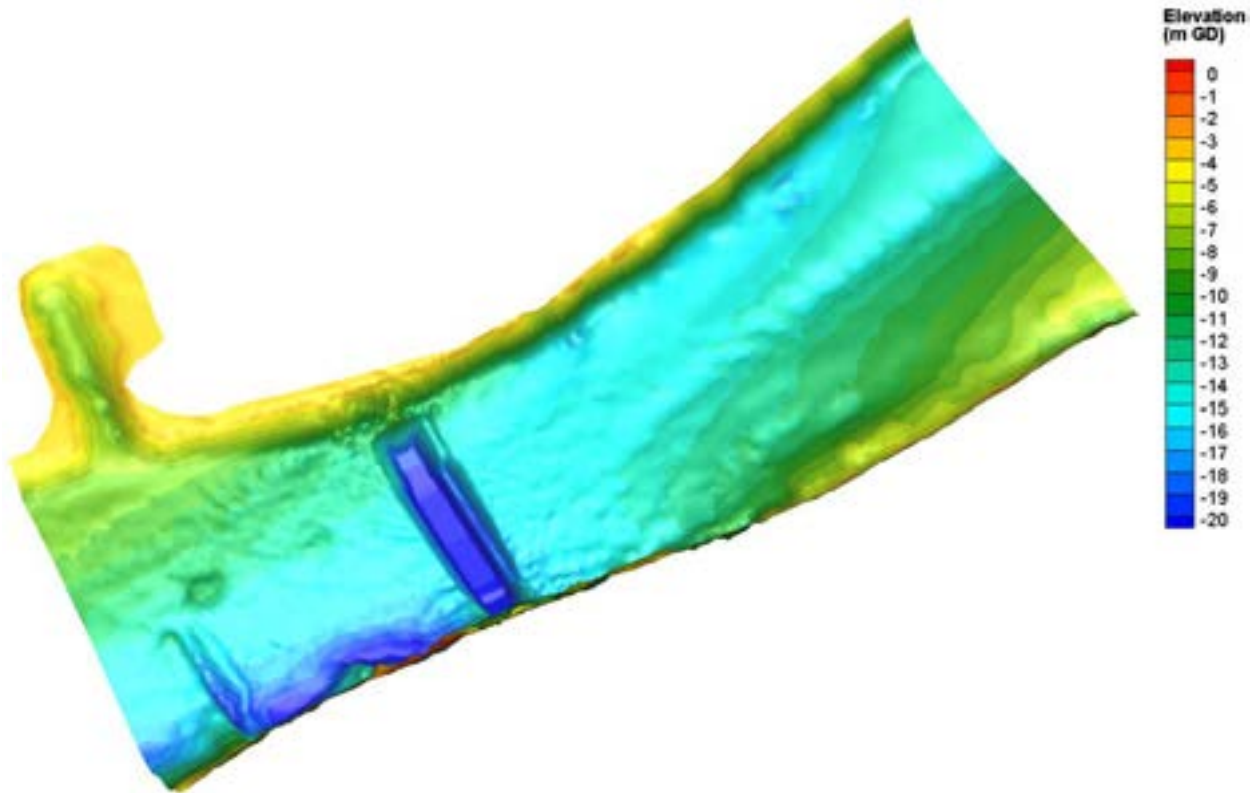


Figure 6-7 No.5 Road Model Geometry for Trench Infilling Scenario Modelling of the Partial Tunnel Removal Option

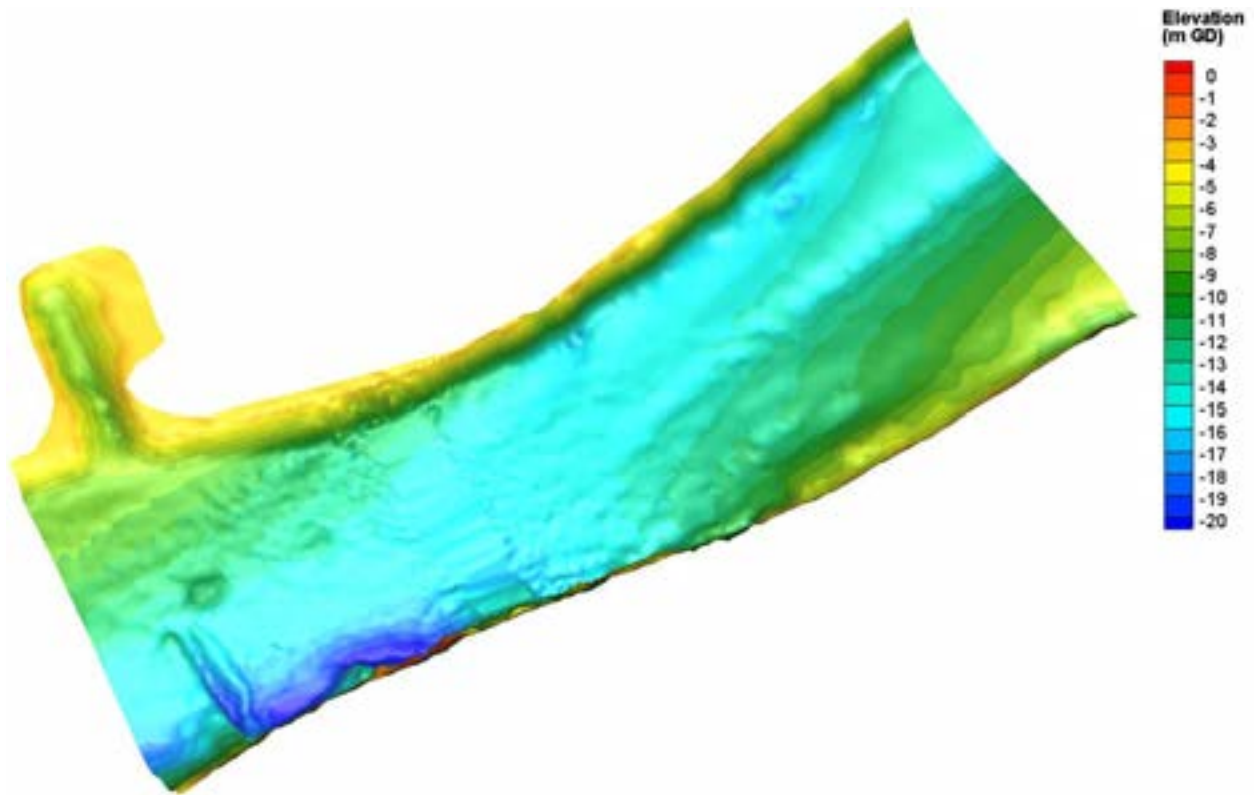


Figure 6-8 No.5 Road Model Geometry for Post-infilling Scenario Modelling of the Partial Tunnel Removal Option

As seen in **Figure 6-5** and **Figure 6-7**, the excavation geometries for the full and partial Tunnel removal options are very similar. The two concrete sections (TE1 and TE6) closest to the river banks are located mostly under existing ground (**Figure 3-1**). For the full Tunnel removal option, it was assumed that the river banks within the extent of the excavation will be re-constructed and armoured to best match the existing river banks on either side of the excavation. After the banks are re-constructed, most of the area above sections TE1 and TE6 would be re-covered. As a result, the net removal of material and shape of the excavation for the full and partial Tunnel removal options are similar. Cross sections along the centreline of the existing Tunnel are shown for existing conditions (black line), full Tunnel removal (red line), and partial Tunnel removal (blue line) options in **Figure 6-9**.

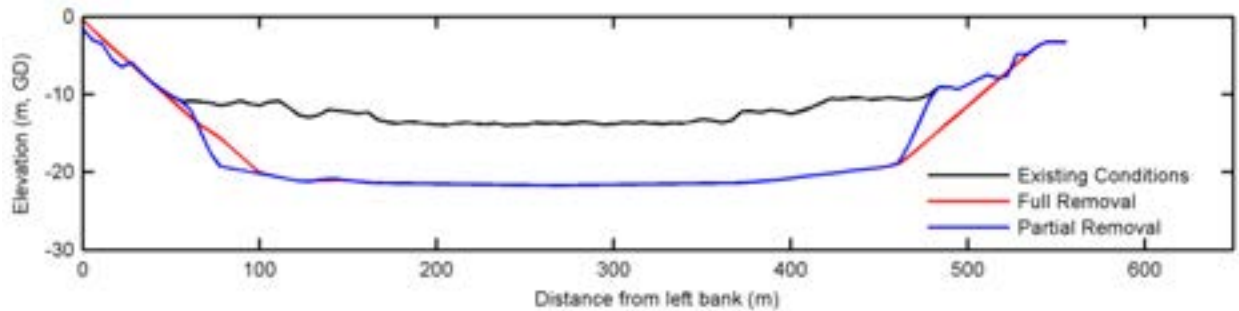


Figure 6-9 Cross-section along the Centreline of the Tunnel and Proposed Excavation Showing Bed Elevations for Existing Conditions, Full Tunnel Removal, and Partial Tunnel Removal Options

6.4 Boundary Conditions

The SOG/LFR model is driven at its open boundaries (Ballenas Island and Port Renfrew) by tidal levels obtained using WebTide Tidal Prediction model (Department of Fisheries and Oceans 2005) based on work by Foreman et al. (2000). Inflows to the Fraser River at Port Mann Bridge (km 42) are computed using a hydraulic model of the Fraser River that uses the MIKE11 one-dimensional hydrodynamic software developed by the Danish Hydraulic Institute. The Fraser River MIKE11 model was developed by NHC for the Fraser Basin Council in 2006 (NHC 2006) and updated two years later for B.C. Ministry of Environment (NHC 2008). The No.5 Road model is driven at its upstream end (flow) and downstream end (water level) by outputs from the aforementioned Fraser River MIKE11 model.

All model simulations were conducted using the 2012 Fraser River flow and tide conditions from WSC and CHS respectively. The year 2012 was selected because of availability of data for model calibration and because freshet flow was high that year. The high freshet flow provides the condition for evaluating the upper end of the potential changes to river hydraulics and sedimentation. The 2012 Fraser River flow at Hope, where discharge is not influenced by the tidal signal, is shown in **Figure 6-10**.

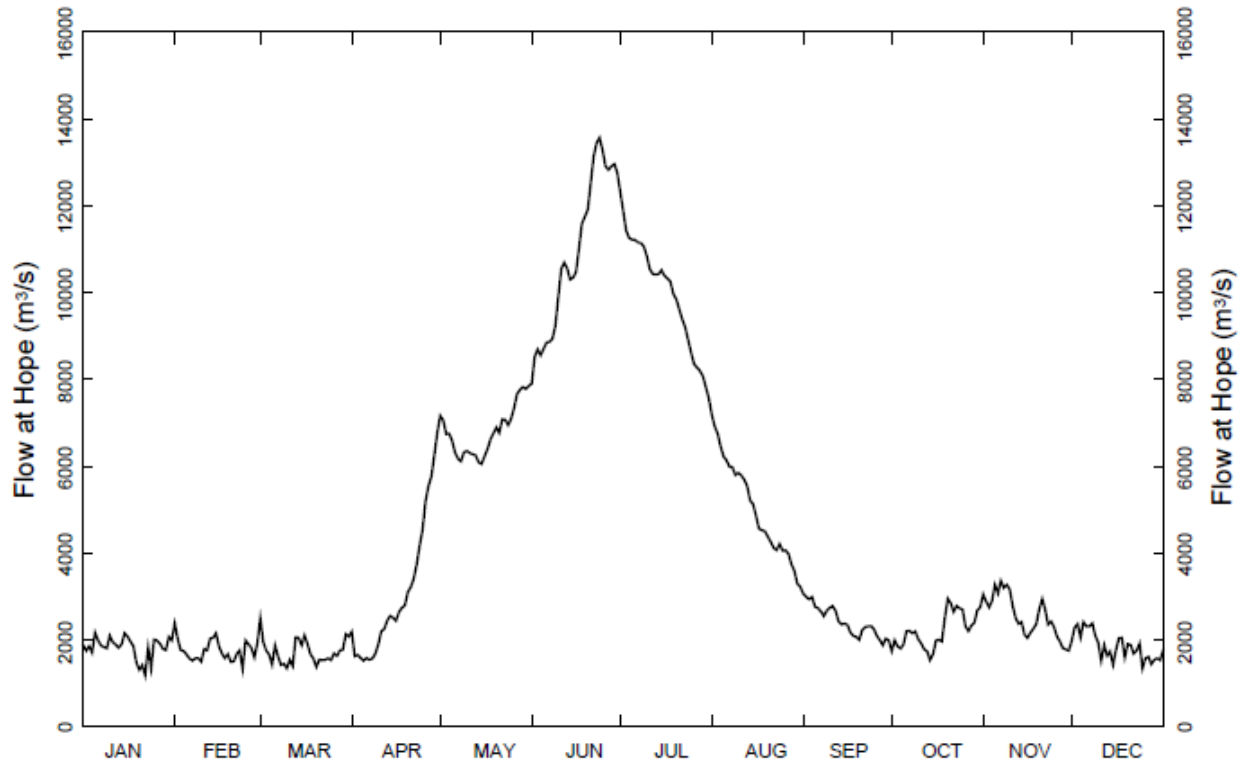


Figure 6-10 2012 Fraser River Daily Flow at Hope (Retrieved from Government of Canada 2014)

Construction work associated with Tunnel removal was assumed to commence in August or September after the Fraser River flow at Hope drops below 5,000 m³/s. In accordance with the Department of Fisheries and Oceans fisheries windows, instream work in the Fraser River estuary is limited to between July 16 and February 28 downstream of the Tunnel, and between June 16 and February 28 upstream of the Tunnel (DFO 2014). However, instream construction work during the summer freshet period (May to July) is generally difficult due to high water levels and velocities. For the trench infilling analysis, the model simulation starts on August 16, 2012 and runs for 210 days. The trench infilling model assumes that Tunnel removal would be instantaneous. Actual Tunnel removal, however, will take place over several months.

For the post-infilling analysis, the model simulation extends from May 26 to July 27, 2012. This represents the time period within the freshet during which Fraser River flows at Hope were greater than 6,000 m³/s (see **Figure 6-10**), an estimated threshold for significant sediment motion in the Fraser River. The freshet period was selected because it is the period when the Fraser River is most active and when most of the sediment transport occurs.

6.5 Sediment Characteristics

The model incorporates transport of suspended bed materials as well as bed load for each scenario. Sediment sizes in the model were based on known characteristics of Fraser River bed materials. Model sediment had a D_{50} (median diameter) of 250 μm and D_{90} (90th percentile diameter) of 450 μm , based on surface samples collected by McLaren and Ren (1995) in the lower Fraser River between February 9 and April 7, 1993.

The van Rijn formula (1993) was used to compute bed load and suspended load transport. This formula distinguishes between sediment transport above or below a reference height: transport below the reference height is treated as bed load transport, and transport above the reference height is treated as suspended load. Sediment is entrained in the water column by imposing a reference concentration at the reference height, which is a function of effective roughness height, dune/ripple height, and water depth.

Equilibrium sediment concentration was prescribed at the upstream model boundary. This modelling approach allows the sediment load entering through the boundary to be near-perfectly adapted to the local flow condition, such that limited accretion or erosion would occur near the model boundary. The daily sediment load (in million cubic metres) prescribed to the SOG/LFR model over the course of the 2012 freshet period is shown in **Figure 6-11**.

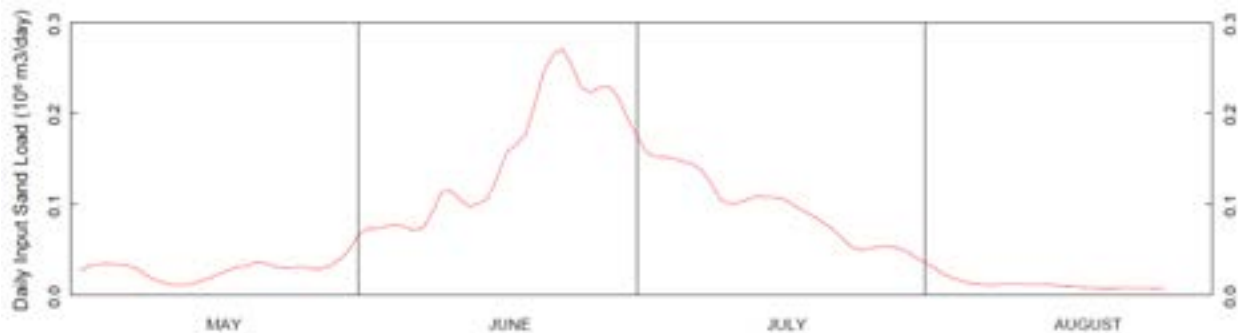


Figure 6-11 SOG/LFR Modelled Daily Input Sand Load

6.6 Calibration and Validation

Model calibration is an iterative process of comparing model results to the actual physical system, and using any discrepancies between the two, along with insights gained, to improve the model. This process is repeated until model accuracy is deemed acceptable. A model that is determined to be an acceptable representation of the real physical system is considered a validated model.

In this study, the hydrodynamic and the morphodynamic components of the models were validated using observed datasets collected from within the LAA, and additional experimental data published in peer-reviewed literature. A brief discussion on model calibration and validation are presented in this section. Further details on the development, calibration, and validation of the numerical models can be found in **Attachment C**.

6.6.1 Hydrodynamics

The hydrodynamic component of the SOG/LFR model was validated by comparing the model results to the following data:

- Observed water levels at Point Atkinson, New Westminster, Steveston, Deas Island Tunnel, and Port Mann Pumping Station
- Discharge, flow split, and velocity measurements from the March 7 and March 27, 2014 ADCP surveys

Overall, the SOG/LFR model reproduced the observed characteristics of the water levels well. The tidal ranges, between the spring and neap tidal cycle, and times of high and low waters, were well reproduced. The computed results generally had slightly lower peaks and higher troughs than the observed data, depending on the tidal conditions. The model was run over a full lunar cycle to capture various tidal ranges. Agreement with the observed water levels at the Tunnel was generally within ± 0.3 m (RMS Error = 0.28 m). Note that the water level and discharge at the Tunnel are strongly influenced by tidal levels and vary rapidly as the tide rises and falls. For example, in March 2014, the observed data at Deas Island show that the water level varied as much as 0.25 m in 15 minutes.

Discharge and velocity data are important for model calibration to confirm whether the model is accurately computing the distribution of flow and to ensure the velocity distribution across the channel is well-represented. The SOG/LFR model results were compared to discharge, flow split, and velocity measurements from the March 7 and March 27, 2014 ADCP surveys. The results show that the model represents the velocity distribution across the various river channels reasonably well. However, it tends to slightly underpredict the magnitude of velocity and discharge compared to the observed data. This discrepancy is likely because the MIKE11 model, from which the upstream boundary conditions for the present model were taken, was calibrated to peak flow conditions, whereas the ADCP measurements were taken during a low freshwater discharge. While the SOG/LFR model slightly underpredicts discharge and velocity compared to the observed values, it does accurately predict the distribution of flow, as a percentage, between the distributary channels near the mouth of the Fraser River. Therefore, the slight underprediction of velocity magnitude and discharge should not limit the utility of the model in comparing existing and proposed conditions.

6.6.2 Morphodynamics

Following the hydrodynamic model validation, the coupled hydrodynamic-morphodynamic model results were compared to experimental results and field data to validate the morphodynamic component of the models. Model validation was divided into two parts. The first part was to demonstrate the ability of the model to predict the migration and infilling of a trench. The modelled results were compared to experimental data from van Rijn (1986). The migration and infilling of the trench, resulting from the Tunnel removal, is one of the key morphodynamic processes present in the LAA. Therefore, the accurate prediction of the trench migration is important in evaluating potential changes due to the Project. The second part of the morphodynamic model validation was to compare the modelled results to measured sediment loads and sedimentation patterns on the lower Fraser River.

Comparison with flume experiments conducted by van Rijn (1986) showed that the model accurately reproduced the trench migration and infilling processes. Van Rijn's experiments observed trench migration and infilling over a range of trench geometries, each of which was well-represented by the model. This demonstrates the robustness of the model and suggests that it can be applied to problems with a range of geometries. The trench resulting from Tunnel removal is expected to have initial side slopes within the range of geometries modelled in this part of the validation. The estimated sediment grain size on the Fraser River is similar to that used in the experiments conducted by van Rijn (1986). While these flume experiments are not necessarily representative of the field conditions in the LAA, the validation shows that the model is in agreement with the theoretical understanding of how an alluvial channel will respond to an excavated trench.

In the second part of the morphodynamic model validation, the model results were compared to observations from the LAA, namely, sediment loads and sedimentation patterns on the lower Fraser River. The model predicted a total sediment input of 15 million tonnes over the 2012 freshet. This estimate falls between the 12.3 million to 31.0 million tonnes/year range estimated by Milliman (1980). The model was run over the 2012 freshet; the modelled sedimentation patterns matched reasonably with the established sedimentation patterns in the lower Fraser River, including the following results:

- Shoaling in the navigation channel in Sand Heads Reach between km 2 and km 4
- Shoaling on the south side of the navigation channel in Sand Heads Reach between km 4 and km 5
- Scour in the Steveston Jetty bend between km 5 and km 7
- Deposition along Steveston Cut between km 7 and km 12

- Scour along Kirkland Island between km 13 and km 14
- Deposition on the outer bend of St. Mungo's Bend between km 27 and km 30
- Deposition at the Fraser Surrey Dock (km 33)

The model morphodynamics were further validated by comparing Port of Vancouver maintenance dredging records with model prediction of the required dredge volumes to meet Port of Vancouver draft requirements. Required maintenance dredging volume was computed by comparing the bed surface elevation at the end of the model simulation to the dredge design grade. In general, the modelled maintenance dredging volumes compared well with the volumes recorded between 2006 and 2012 (**Attachment C: Section 3.1.5.3**).

Overall, the model has demonstrated the ability to replicate the general sedimentation pattern, and to hindcast the annual maintenance dredging in the lower Fraser River, and can be used to evaluate the relative hydraulic and sedimentation changes resulting from the proposed Tunnel decommissioning options.

6.7 Salt Wedge

Salinity was not incorporated in the model analyses; thus, the potential effect of the salt wedge on sediment dynamics (see **Section 4.1.3**) is not represented. However, this is not expected to have a significant effect on model morphodynamics because approximately 80% of sediment discharge in the Fraser River occurs during freshet (Milliman 1980), when the salt wedge is forced to the mouth of the river. The relationship between discharge and sediment load can be better visualized in **Figure 6-12**.

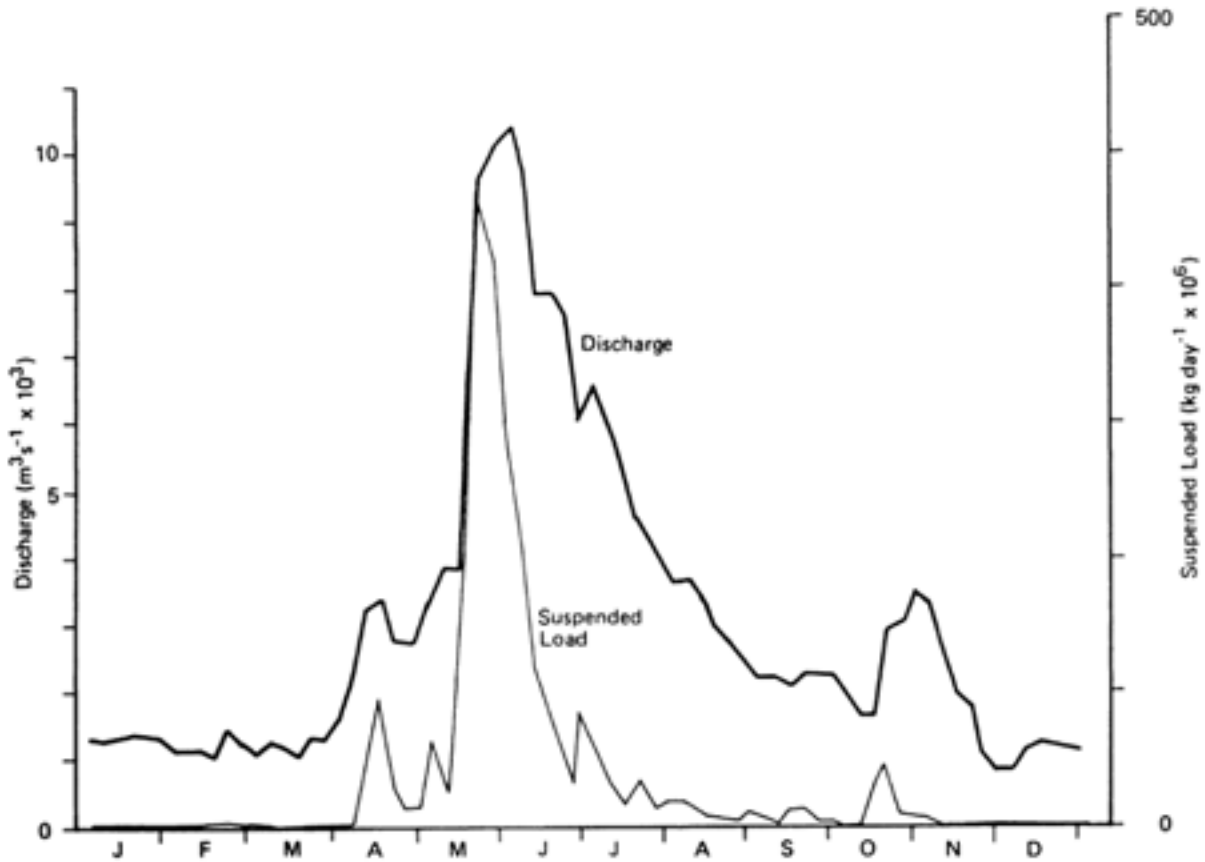


Figure 6-12 Mean daily Discharge and Daily Suspended Sediment Load for the Fraser River at Mission during 1985 (Retrieved from Kostaschuk and Luternauer 1989).

Studies by Ward (1976) and Villard and Church (2003) stated that the salt wedge rarely extends farther than Steveston Bend when the Fraser River flow is greater than $5,000 \text{ m}^3/\text{s}$. **Figure 6-13** shows the 2012 Fraser River flow at Hope and specific conductivity (a function of salinity) measured from Environment Canada Fraser River Water Quality Monitoring Station located about three kilometres upstream of the Tunnel. **Figure 6-13** shows that limited saline water was detected at the buoy when the flows were greater than $4,500 \text{ m}^3/\text{s}$.

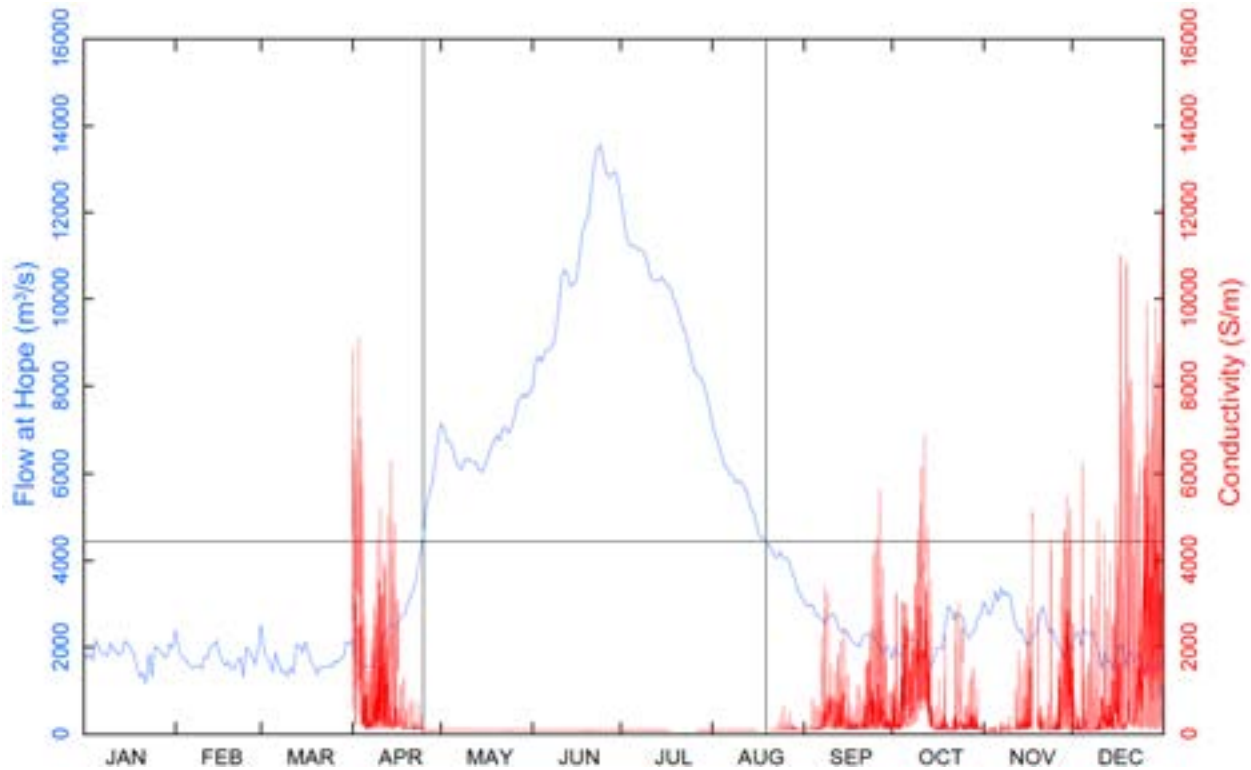


Figure 6-13 2012 Fraser River Flow at Hope (WSC 08MF005) and Water Quality Monitoring Station (Environment Canada)

It is anticipated that the model may underestimate sediment shoaling in the lower reaches between Sand Heads and Steveston Bend where the salt wedge persists during the freshet. Since the Tunnel is approximately 10 km upstream of the Steveston Bend, this simplification is not likely to have a large influence on the modelling results during the freshet period.

During the non-freshet period, when the salt wedge could intrude over 30 km upstream of Sand Heads, the sediment load in the Fraser River is small compared to that during the freshet (**Figure 6-12**), and sediment movement is also small. Therefore, not incorporating salinity into the model analyses is not likely to have any substantial influence on the modelling results during the non-freshet period.

The riverbed profiles shown in **Figure 5-2** and **Figure 5-3** and show the Tunnel is several meters lower than the bed downstream (km 15) and upstream (km 19). Therefore, temporary lowering of the bed levels by one to three metres at the Tunnel is not likely to influence the maximum distance of salt wedge intrusion. Results of hydrodynamic modelling, as discussed in detail in **Section 16.7** of the Application, indicates that the proposed removal of the Tunnel will not affect the behaviour of the salt wedge.

7.0 Model Simulation Results

7.1 Existing Conditions during Low Flow Period

Existing conditions were modelled for the period of August 16 - November 14, 2012 (the low flow period) as a basis for comparison with the trench infilling scenario during the same time period. The results are presented below.

7.1.1 Hydrodynamics

7.1.1.1 Current Velocities

Local velocities for the existing condition near the time of maximum ebb tide on August 16, 2012 (day one of the assumed Tunnel removal work) were examined using the No.5 Road model.

Modelled surface velocities (**Figure 7-1**) were generally highest on the right side of the channel and in the zone of flow acceleration over the Tunnel. Surface velocities in the middle of the navigation channel upstream, on top of, and downstream of the Tunnel are 1.5, 1.7, and 1.6 m/s, respectively. Similar flow acceleration is also predicted over the Lulu Island–Delta water main downstream.

Closer to the river bed at -12 m GD elevation, predicted velocities (**Figure 7-2**) were highest in the zones of acceleration over the Tunnel, and downstream Lulu Island–Delta water main crossing. Upstream of the Tunnel, maximum velocities of 1.4 m/s were predicted on the right (north) side of the channel. Downstream of the Tunnel, the maximum velocity was similar in magnitude but more evenly distributed across the channel. This is probably due to a combination of bathymetric variations (the channel is deepest on the right side downstream of the Tunnel) and acceleration of near-bed flows over the sill formed by the Tunnel.

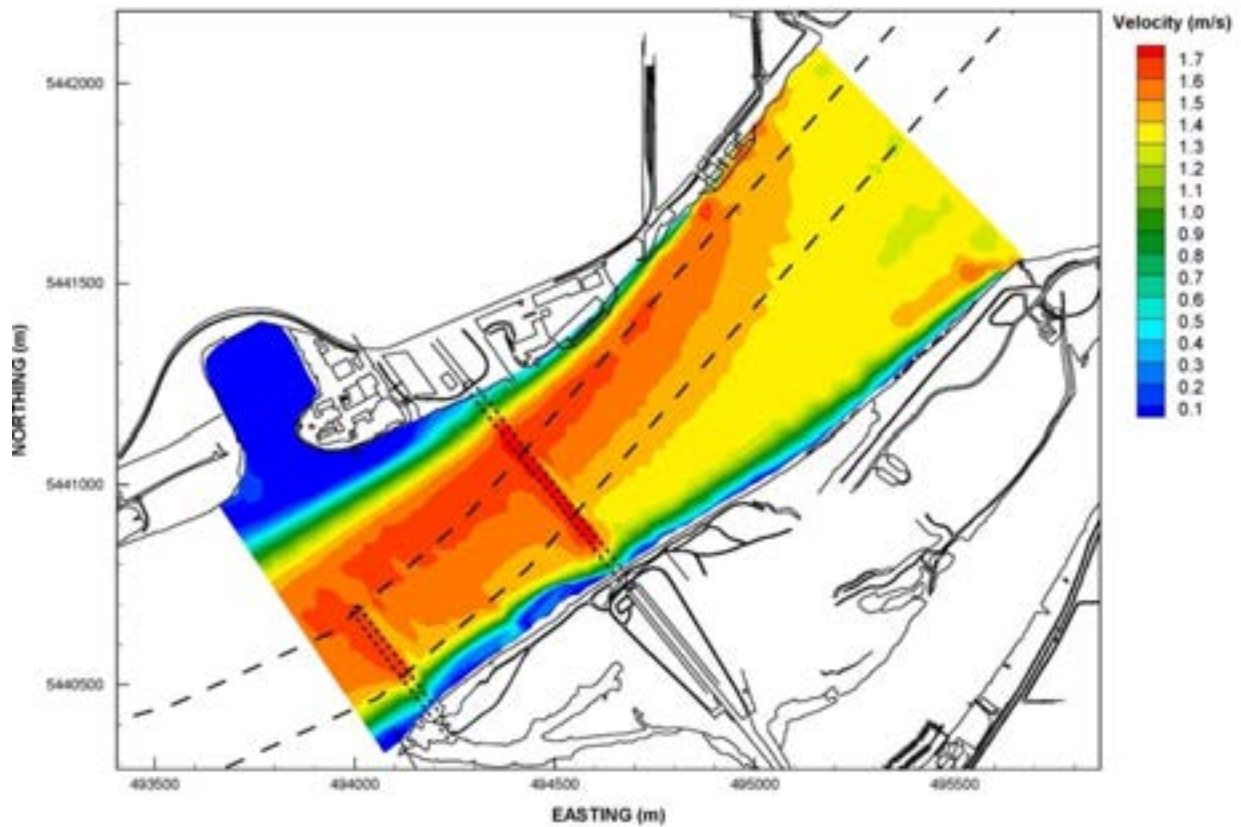


Figure 7-1 Modelled Surface Velocity Distribution under Existing Conditions, August 16, 2012.

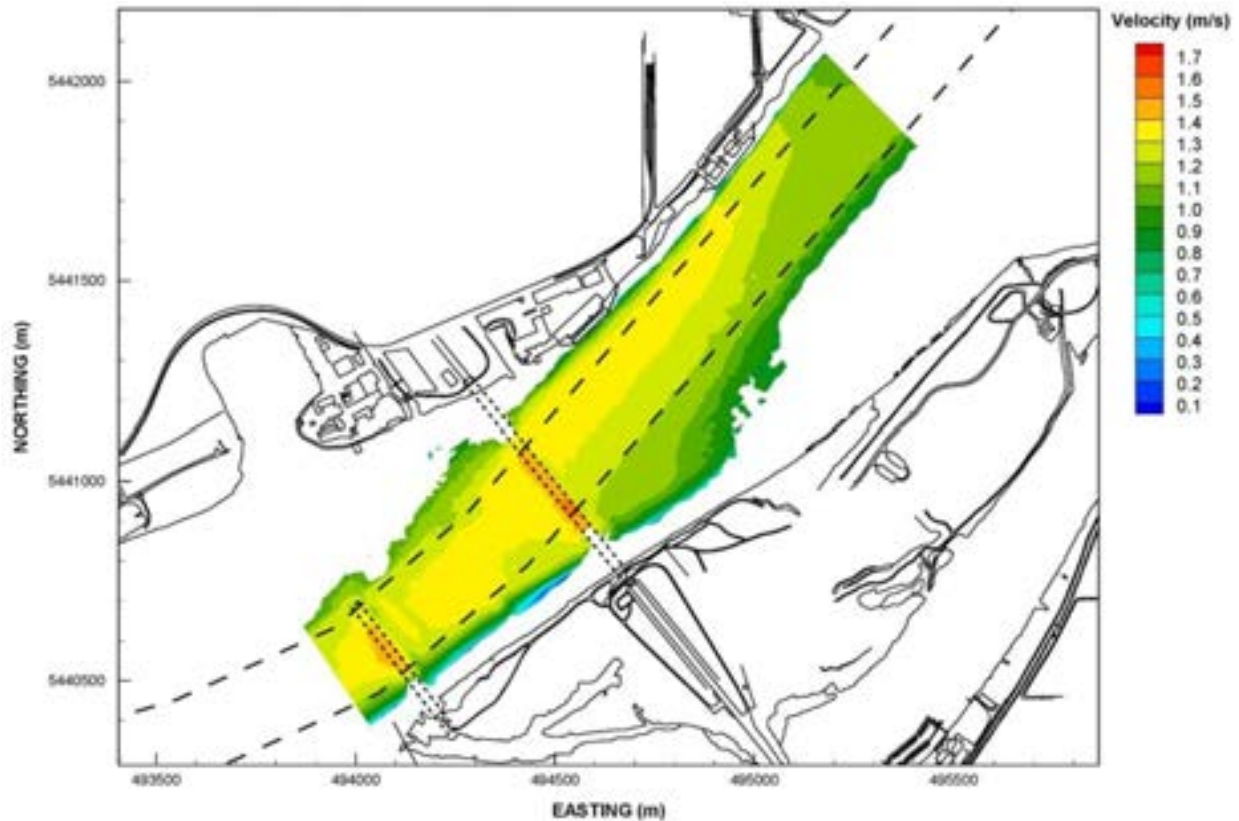


Figure 7-2 Modelled Near-bed Velocity Distribution (elevation -12 m GD) under Existing Conditions, August 16, 2012.

7.1.1.2 Water Levels

For comparison with the far-field Tunnel removal options, hourly water levels at several locations upstream and downstream of the Tunnel (**Figure 7-3**) were extracted from the SOG/LFR model for the existing conditions on August 16, 2012. The minimum and maximum modelled water levels at these locations are summarized in **Table 7-1**.

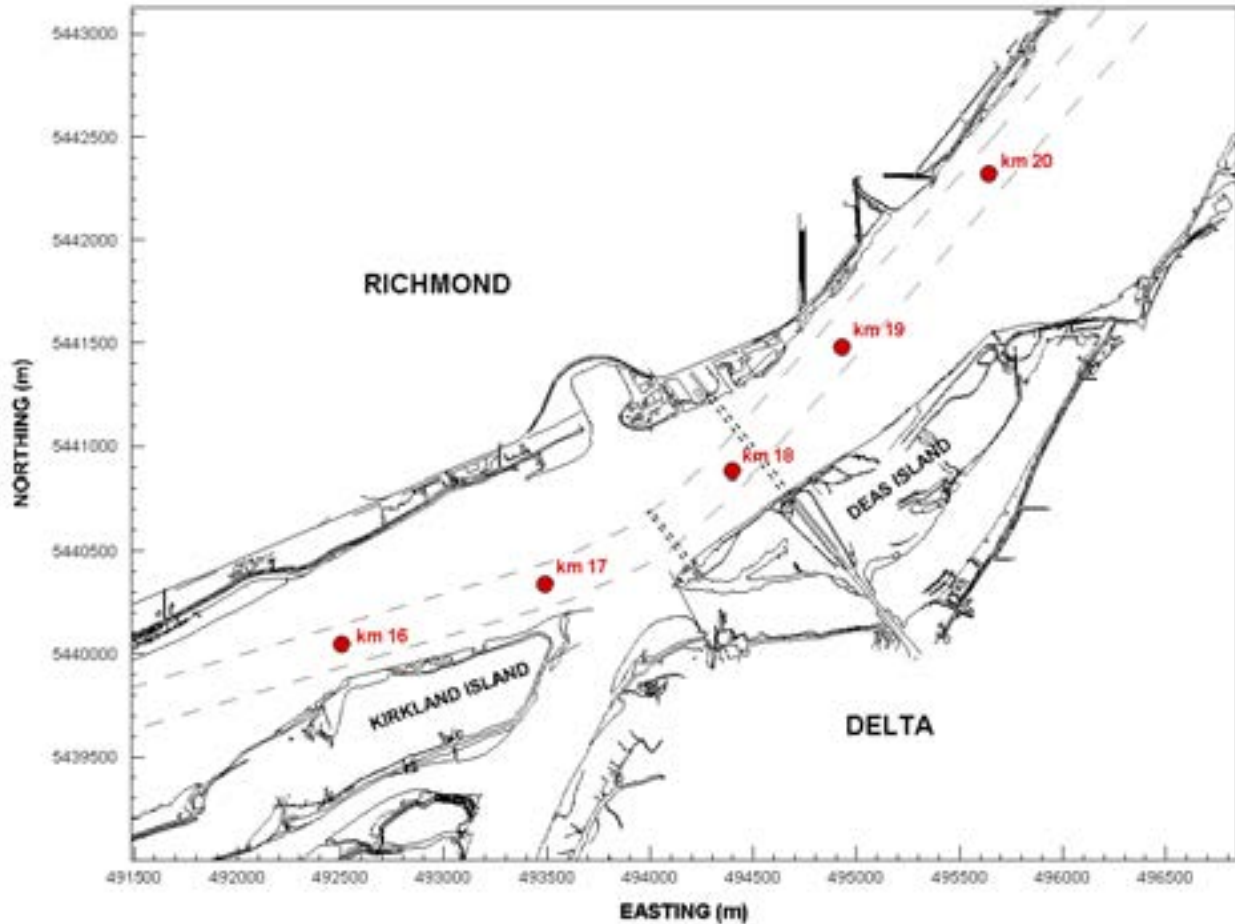


Figure 7-3 Stations Upstream and Downstream of the Tunnel where Water Level Analyses were Conducted.

Table 7-1 Modelled non-freshet water level statistics for August 16, 2012

| Station | Maximum Water Level (m GD) | Minimum Water Level (m GD) |
|---------|----------------------------|----------------------------|
| km 16 | 1.29 | -1.60 |
| km 17 | 1.30 | -1.55 |
| km 18 | 1.30 | -1.53 |
| km 19 | 1.30 | -1.50 |
| km 20 | 1.31 | -1.48 |

Near-field water levels for the existing conditions were extracted from the No.5 Road model for comparison with local water levels in the Tunnel removal options. The low-flow hydraulic analysis was based on the king tide event that occurred on December 16, 2012. The Fraser River flow at Hope on this date was 1,770 m³/s, a typical Fraser River flow during the winter period. The water level at the Tunnel during this period is shown on **Figure 7-4**.

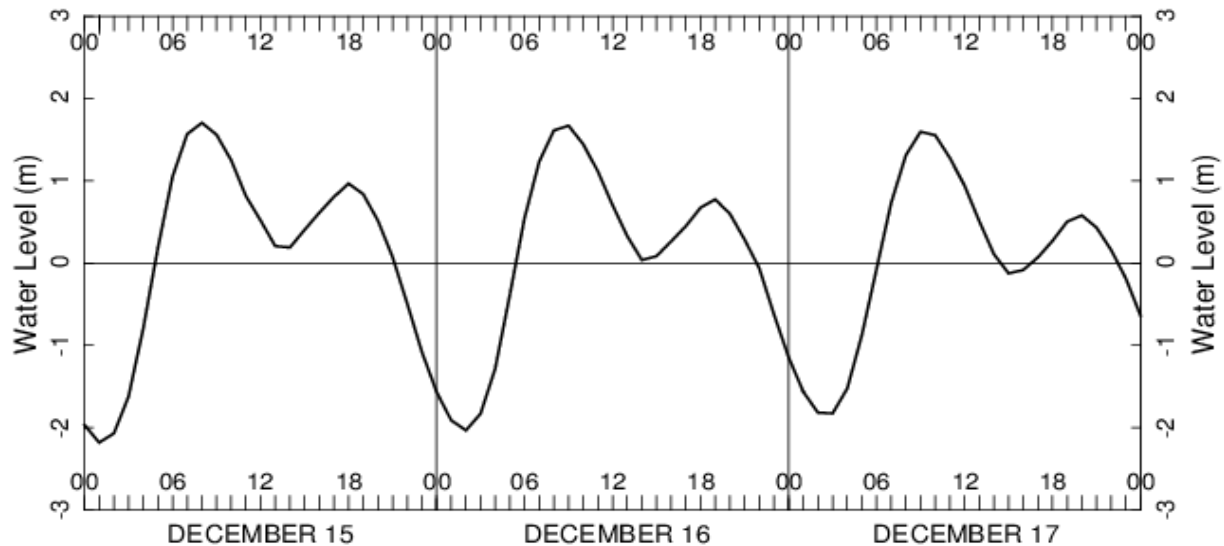


Figure 7-4 Modelled Water Level (m GD) at the Tunnel during the Period from December 15 to 17, 2012.

Modelled current velocity distribution at maximum ebb and maximum flood conditions for June 23 and December 16, 2012 were first evaluated. The results indicate that the hydraulic condition under which Tunnel removal will likely have the greatest changes is the freshet ebb tide. Consequently, only results from the freshet ebb tide condition (i.e., 13:00 on June 23) are presented for the hydrodynamic assessment. Further details on other hydrodynamic conditions (i.e., freshet flood tide, non-freshet ebb tide, and non-freshet flood tide) are presented in **Attachment C**.

7.1.1.3 Flow Split

Flow splits between Woodward Reach and Ladner Reach were calculated from the SOG/LFR model for existing conditions at maximum ebb (at 12:00) and maximum flood (at 18:00) tides on August 16, 2012 (**Table 7-2**).

Table 7-2 Modelled Flow Splits on August 16, 2012

| Condition | Woodward Reach | Ladner Reach |
|------------------|-----------------------|---------------------|
| Ebb tide | 93% | 7% |
| Flood tide | 95% | 5% |

7.1.2 Morphodynamics

Bed evolution under existing conditions was modelled using the No.5 Road model over the period of August 16 to November 14, 2012 for comparison with the Tunnel removal options.

Figure 7-5 shows the modelled bed elevations at the end of the simulation. In general, the modelled sedimentation pattern matches reasonably with the established sedimentation patterns in this part of the lower Fraser River, including:

- Minimal deposition in the navigation channel
- Shoaling on the left bank upstream of the Tunnel
- Shoaling on the right bank downstream of the Tunnel in front of Deas Dock
- Erosion downstream of the Tunnel and the Lulu Island–Delta water main

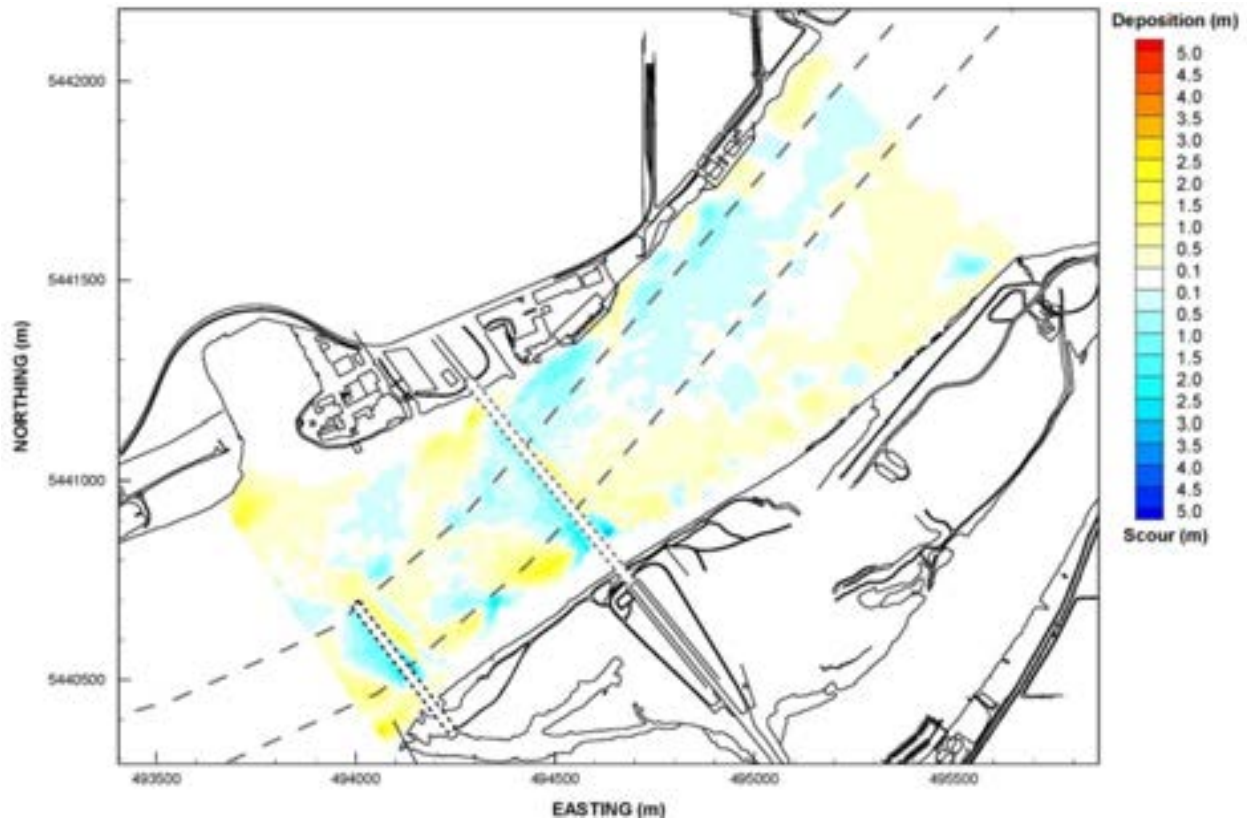


Figure 7-5 Modelled Morphodynamic Evolution under Existing Conditions – Trench Infilling

The model predicts erosion upstream of the Tunnel and the Lulu Island–Delta water main, primarily outside of the navigation channel. From the bathymetry survey, it appears that erosion also occurs upstream of the Tunnel within the navigation channel. The model mesh size (5 m) may be too large to resolve the local hydraulic effect that induces erosion immediately upstream of these two crossings. A finer model might better reproduce this process but would require excessive computation time. The model demonstrates the ability to replicate the general sedimentation pattern and can be used to evaluate the relative hydraulic and sedimentation changes due to Tunnel removal.

7.2 Existing Conditions during Freshet

Existing conditions were modelled for the period of May 26 - July 27, 2012 (freshet) as a basis for comparison with the post-infilling scenario during the same time period. The results are described below.

7.2.1 Hydrodynamics

The freshet hydrodynamic analysis was based on a tide occurring on June 23, 2012 when the Fraser River flow at Hope was close to its peak discharge value of 13,500 m³/s.

7.2.1.1 Current Velocities

Current velocities were extracted from the No.5 Road model at maximum ebb tide, about 13:00 on June 23, 2012. Surface and near-bed velocities showed similar patterns as the low flow simulation (**Section 7.1.1**); however, currents were generally faster for the freshet. Maximum predicted surface velocities were highest on the right side of the channel and in the zone of flow acceleration over the Tunnel (**Figure 7-6**). Surface velocities in the middle of the navigation channel upstream, on top of, and downstream of the Tunnel are 2.2, 2.6, and 2.5 m/s, respectively. A similar acceleration is also predicted over the Lulu Island–Delta water main downstream of the Tunnel.

Closer to the river bed at -12 m GD elevation, predicted velocities (**Figure 7-7**) are highest in the zones of acceleration over the Tunnel and downstream of Lulu Island–Delta water crossings. Predicted velocities upstream, on top of, and downstream of the Tunnel are 1.9, 2.3, and 2.1 m/s, respectively. Upstream of the Tunnel, maximum velocities of 2.3 m/s are predicted on the right side of the channel. Downstream of the Tunnel, the maximum velocity is similar in magnitude but more evenly distributed across the channel. This is probably due to a combination of bathymetric variations (the channel is deepest on the right side downstream of the Tunnel) and acceleration of near-bed flows over the sill formed by the Tunnel.

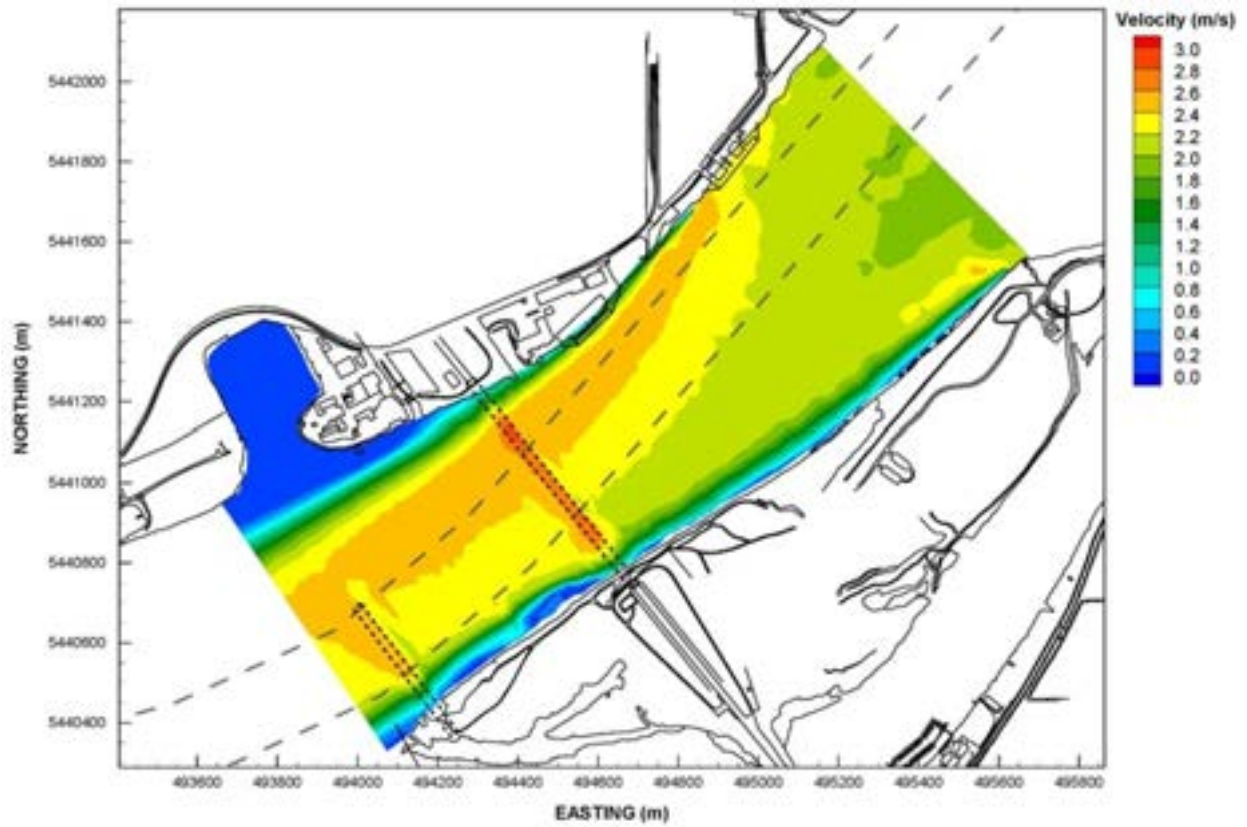


Figure 7-6 Modelled Surface Velocity Distribution under Existing Conditions, Ebb Tide June 23, 2012.

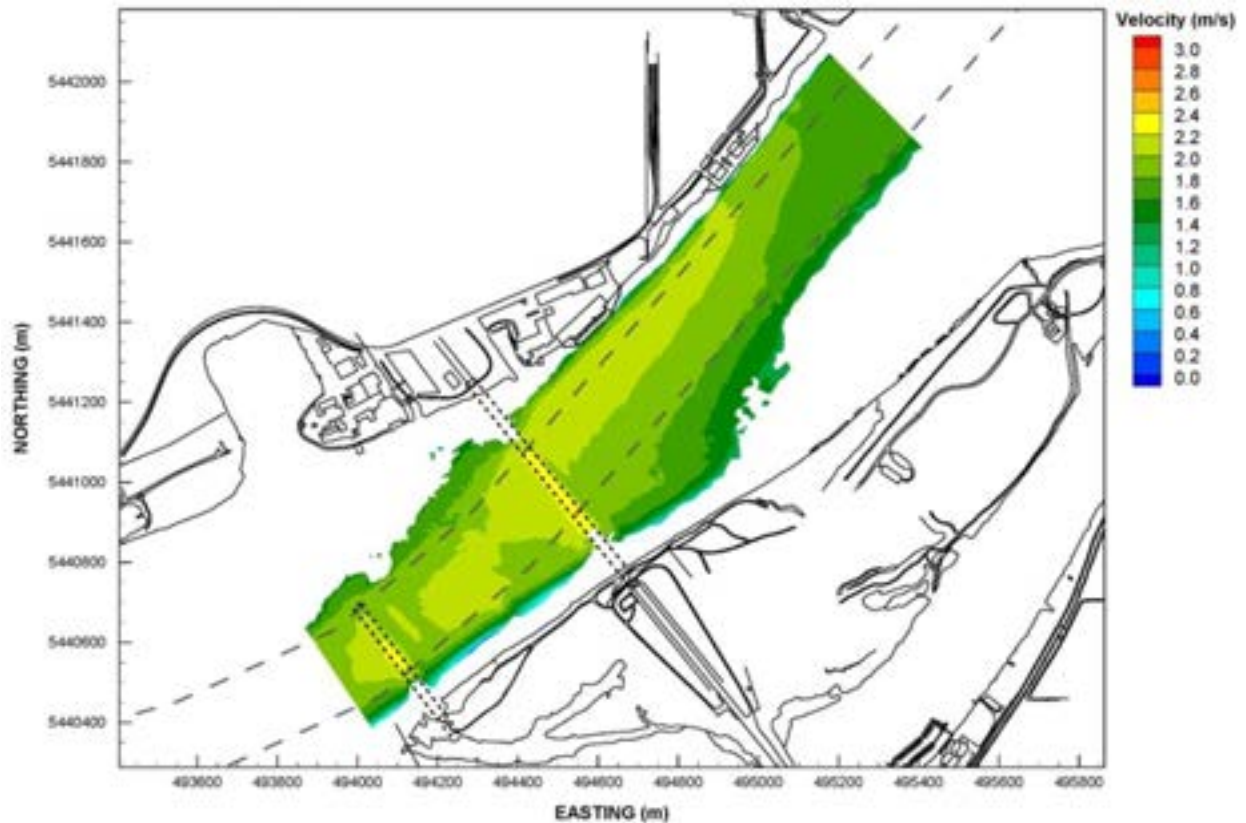


Figure 7-7 Modelled Velocity Distribution at -12 m GD Elevation under Existing Conditions, Ebb Tide June 23, 2012.

7.2.1.2 Water Levels

For comparison with the far-field Tunnel removal options, hourly water levels at several stations upstream and downstream of the Tunnel (**Figure 7-3**) were extracted from the SOG/LFR model over the period from June 22 to June 24, 2012. The maximum and minimum modelled water levels at these stations are summarized in **Table 7-3**.

Table 7-3 Modelled Minimum and Maximum Water Levels under Existing Conditions for June 22 to June 24, 2012

| Station | Maximum Water Level (m GD) | Minimum Water Level (m GD) |
|---------|----------------------------|----------------------------|
| km 16 | 1.608 | -1.141 |
| km 17 | 1.632 | -1.037 |
| km 18 | 1.633 | -0.995 |
| km 19 | 1.647 | -0.949 |
| km 20 | 1.671 | -0.876 |

Near-field water levels for the existing conditions were extracted from the No.5 Road model for comparison with local water levels in the Tunnel removal options. The modelled water levels at the Tunnel during the 2012 freshet peak period are shown in **Figure 7-8**.

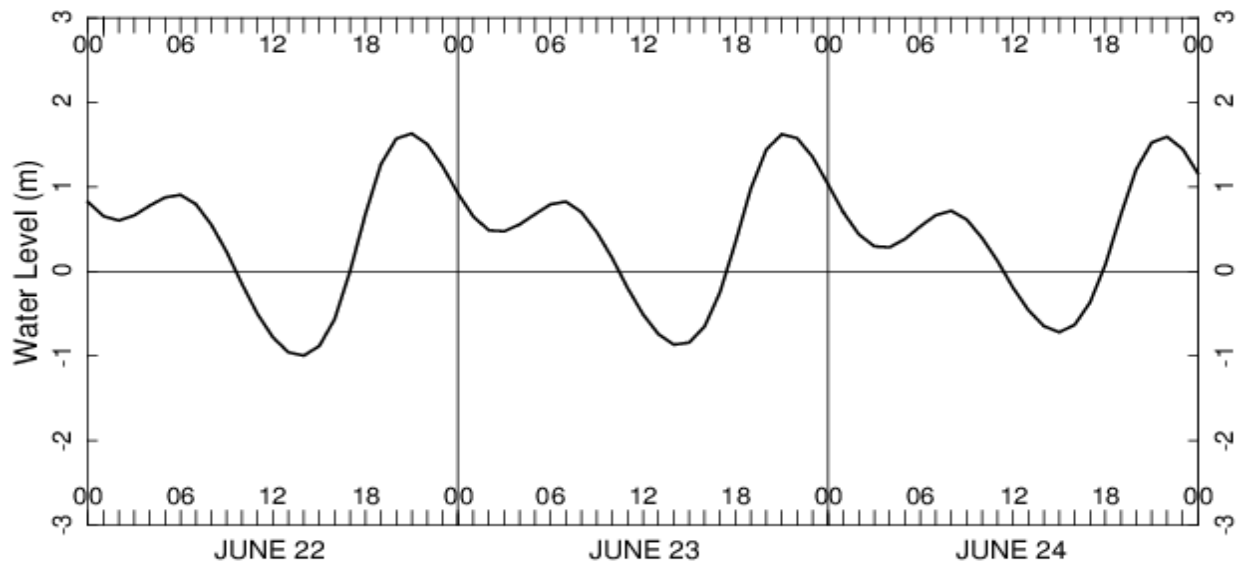


Figure 7-8 Modelled Water Level (m GD) at the Tunnel during the Period from June 22 to June 24, 2012

7.2.1.3 Flow Splits

Flow split between the Fraser River South Arm and Ladner Reach were calculated from the SOG/LFR model for conditions at maximum ebb (at 3:00) and maximum flood (at 20:00) on June 23, 2012. These are summarized in **Table 7-4**.

Table 7-4 Flow splits under existing conditions on June 23, 2012

| Condition | South Arm | Ladner Reach |
|------------|-----------|--------------|
| Ebb tide | 94% | 6% |
| Flood tide | 88% | 12% |

7.2.2 Morphodynamics

Bed evolution under existing conditions was modelled using the No.5 Road model over the freshet period for comparison with Tunnel removal options. **Figure 7-9** shows the modelled sedimentation pattern at the end of the simulation.

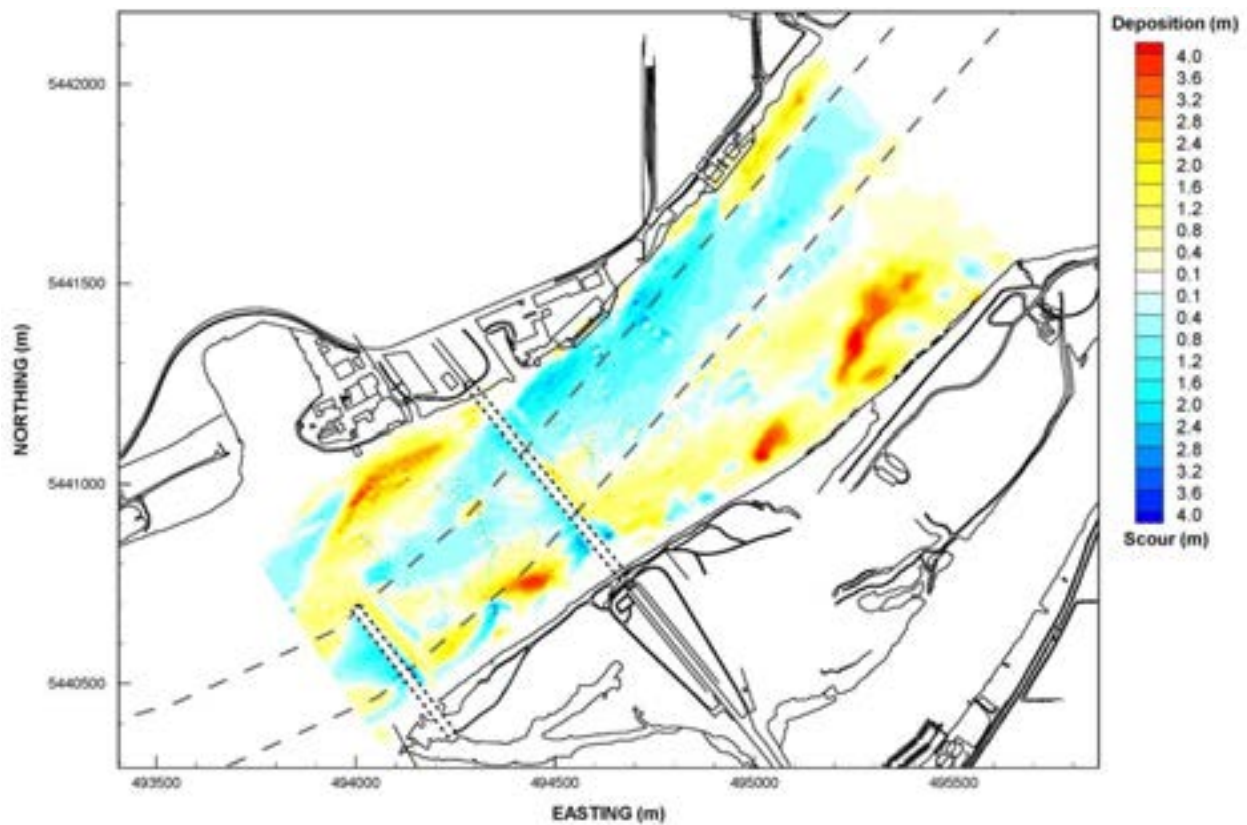


Figure 7-9 Modelled Local Morphodynamic Evolution under Existing Conditions Over the 2012 Freshet

Similar to the findings from the low-flow model results for the existing conditions (**Figure 7-5**), the modelled sedimentation pattern matched reasonably with the established sedimentation patterns in this part of the lower Fraser River. The key difference between the low-flow and freshet simulations is that the magnitudes of sediment scour and deposition are greater over the freshet period than over the non-freshet period.

Far-field bed evolution over the freshet period under existing conditions was investigated using the SOG/LFR model. **Figure 7-10** shows the modelled sedimentation pattern from the SOG/LFR model at the end of the simulation period. As discussed in **Section 6.6.2**, the hindcast sedimentation pattern matches reasonably well with the established sedimentation patterns in the lower Fraser River.

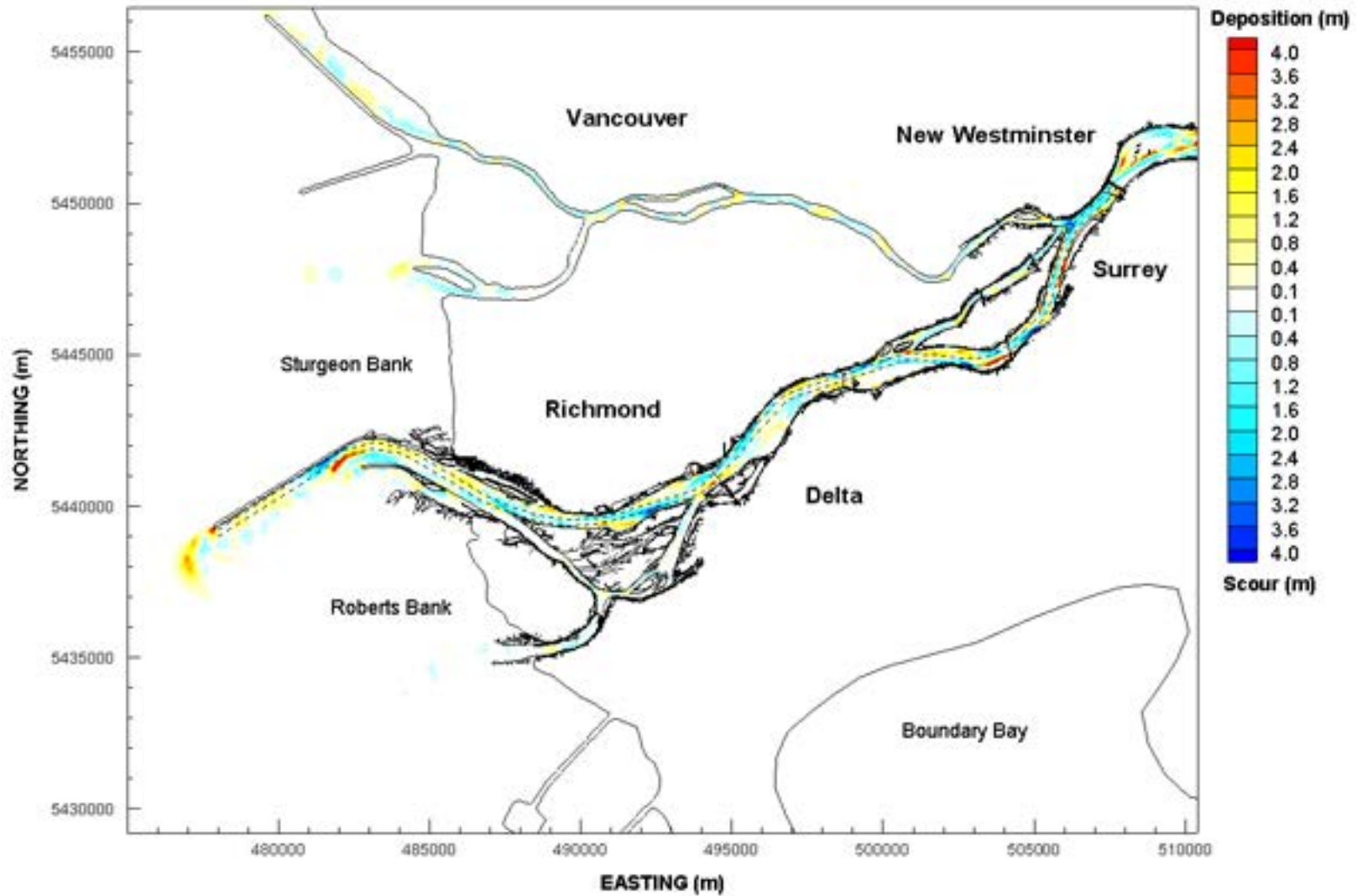


Figure 7-10 Modelled Morphodynamic Evolution under Existing Conditions During the 2012 Freshet

7.3 Trench Infilling Scenario

The trench infilling model examines the short-term channel response to Tunnel removal, assuming the trench is not backfilled. The model simulation is based on Fraser River flows and tidal water levels from the low flow period August 16 to November 14, 2012. Model results for full and partial Tunnel removal conditions are very similar, as expected based on their similar geometry (see **Section 6.3.2**). Therefore, only the full Tunnel removal condition is presented here since the results are also applicable to the partial Tunnel removal condition.

7.3.1 Hydrodynamics

7.3.1.1 Current Velocities

Current velocities near the time of maximum ebb tide on August 16 (day one of the Tunnel removal in the model) for the full Tunnel removal condition were extracted from the No.5 Road model. When the Tunnel is removed from the riverbed, flow is expected to decelerate over the deeper trench region. Immediately after the Tunnel is removed, the predicted surface velocity over the trench was about 1.2 m/s (**Figure 7-11**), approximately 0.5 m/s less than for the existing low-flow condition. The general pattern is similar to the existing condition, with maximum velocities on the right side of the channel.

Overall, near-bed velocities exhibit a smaller decrease than surface velocities. Predicted maximum velocity at -12 m GD elevation is approximately 1.6 m/s, occurring immediately upstream and downstream of the trench, near the right bank (**Figure 7-12**). In contrast with the existing low-flow condition, the maximum velocity occurs directly upstream and downstream of the trench, near the right bank. Velocities over the trench decreased markedly in comparison with the accelerating flow predicted for the existing condition, to around 1.0 m/s. Velocities downstream of the trench also decrease slightly to about 1.3 m/s.

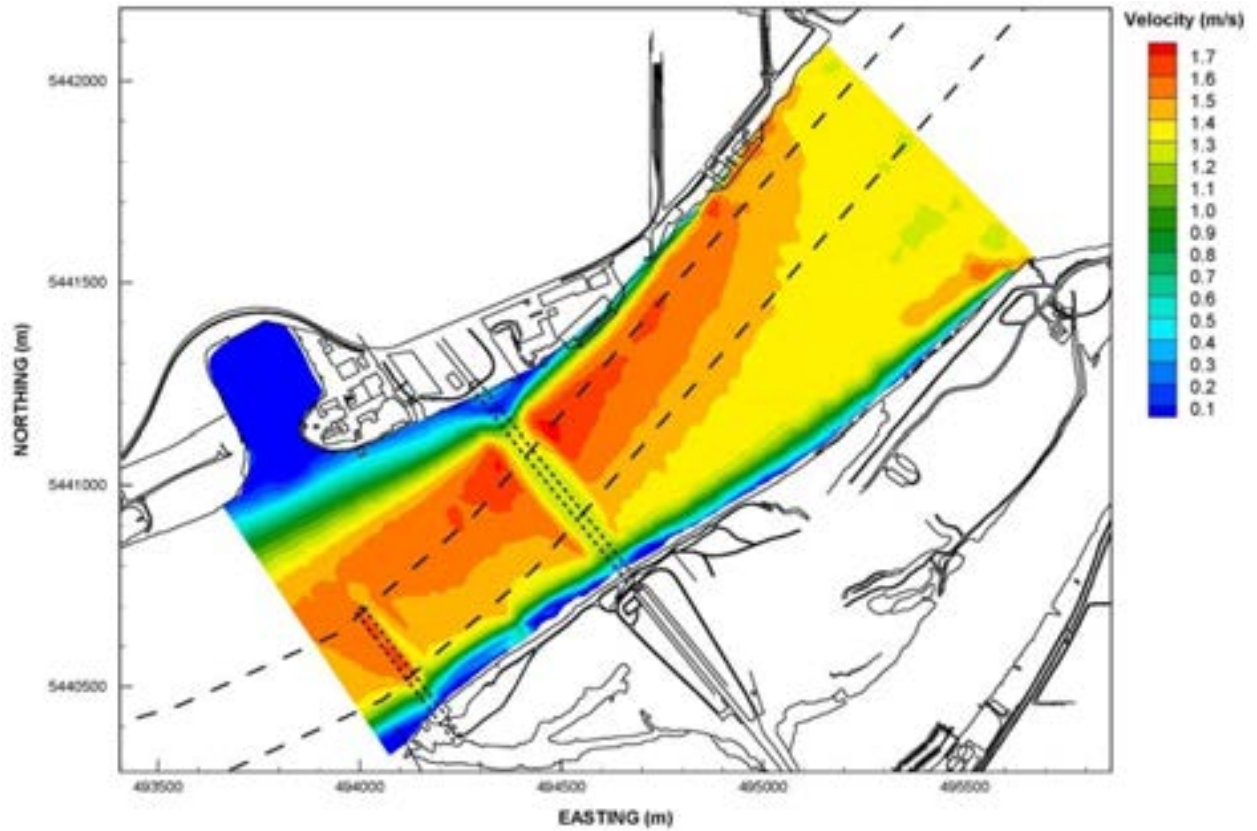


Figure 7-11 Modelled Surface Velocity Distribution Immediately after the Tunnel is Removed, August 16, 2012.

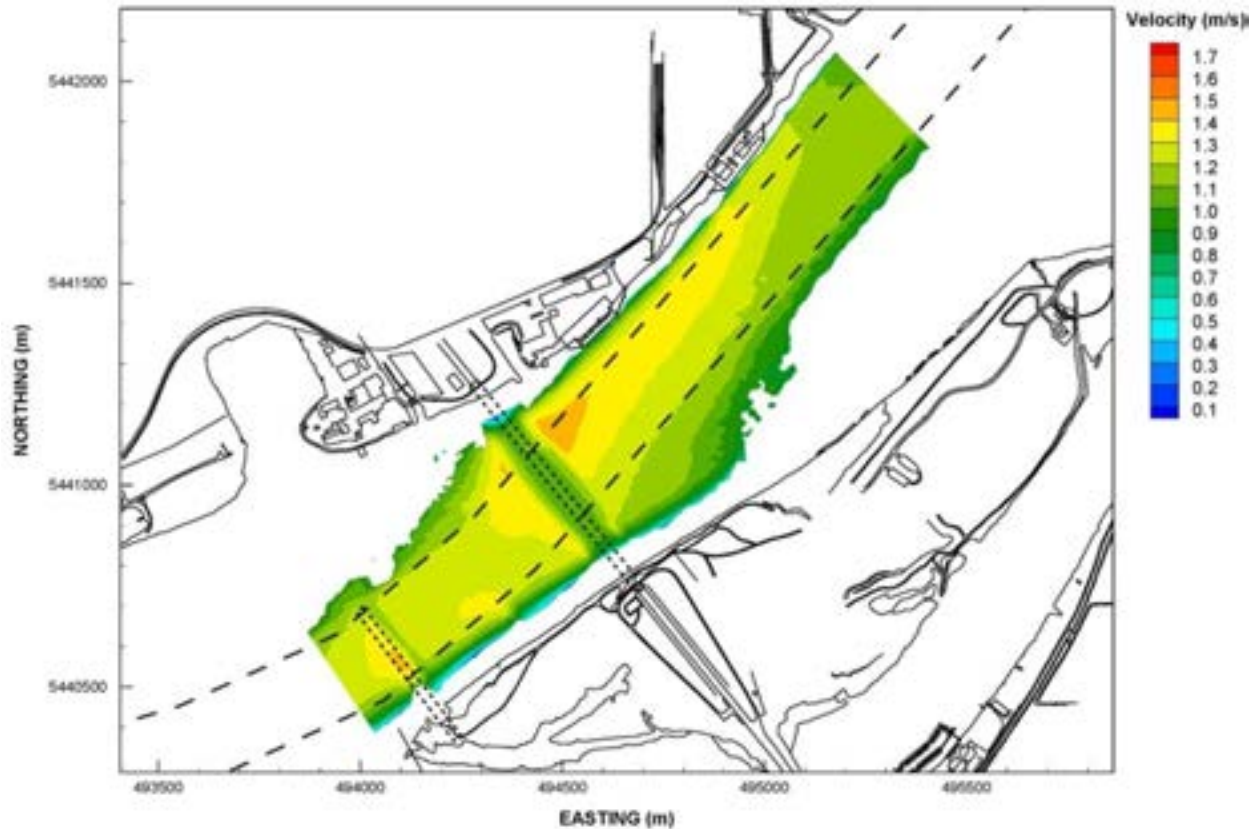


Figure 7-12 Modelled Near-bed Velocity Distribution at -12 m GD Immediately after the Tunnel is Removed, August 16, 2012

7.3.1.2 Water Levels

Hourly water levels at several stations upstream and downstream of the Tunnel (**Figure 7-3**) were extracted from the SOG/LFR model over August 16, 2012. The maximum and minimum modelled water levels at these stations are summarized in **Table 7-5**.

Table 7-5 Modelled Non-freshet Water Level Statistics for August 16, 2012

| Station | Maximum Water Level (m GD) | | | Minimum Water Level (m GD) | | |
|---------|----------------------------|---------------------|------------|----------------------------|---------------------|------------|
| | Existing | Full Tunnel Removal | Difference | Existing | Full Tunnel Removal | Difference |
| km 16 | 1.29 | 1.30 | 0.01 | -1.60 | -1.60 | - |
| km 17 | 1.30 | 1.30 | - | -1.55 | -1.56 | -0.01 |
| km 18 | 1.30 | 1.30 | 0.00 | -1.53 | -1.54 | -0.01 |
| km 19 | 1.30 | 1.31 | 0.01 | -1.50 | -1.50 | - |
| km 20 | 1.31 | 1.31 | - | -1.48 | -1.48 | - |

The predicted changes in water level for the trench infilling simulation are within the range of model uncertainty and considered negligible. As such, Tunnel removal is not expected to produce a substantial change in water levels during the low-flow period prior to trench infilling.

7.3.1.3 Flow Splits

Flow splits between Woodward Reach and Ladner Reach were calculated for the maximum ebb (at 12:00) and maximum flood (at 18:00) conditions on August 16, and are summarized in **Table 7-6**.

Table 7-6 Modelled Flow Splits on August 16, 2012

| Condition | Existing | | Full Tunnel Removal | | % Difference | |
|------------|----------------|--------------|---------------------|--------------|----------------|--------------|
| | Woodward Reach | Ladner Reach | Woodward Reach | Ladner Reach | Woodward Reach | Ladner Reach |
| Ebb tide | 93% | 7% | 94% | 6% | +1 | -1 |
| Flood tide | 95% | 5% | 95% | 5% | - | - |

The predicted difference in flow splits for the low-flow period prior to trench infilling is within the range of natural variability and considered negligible. On this basis, the removal of the Tunnel is not expected to affect the flow split between Woodward Reach and Ladner Reach.

To evaluate potential changes in flow direction due to the Tunnel removal, the modelled depth-averaged velocities for (a) existing conditions and (b) conditions under full Tunnel removal for March 27, 2014 at 09:10 were compared against each other (**Figure 7-13 a and b**) and against ADCP measurements collected at the same date and time.

Tunnel removal reduces the velocity magnitude in the immediate vicinity of the excavation, but does not noticeably change the flow direction due to Tunnel removal. ADCP measurements also showed that near-bed flow direction at the Tunnel is similar to surface flow direction (**Figure 4-2**). The modelled flow splits and velocities, in combination with ADCP results indicate that Tunnel removal will not result in changes to flow patterns or increased flow into Ladner Reach.

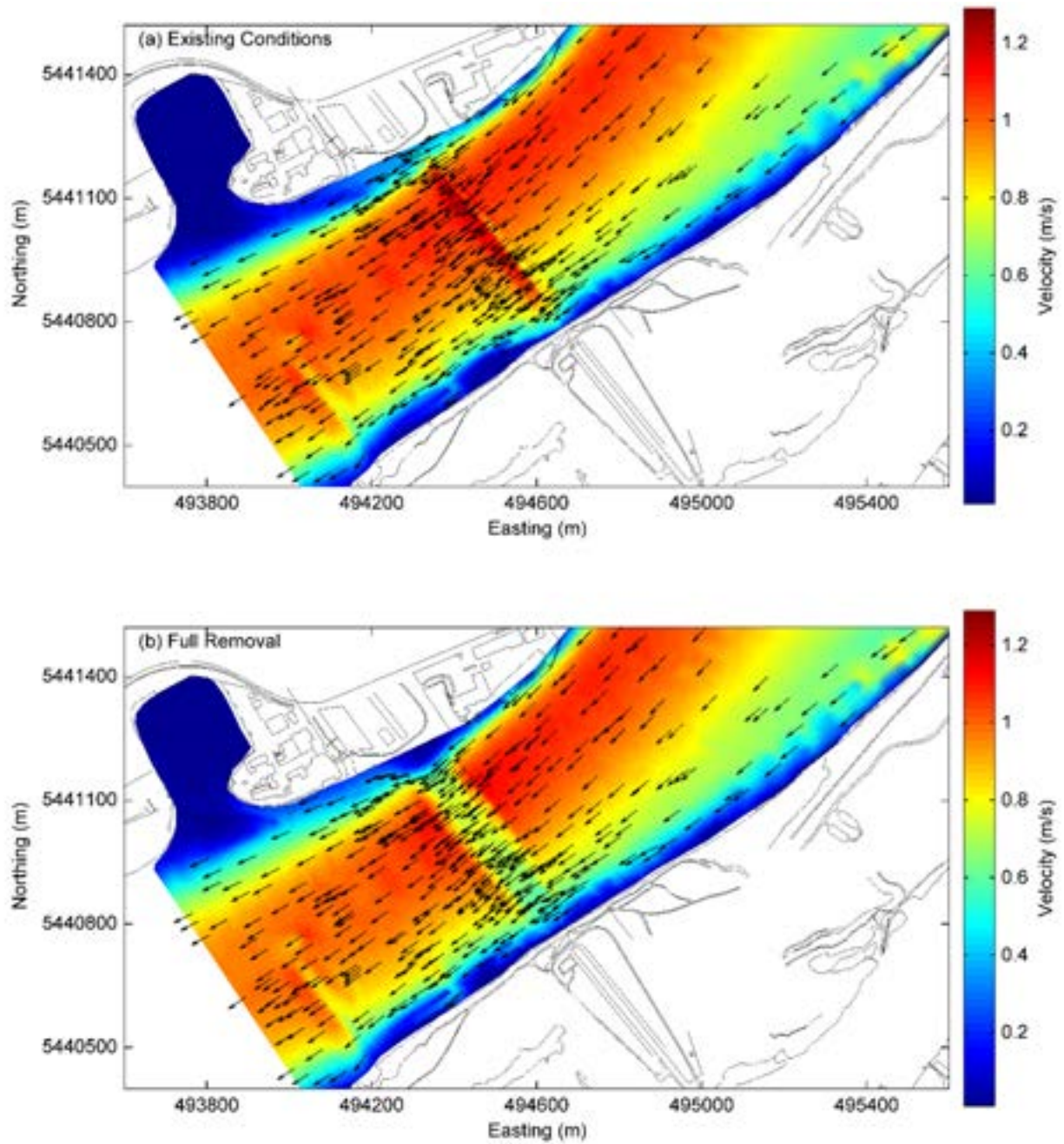


Figure 7-13 Modelled Depth-averaged Velocities under (a) Existing Conditions and (b) Conditions with Full Tunnel Removal, for March 27, 2014 at 09:10 (PST).

7.3.2 Morphodynamics

The model results show that, as the flow decelerates over the deeper trench region, sediment is deposited (**Figure 7-14** and **Figure 7-15**). Nearly complete infilling of the trench is predicted by the model over the course of the 210 day simulation. More sediment tends to deposit on the north side of the trench, where faster velocities likely carry more sediment in the water column than does the flow on the south side, before reaching the trench. At the downstream edge of the trench, the model predicts that sediment is entrained by the accelerating flow, and that the trench migrates downstream. This process is illustrated in **Figure 7-16**, which shows a time-series of the bed profile along the centreline of the navigation channel under the conditions of full Tunnel removal.

As shown on **Figure 7-16**, after 210 days of simulation, the trench has mostly filled in, but temporary bed lowering of one to two metres in the region between the Tunnel and the Lulu Island–Delta water main occurs. The magnitude of lowering is about one metre greater than the general bed lowering predicted under existing conditions over the same period. The figure also shows deposition in a localized region directly upstream of the Lulu Island–Delta water main. The bathymetric survey conducted in April 2014 showed considerable scour in this area, concentrated within approximately 25 m of the water main alignment. Previous work by NHC suggests the scour upstream of the Lulu-Delta water main may be a seasonal phenomenon, wherein upstream flow driven by large winter tides results in scour on the lee (upstream) side of the apron, and the scoured area is then filled in during freshet, when bedload is high and flow reversals do not occur (NHC 2015). If this is the case, the model would be expected to fill in the scoured region based on flow conditions and sediment load during freshet.

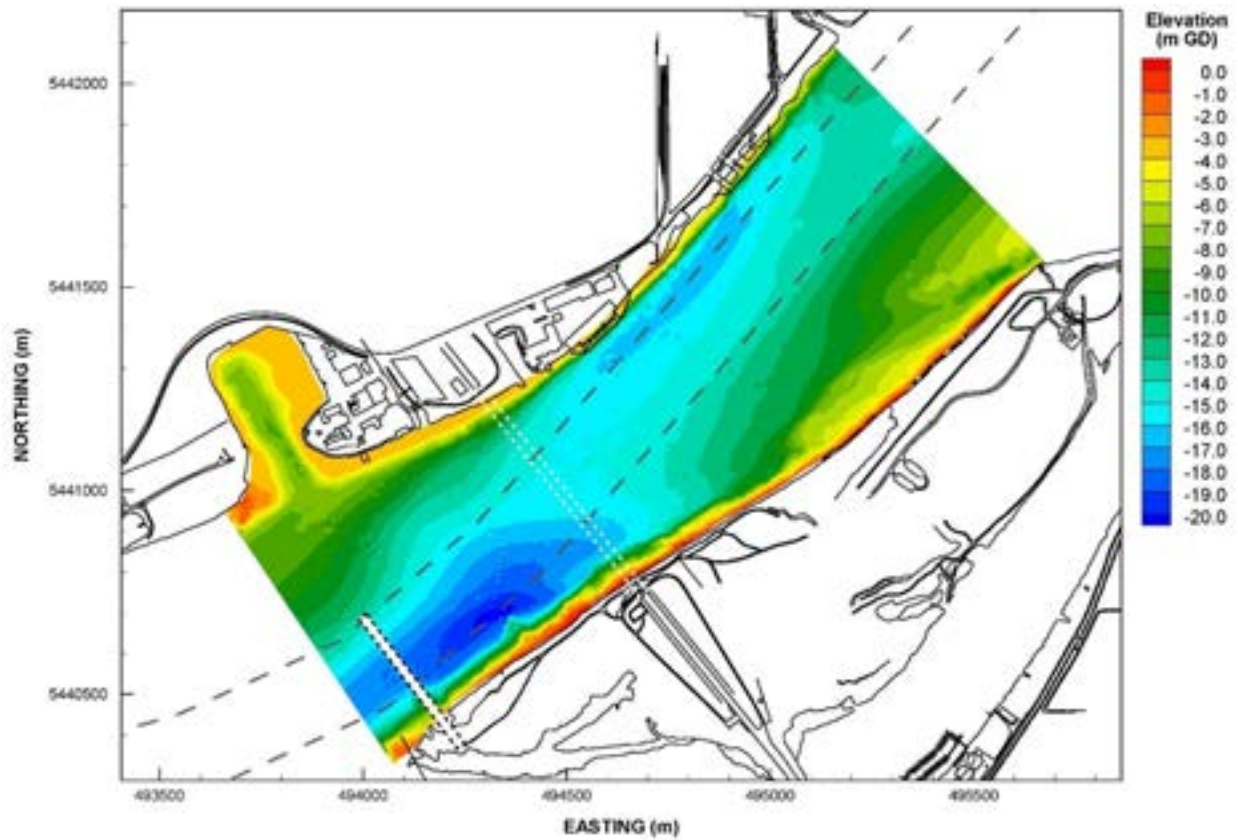


Figure 7-14 Bed Elevation after 210 Simulation Days Under Full Tunnel Removal Conditions with Trench Infilling

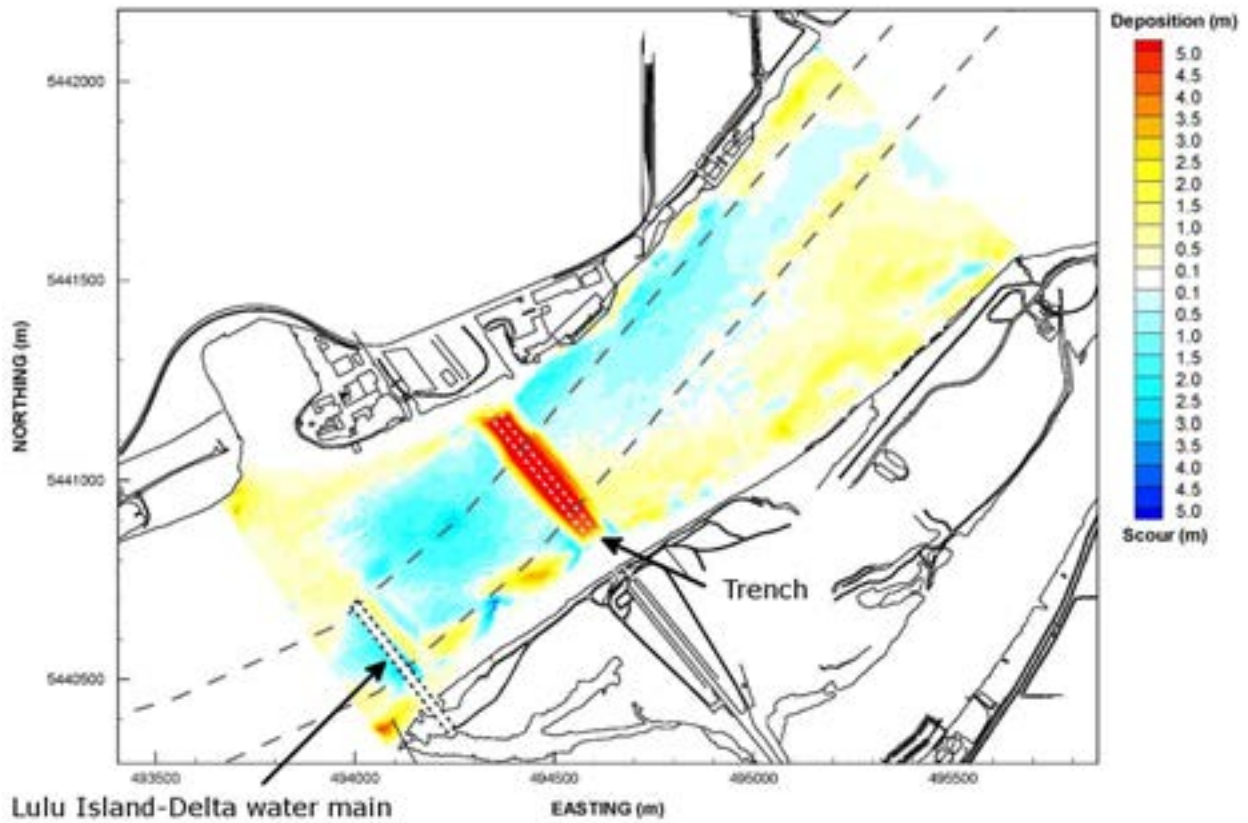


Figure 7-15 Morphodynamic Evolution after 210 Day Simulation of Trench Infilling under Full Tunnel Removal conditions⁸

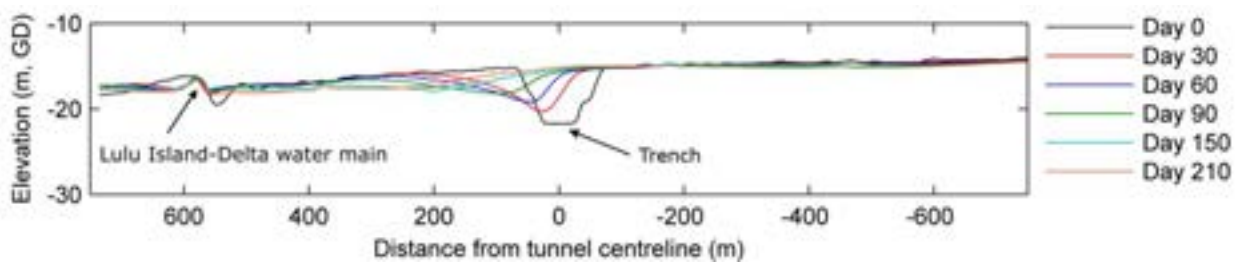


Figure 7-16 Riverbed Profile along the Centreline of the Navigation Channel under Full Tunnel Removal Conditions

⁸ Flow is From Right to Left.

To visualize changes to the sedimentation pattern due to the Project, a bed difference map (Figure 7-17) was prepared showing the difference between the bathymetry under existing conditions and full Tunnel removal after 210 days' simulation. Positive values indicate that the bed elevation under the Tunnel removal condition would be shallower than the bed elevation under existing conditions at the end of the freshet. Negative values indicate that the bed elevation under the proposed condition would be deeper than the bed elevation under existing conditions. After 210 days of simulation, the trench is mostly filled in, but bed lowering of up to two metres persists north of the navigation channel, between the Tunnel and the Lulu Island–Delta water main. Lowering does not affect the water main at 210 days. This lowering is expected to be temporary. It is most likely caused by sediment being “trapped” by the trench, resulting in less sediment available to replenish the downstream bed. Given the general tendency of the trench to migrate downstream as it fills in, it is reasonable to expect one to two metres of scour to occur upstream of the water main crossing within one or two freshets after Tunnel removal.

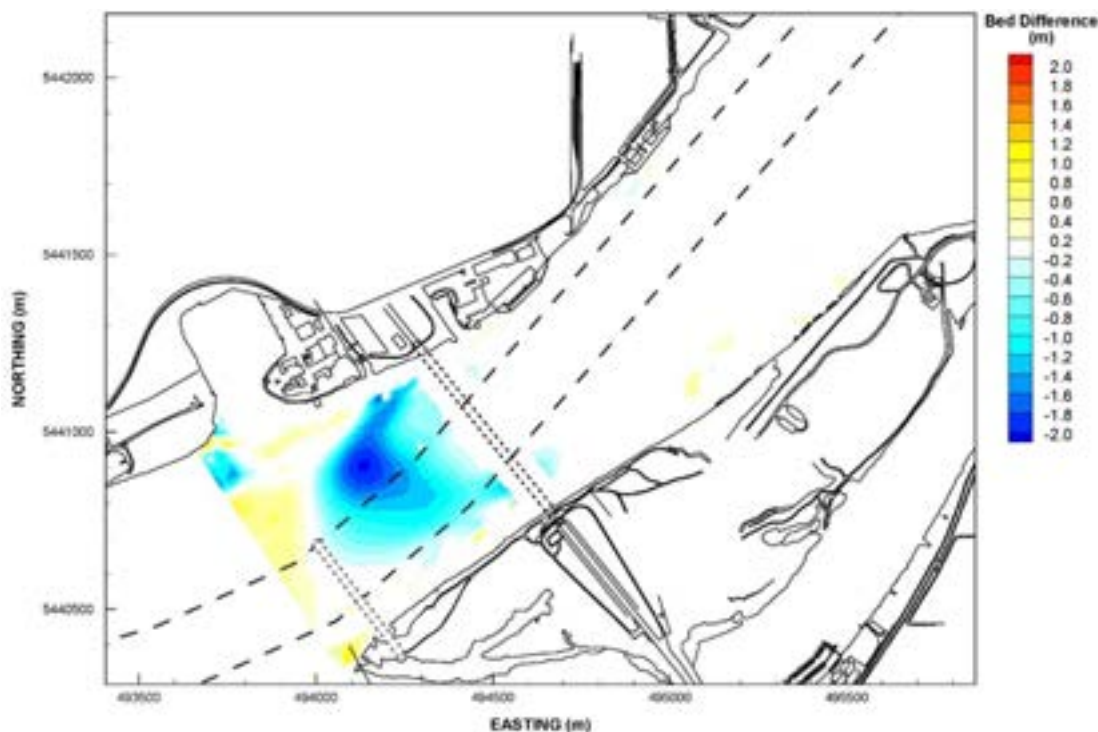


Figure 7-17 Bed Elevation Difference between Existing Conditions and Full Tunnel Removal After 210-days' Trench Infilling Simulation⁹

⁹ Positive Values Indicate Higher Bed Elevations for Full Tunnel Removal than for Existing Conditions.

7.4 Post-Infilling Scenario

As discussed in **Section 7.3.2**, deposition of river sediments is expected to fill in the trench completely within one to two years after removal. The post-infilling model examines the potential Project-related changes to hydraulics and morphodynamics after trench infilling is complete. The simulation is based on freshet conditions, between May 26 and July 27, 2012.

7.4.1 Hydrodynamics

7.4.1.1 Current Velocities

Current velocities were extracted from the No.5 Road model at maximum ebb tide, about 13:00 on June 23, 2012. The results show that, once the Tunnel has filled in, the zone of acceleration previously seen in existing conditions (i.e., with the Tunnel), no longer occurs (**Figure 7-18** and **Figure 7-19**). Velocities in the middle of the navigation channel are more uniform, at 2.3 m/s. The flow acceleration pattern can still be seen at the Lulu Island–Delta water main crossing, downstream.

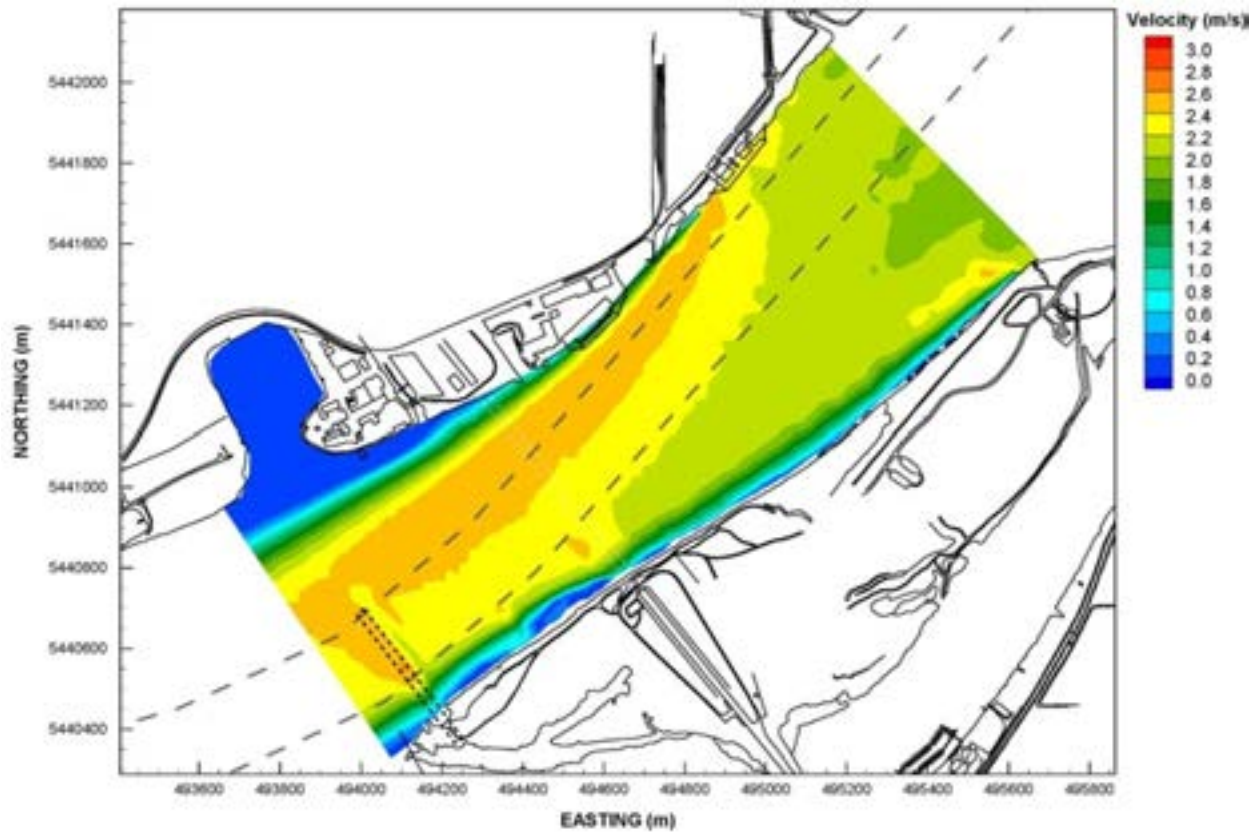


Figure 7-18 Modelled Surface Velocity Distribution under Full Tunnel Removal Conditions, Post-infilling, at Summer Ebb Tide

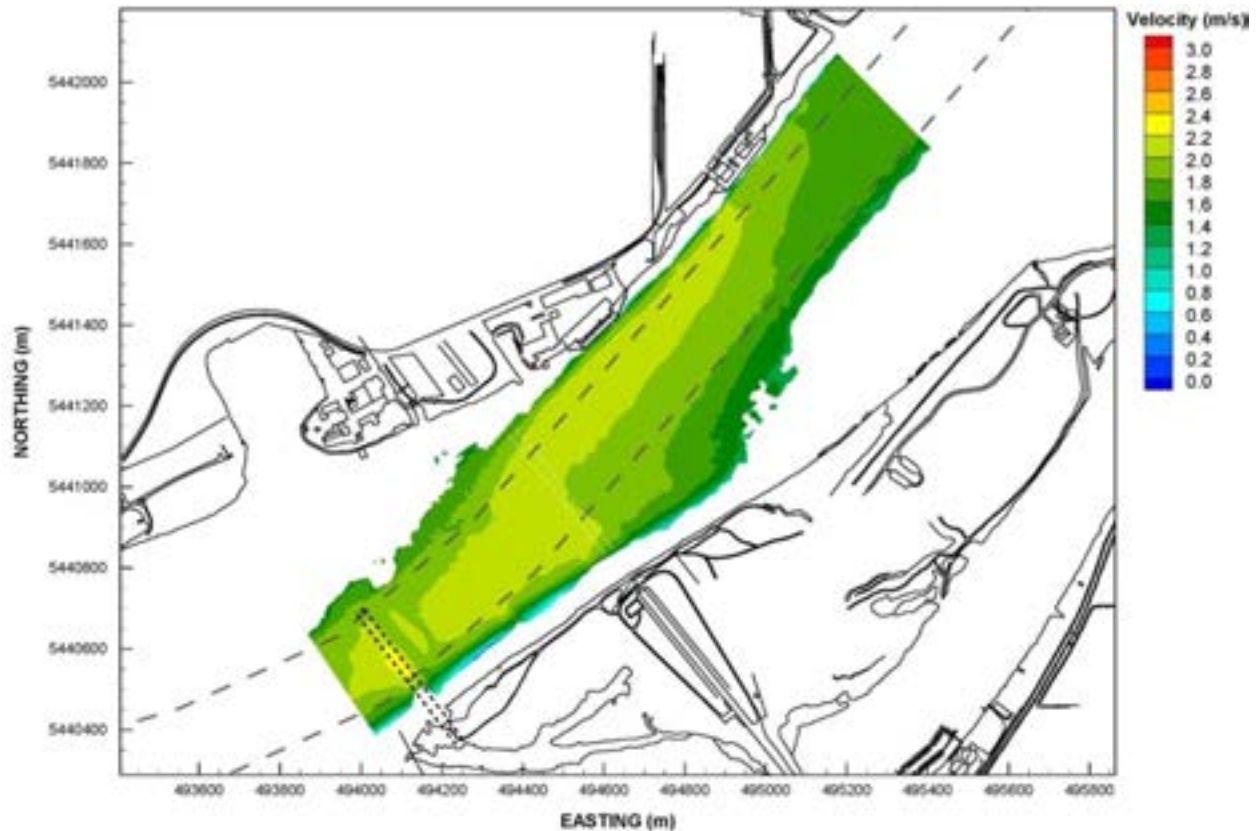


Figure 7-19 Modelled Near-bed Velocity Distribution at -12 m GD Elevation under Full Tunnel Removal Conditions, Post-infilling, at Summer Ebb Tide

To better visualize the difference between existing conditions (**Figure 7-6**) and the full Tunnel removal conditions (**Figure 7-18**), velocity difference maps were prepared for full Tunnel removal conditions minus existing conditions at the surface (**Figure 7-20**), and near the bed at -12 m GD elevation (**Figure 7-21**).

Figure 7-20 and **Figure 7-21** show the following post-infilling changes relative to existing conditions:

- Tunnel removal (both full and partial) is predicted to reduce surface velocities by about 0.3 m/s to 0.5 m/s between the Tunnel and about 50 m downstream. The reduction in near-bed velocities at -12 m GD elevation is smaller, ranging from 0.1 m/s to 0.4 m/s.

- Full removal of the Tunnel may require removal of existing bank protection materials along the Fraser River right (north) bank. This is expected to yield reductions in surface velocities by about 0.2 m/s along this bank, extending about 400 m downstream of the Tunnel.
- Full Tunnel removal may require removal of existing bank protection materials along the left (south) bank, which is predicted to result in reductions in surface velocities by about 0.5 m/s. The region that will experience this reduction extends from the Tunnel to about 150 m downstream.

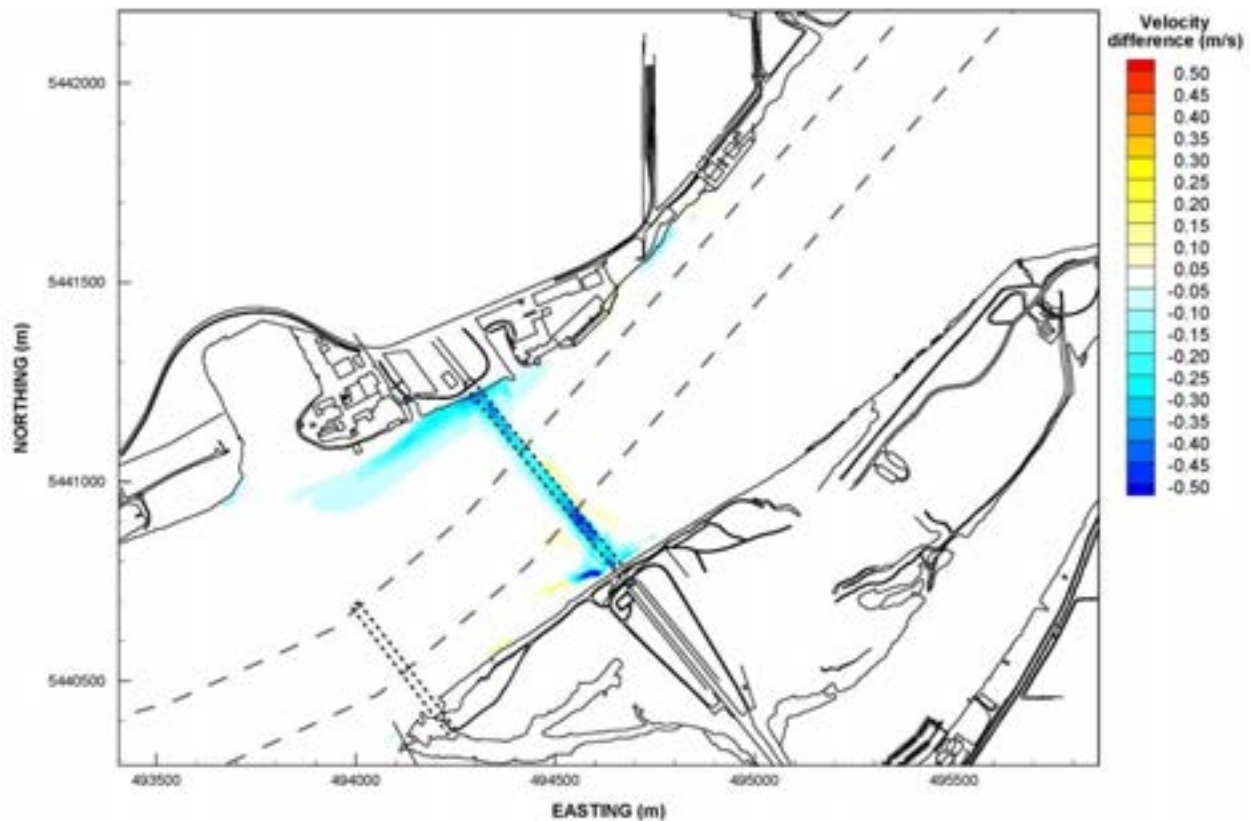


Figure 7-20 Modelled Difference in Surface Velocities between Full Tunnel Removal Conditions and Existing Conditions (i.e., with the Tunnel) During Summer Ebb Tide

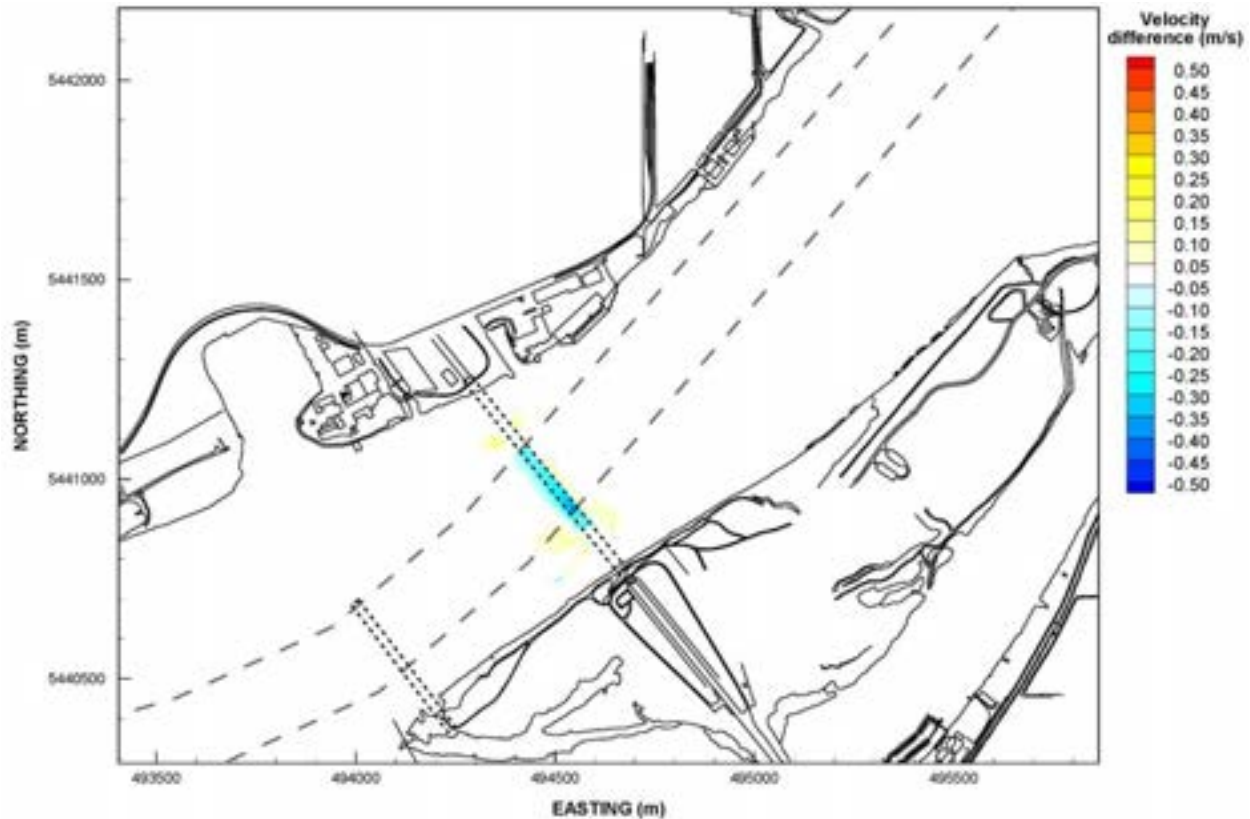


Figure 7-21 Modelled Difference in Near-bed Velocities at -12 m GD Elevation between Full Tunnel Removal Conditions and Existing Conditions (i.e., with the Tunnel) During Summer Ebb Tide

7.4.1.2 Water Levels

Hourly water levels at several stations upstream and downstream of the Tunnel (**Figure 7-3**) were extracted from the SOG/LFR model for the period from June 22 to June 24, 2012. The maximum and minimum modelled water levels at these stations during this period under existing conditions and the full Tunnel removal conditions are summarized in **Table 7-7**. As discussed in **Section 7.3**, model results for full and partial Tunnel removal conditions are virtually identical, as expected based on their similar geometry (**Section 6.3.2**). Therefore, only the full Tunnel removal condition is presented here since the results are also applicable to the partial Tunnel removal condition.

Table 7-7 Modelled Freshet Water Level Statistics and Differences between Existing Conditions and the Full Tunnel Removal Conditions for June 22 to June 24, 2012

| Station | Maximum Water Level (m GD) | | | Minimum Water Level (m GD) | | |
|---------|----------------------------|----------|------------|----------------------------|----------|------------|
| | Existing | Proposed | Difference | Existing | Proposed | Difference |
| km 16 | 1.61 | 1.61 | - | -1.14 | -1.14 | - |
| km 17 | 1.63 | 1.63 | - | -1.04 | -1.04 | - |
| km 18 | 1.63 | 1.63 | - | -0.10 | -0.10 | - |
| km 19 | 1.65 | 1.65 | - | -0.95 | -0.96 | -0.01 |
| km 20 | 1.67 | 1.67 | - | -0.88 | -0.88 | - |

The predicted change in water level for the post-infilling simulation is within the natural variability of the river system and considered negligible. On this basis, the proposed Tunnel modifications are not expected to affect water levels in the adjacent channel reach during the freshet.

7.4.1.3 Flow Splits

As discussed in **Section 4.1.2**, alteration of flow patterns at the nose of Kirkland Island where Ladner Reach splits off was identified as a concern during early Project planning, as it could potentially result in scour and erosion in Ladner Reach. Conversely, there were concerns about Tunnel removal altering flow patterns.

Flow split between Woodward Reach and Ladner Reach was calculated for the maximum ebb (at 13:00) and maximum flood (at 20:00) conditions for June 23, 2012, and compared with that from the existing conditions (**Table 7-8**). The predicted changes in flow splits are within the range of natural variability and considered negligible. On this basis, Tunnel removal is not expected to alter the flow split between Woodward Reach and Ladner Reach.

Table 7-8 Flow splits under existing conditions on June 23, 2012

| | Existing | | Full Tunnel Removal | | % Difference | |
|------------|----------------|--------------|---------------------|--------------|----------------|--------------|
| | Woodward Reach | Ladner Reach | Woodward Reach | Ladner Reach | Woodward Reach | Ladner Reach |
| Ebb Tide | 94% | 6% | 94% | 6% | - | - |
| Flood Tide | 88% | 12% | 89% | 11% | -1 | +1 |

7.4.2 Morphodynamics

7.4.2.1 Near-field Changes

Near-field bed evolution for the full Tunnel removal option was modelled using the No.5 Road model over the freshet period. Similar to the existing conditions simulation, the model predicted bed lowering within 150 m upstream and downstream of the Tunnel. However as shown in **Figure 7-22**, compared with existing conditions there will be about 0.5 – 1.0 m less erosion. This is consistent with the results of the hydraulic analysis which show that the flow will not accelerate across the Tunnel cross-section and that current velocities will be generally lower when the Tunnel is removed. The consequent reduction in erosion in this region will likely result in less sediment available to be deposited in the channel downstream between the Tunnel and Lulu Island–Delta water main, contributing to bed lowering of up to 1.0 m in that segment.

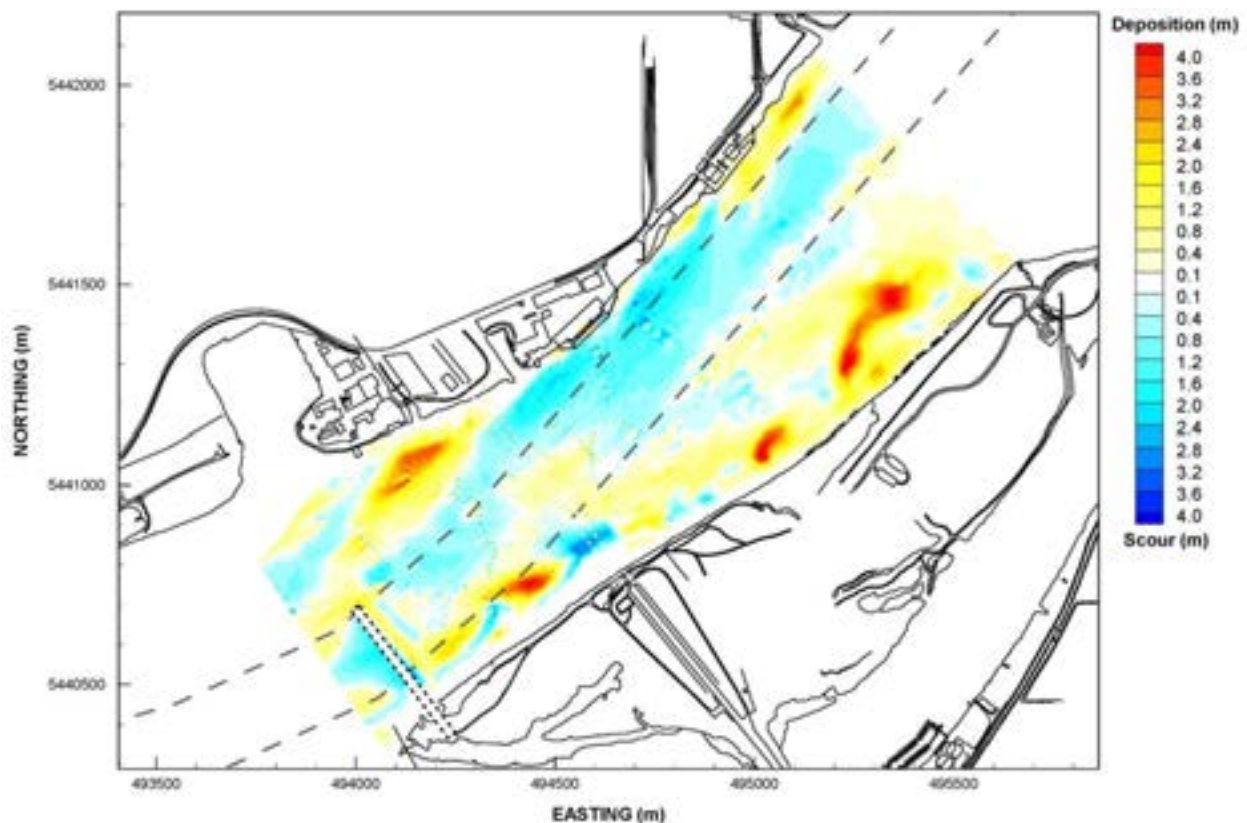


Figure 7-22 Local Morphodynamic Evolution under Full Tunnel Removal Conditions during the Freshet

7.4.2.2 Far-Field Changes

Far-field sedimentation changes under Tunnel removal conditions were investigated using the SOG/LFR model. To visualize the far-field changes to the sedimentation pattern from the Tunnel removal, modelled differences in bed elevations were mapped. **Figure 7-23** shows the difference in bed elevations for existing conditions and Tunnel removal conditions at the end of the freshet simulation period.

Simulated changes in bed elevation as a result of Tunnel removal following the freshet period are limited to the region within about 500 m upstream and 1500 m downstream of the Tunnel. The model suggests that deposition of about 0.5 m will occur in the middle part of the channel upstream of the Tunnel, and north of the navigational channel downstream. Bed lowering of 0.5 to 1.0 m is expected to occur at the margins of the channel, and in the navigational channel downstream of the tunnel. Negligible changes (i.e., $< \pm 0.05$ m) are predicted to occur to the bed levels adjacent to Tilbury Island.

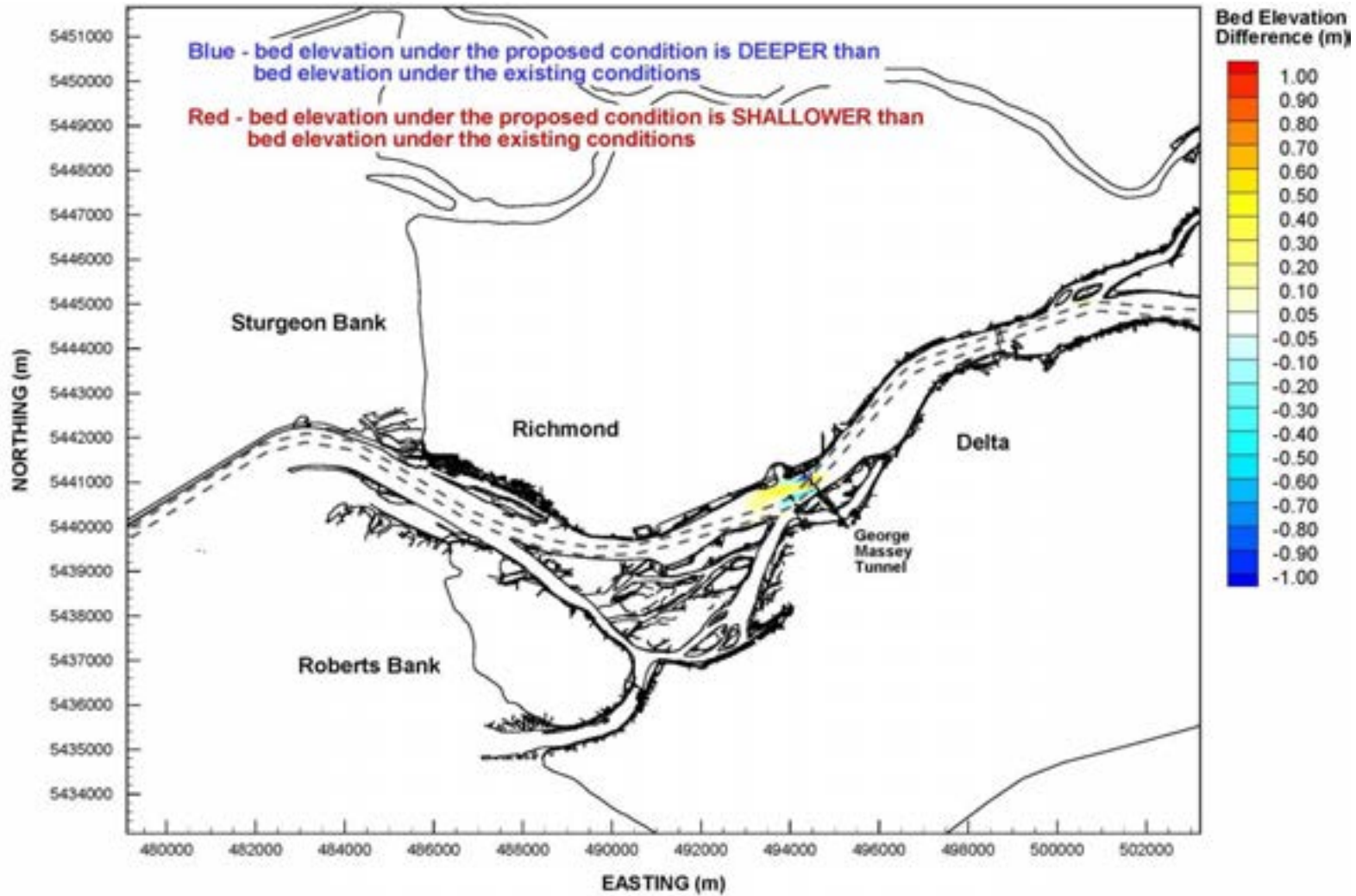


Figure 7-23 Modelled difference in Far-field Bed Elevations between the Full Tunnel Removal Conditions and Existing Conditions from Tilbury Island to the – SOG/LFR Model

The SOG/LFR model was used to predict changes to the dredging volumes required to maintain the existing navigational draft through the lower Fraser River. Modelled dredging volumes under existing and Tunnel removal conditions are summarized in **Table 7-9**. The net change in dredging requirement predicted by the model represents less than 0.5% of the existing total dredge requirement, and falls within the range of model uncertainty for sediment transport. No change in overall dredging requirement is expected to result from the Project.

Table 7-9 Required Maintenance Dredging Volumes (m³) under Existing Conditions and Proposed Tunnel Removal Conditions

| Reach | km | Existing (m ³) | Tunnel Removal (m ³) | Difference (m ³) |
|--------------------|----------|----------------------------|----------------------------------|------------------------------|
| Sand Heads | -1 to 1 | 33,000 | 33,000 | 0 |
| Sand Heads Reach | 1 to 4 | 416,200 | 416,000 | -200 |
| Steveston Bend | 5 to 7 | 342,900 | 342,800 | -100 |
| Steveston Cut | 7 to 10 | 460,100 | 459,900 | -200 |
| No. 5 Road | 16 to 18 | 39,000 | 39,400 | 400 |
| Gravesend Reach | 20 to 22 | 73,600 | 73,500 | -100 |
| Purfleet Reach | 24 to 27 | 168,800 | 168,500 | -300 |
| St. Mungo's Bend | 27 to 29 | 332,300 | 331,900 | -400 |
| Annieville Channel | 32 to 34 | 620,400 | 620,600 | 200 |
| Total | - | 2,486,300 | 2,485,600 | -700 |

8.0 Discussion of Potential Changes Due to the Project

This section summarizes potential changes to river hydraulics and morphology as a result of the Project. The assessment is based on a synthesis of the field observations, and hydrodynamic and morphodynamic model results.

8.1 Construction Phase

8.1.1 New Bridge Crossing

The new bridge will be a clear-span crossing. Potential change to river hydraulics and morphology due to bridge construction activities are limited to the upgrading of existing riprap bank protection on the left and right banks. If banks are left intact during Tunnel removal (i.e., the partial removal option), bank protection upgrades would be limited to placement of additional riprap.

Assuming upgrades are limited to moderate rock placement on the existing armoured slope (i.e., no instream excavation, no increase in rock footprint and no river training works), this work would not result in changes to river hydraulics or morphology. This type of riprap placement would generate a limited supply of suspended sediment, assuming standard best management practices are adhered to, such as use of washed rock with no fines or debris. Changes to the river system due to suspended sediment input resulting from such work would be negligible.

8.1.2 Tunnel Removal

Tunnel removal has the potential to result in changes to river hydraulics and fluvial morphology during the Project construction phase. The nature and severity of these changes depends heavily on Tunnel removal methodology and timing. Tunnel removal is expected to involve removing the rock apron/ballast and concrete mattress, excavating beneath the Tunnel segments to break suction, and then floating the pre-cast concrete Tunnel segments to the surface. The process is expected to take several months to complete. The potential changes are discussed below.

8.1.2.1 Local Scour and Deposition

Local scour and deposition are expected during Tunnel removal due to flow acceleration around exposed edges of Tunnel segments. Since the segments are expected to be removed in sequence, flow will accelerate around the exposed ends and entrain sediment, which would then be deposited downstream. The degree of sediment transport associated with local flow accelerations during construction will depend on time of year and associated current velocities. These changes are expected to be temporary and small in scale compared with overall bed material transport.

8.1.2.2 Suspended Sediment

Removal of the components as described above, and excavation of the river bed, will generate suspended sediment. The resulting changes to river hydraulics and morphology will depend on the ambient suspended sediment concentrations at the time of removal, river discharge, tidal amplitude, and details of Tunnel removal methods. This study has assumed Tunnel removal will commence in mid-August, after freshet flows have receded, and continue into the winter low flow period (December). Suspended sediment concentrations in the low-flow period are typically low, so change in concentrations due to Project-related input of sediment to the water column could be substantial.

The volume of suspended sediment that could be generated by the Tunnel removal was estimated and compared it to the typical ambient volumes of suspended sediment transported during the Tunnel removal period. Each Tunnel segment is overlain by approximately 28,000 m³ of sediment or sand fill material (**Figure 3-2**). Assuming this material has the same size gradation as the bed material in the lower Fraser River, approximately 10% (2,800 m³) of the overlying material would be smaller than 0.177 mm in diameter, and could therefore remain suspended in the water column (NHC 2002*b*). Assuming that removal of one tunnel segment takes two weeks, the natural or ambient volume of suspended sediment transported through the assessment area during removal of one segment ranges from a maximum of 3x10⁵ m³ in August to a minimum of 3x10⁴ m³ in December. These estimates are based on analyses of seasonal flows and measured suspended sediment concentrations in the lower Fraser River (Milliman 1980, Kostaschuk, Luternauer, et al. 1989, Attard and Venditti 2014). Based on the above estimates, the increase in suspended sediment volume due to the Tunnel removal ranges from one per cent to nine per cent over ambient volumes. Considering the natural variability of suspended sediment seasonally and annually, such an increase is considered low.

Suspended sediment concentrations resulting from Tunnel removal have not been estimated in this study. Although such an estimate could be accomplished by calculating advection and dispersion of fine sediments, it is complicated by temporal variability and tidal flow reversal at the site. Numerical dispersion models are capable of estimating sediment concentrations under these conditions.

Depositional changes resulting from suspended sediment generation are expected to be minimal. Suspended fine sediments generated during Tunnel removal would be transported to the Strait of Georgia before deposition could occur. Since the incremental volume of suspended sediment generated during Tunnel removal is expected to be small in comparison with the ambient load, and the depositional area at Sand Heads is large, no noticeable changes to deposition in the Strait of Georgia are expected.

8.2 Operation Phase

8.2.1 New Bridge Crossing

No changes to river hydraulics and morphology are expected to result from the new bridge during the Project operation phase. Normally, hardening of banks with riprap could result in incremental changes to both hydraulics and morphology, but the banks are already hardened and simply upgrading the existing protection would not increase these changes.

8.2.2 Tunnel Removal

8.2.2.1 Current Velocities

Compared with existing conditions, minor changes in current velocities are expected to result from Tunnel removal. The predicted changes in velocity do not suggest that Tunnel removal would result in substantial bank erosion, barriers to fish migration, or impediments to vessel traffic. Changes are as follows:

- Local reductions of about 0.3 m/s in surface velocities at the crossing alignment during summer ebb tide conditions
- Decrease in surface velocity of about 0.2 m/s at the right bank for 400 m downstream of the crossing during summer ebb tide conditions
- Decrease in surface velocity of about 0.5 m/s at the left bank for about 150 m downstream of the crossing due to slight differences in bank geometry
- Slight decrease in near-bed velocity in the navigation channel, of around 0.1 to 0.4 m/s at the crossing alignment
- Changes to velocity during summer flood tide are similar, but smaller in magnitude and extents
- Changes to velocity during winter ebb tide are similar but smaller in magnitude
- Winter flood tide changes in velocity are comparable to the ebb tide condition, but smaller in magnitude. As with the summer flood tide condition, no changes in velocity are anticipated along the banks at the surface.

8.2.2.2 Water Levels

Predicted changes in water level resulting from Tunnel removal varied between an increase of two millimetres and a decrease of five millimetres. These changes are within the range of natural variability and considered negligible. Tunnel removal is not expected to produce a change in water levels.

8.2.2.3 Flow Splits

The predicted changes in flow splits are within the range of natural variability and considered negligible. Tunnel removal is not expected to cause changes to the flow split between Woodward Reach and Ladner Reach. This suggests that Tunnel removal is not likely to result in the development of Ladner Reach through erosion of Deas Island and/or the nose of Kirkland Island.

8.2.2.4 Salt Wedge

Salinity is not incorporated in the model analyses. However, because the Tunnel elevation is several metres lower than the bed downstream (km 15) and upstream (km 19), temporary lowering of bed levels by one to two metres at the Tunnel is not likely to influence the overall distance of salt wedge intrusion. Results of hydrodynamic modelling, as discussed in **Section 16.7** of the Application, indicates that the proposed removal of the Tunnel will not affect the behaviour of the salt wedge.

8.2.2.5 Trench Infilling and Migration

The primary concern during the Project operation phase is that the knickpoint in the longitudinal profile of the river created by the trench feature could propagate either upstream or downstream, or both, leading to bed degradation and bank erosion. Modelling suggests the trench is mostly filled in after 210 days following Tunnel removal; however, bed lowering of up to two metres persists north of the navigation channel between the Tunnel and the Lulu Island–Delta water main. Lowering does not appear to affect the water main pipe at 210 days; however, given the general tendency of the trench to migrate downstream as it fills in, it is reasonable to expect one to two metres of scour to occur at the upstream margins of the water main scour protection within one or two freshets after Tunnel removal.

The expected changes beyond the trench footprint are in the same order as normal variation in bed levels in the lower Fraser River. Historical bathymetric surveys indicate that the riverbed at the Tunnel crossing is very dynamic, with bed lowering of 0.15 to 0.50 m/year attributed to changes in flow alignment and/or reduction in sediment supply, depending on the time period considered. Temporary scour during freshets can be on the order of several metres, especially when the migration of sand dunes as much as four metres in height is taken into account.

8.2.2.6 Post-Infilling Morphological Changes

Near-field modelling (No.5 Road model) suggests the magnitude of bed lowering will be 0.5 to 1.0 m less with Tunnel removal than under existing conditions. This will likely result in less sediment available to be deposited in the channel downstream between the Tunnel and the Lulu Island–Delta water main, and consequently bed lowering of about 0.5 m in the northern part of the navigational channel, from about 150 m downstream of the Tunnel to upstream of Lulu-Delta watermain.

Far-field modelling (SOG/LFR model) suggests changes are limited to about 500 m upstream and 1500 m downstream. Deposition of about 0.5 m is expected in the middle of the channel upstream of the Tunnel, and north of the navigational channel downstream of the Tunnel. Bed lowering of 0.5 to 1.0 m is expected to occur at the margins of the channel, and in the navigational channel downstream of the tunnel. Negligible changes ($< \pm 0.05$ m) are predicted to occur to the bed levels adjacent to Tilbury Island.

9.0 Limitation

This document has been prepared by **Northwest Hydraulic Consultants Ltd.** (NHC) in accordance with generally accepted engineering practices and is intended exclusively for use in relation to the Environmental Assessment for the George Massey Tunnel Replacement Project. The contents of this document are not to be relied upon or used, in whole or in part, for any other purpose without specific written authorization from **Northwest Hydraulic Consultants Ltd.** No other warranty, expressed or implied, is made.

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10.0 References

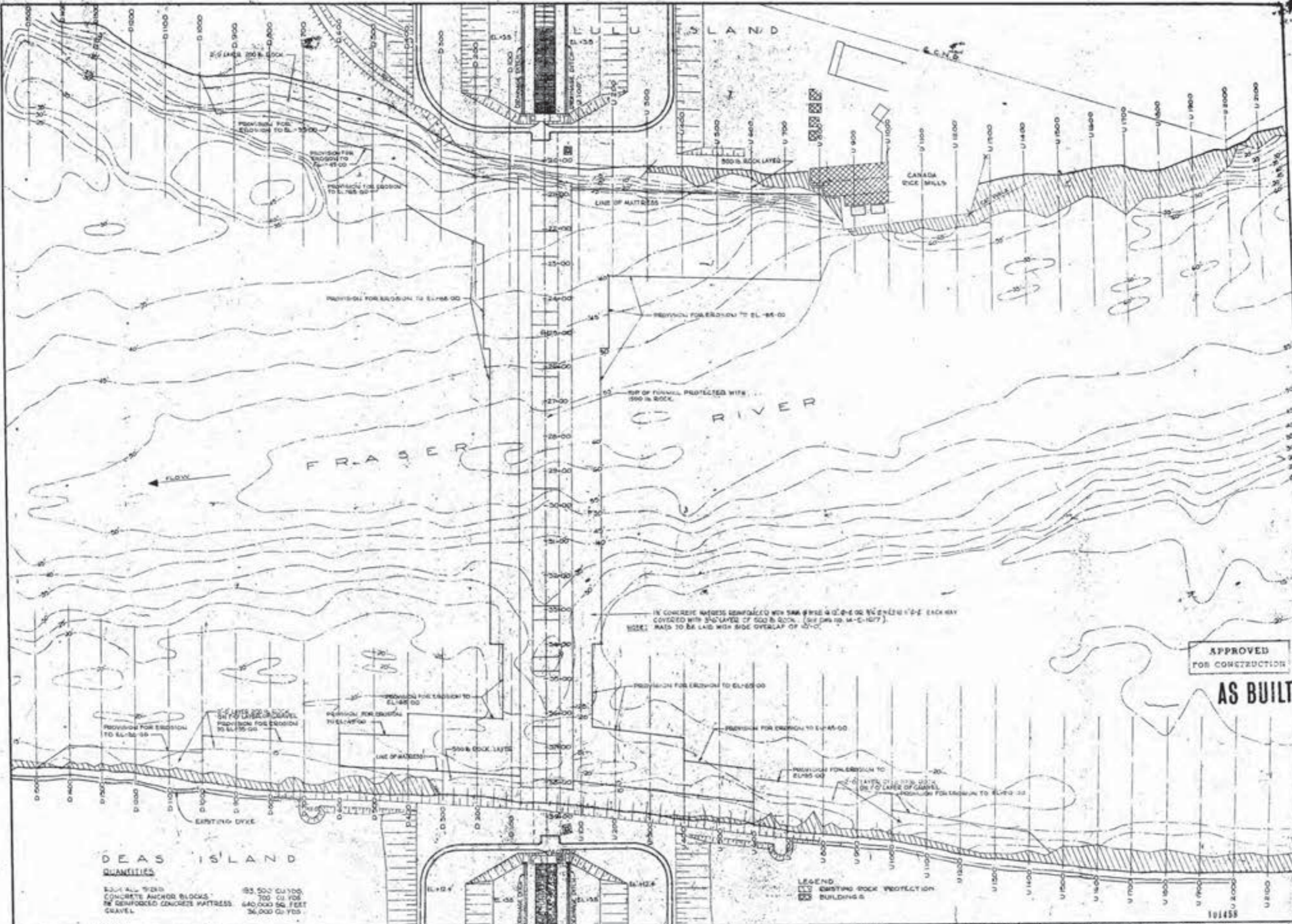
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ATTACHMENT A
As-built Drawings



APPROVED
FOR CONSTRUCTION

AS BUILT

DEAS ISLAND QUANTITIES

| | |
|---------------------------------|-----------------|
| ROCK ALL TYPES | 183,500 CU YDS |
| CONCRETE ANCHOR BLOCKS | 700 CU YDS |
| 12' REINFORCED CONCRETE MATRESS | 640,000 SQ FEET |
| GRAVEL | 30,000 CU YDS |

LEGEND
 EXISTING ROCK PROTECTION
 BUILDINGS

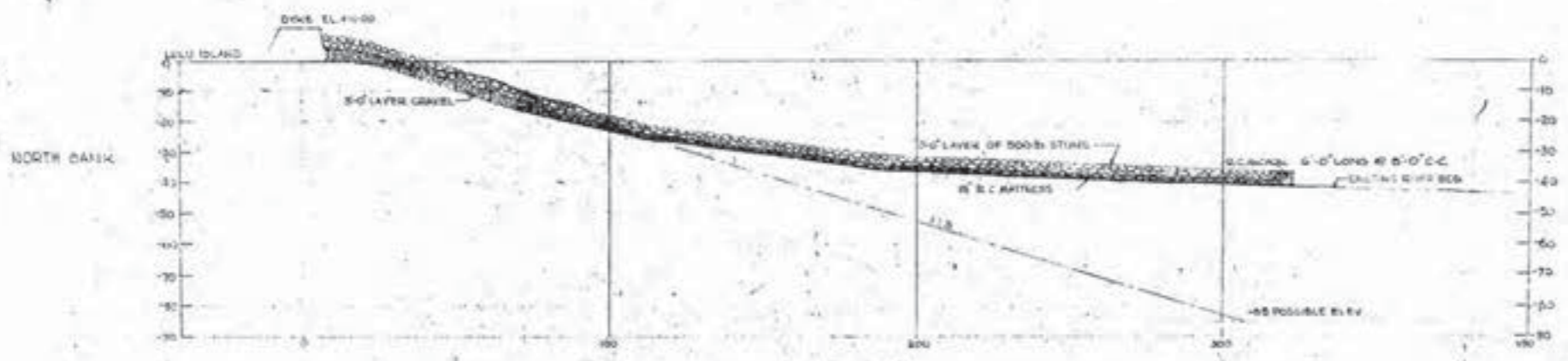
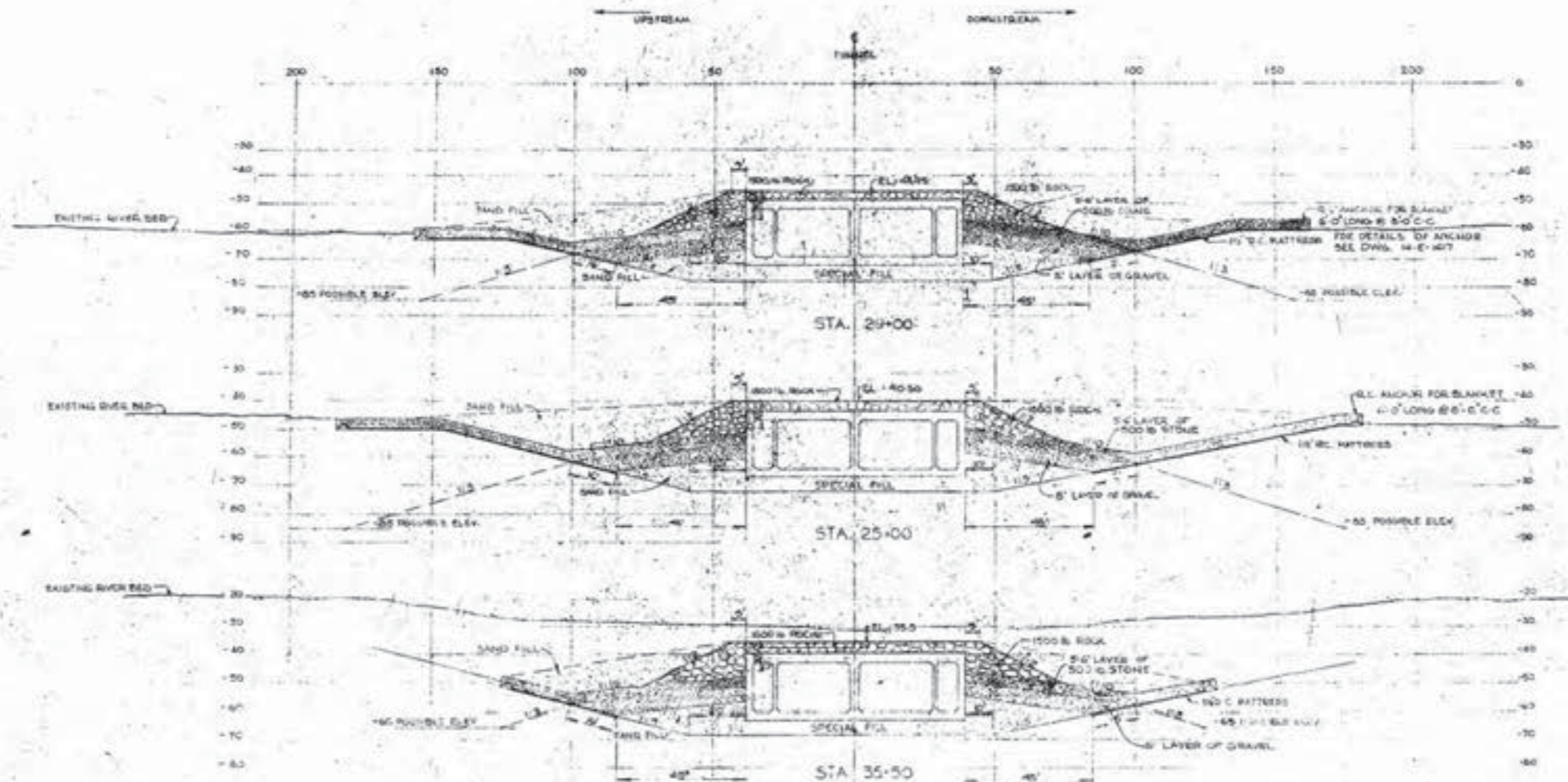
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| 2 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 3 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 4 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 5 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 6 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 7 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 8 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 9 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |
| 10 | CONSTRUCTION OF 12' CONCRETE MATRESS PROTECTION |

NOTES
 1. ALL SOUNDINGS IN FEET BELOW CLOSING ZERO
 2. CONTOURS SHOWN ARE BASED ON SOUNDINGS TAKEN FEBRUARY 1957

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101458

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U 300

AS BUILT

APPROVED FOR CONSTRUCTION

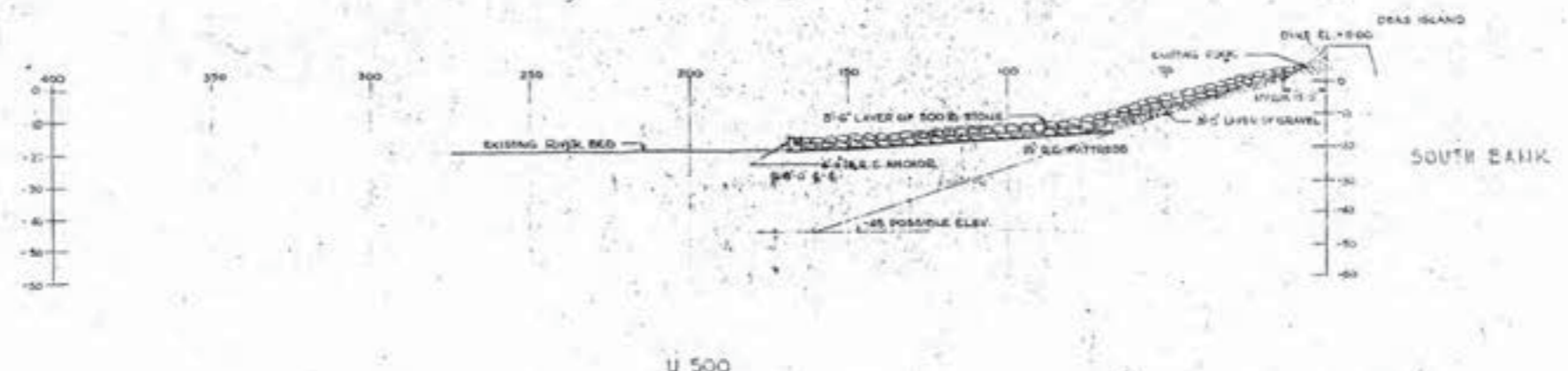
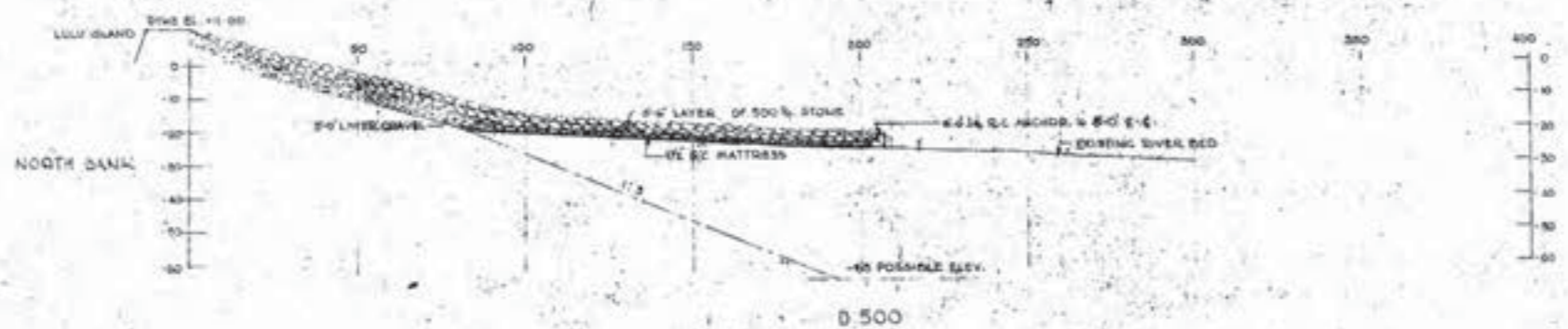
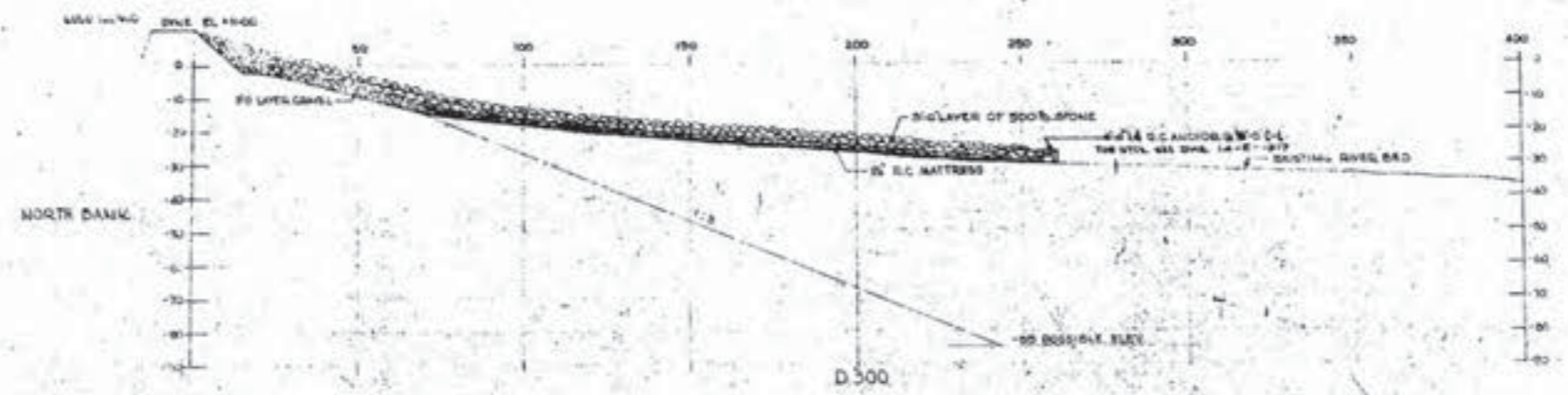
101455

| NO. | DATE | DESCRIPTION |
|-----|------|---|
| 1 | | 14-E-101455 PROTECTION PLAN |
| 2 | | 14-E-101455 PLAN OF EROSION PROTECTION OPERATIONS |

NOTES
1. FOR LOCATION OF SECTIONS SEE DWS 14-E-101455

| NO. | DATE | REVISIONS |
|-----|-------------|------------------------------------|
| 1 | MAY 2, 1955 | REVISION AND CORRECT MODIFICATIONS |
| 2 | | REVISED BY: [Signature] |

BRITISH COLUMBIA TOLL HIGHWAYS AND BRIDGES AUTHORITY
 CHRISTIAN & WIELER
 DEAS ISLAND TUNNEL
 EROSION PROTECTION SECTIONS
 STA. 20+00, STA 25+00, STA 35+50, U300
 14-E-1015



AS BUILT
 APPROVED
 FOR CONSTRUCTION

101860

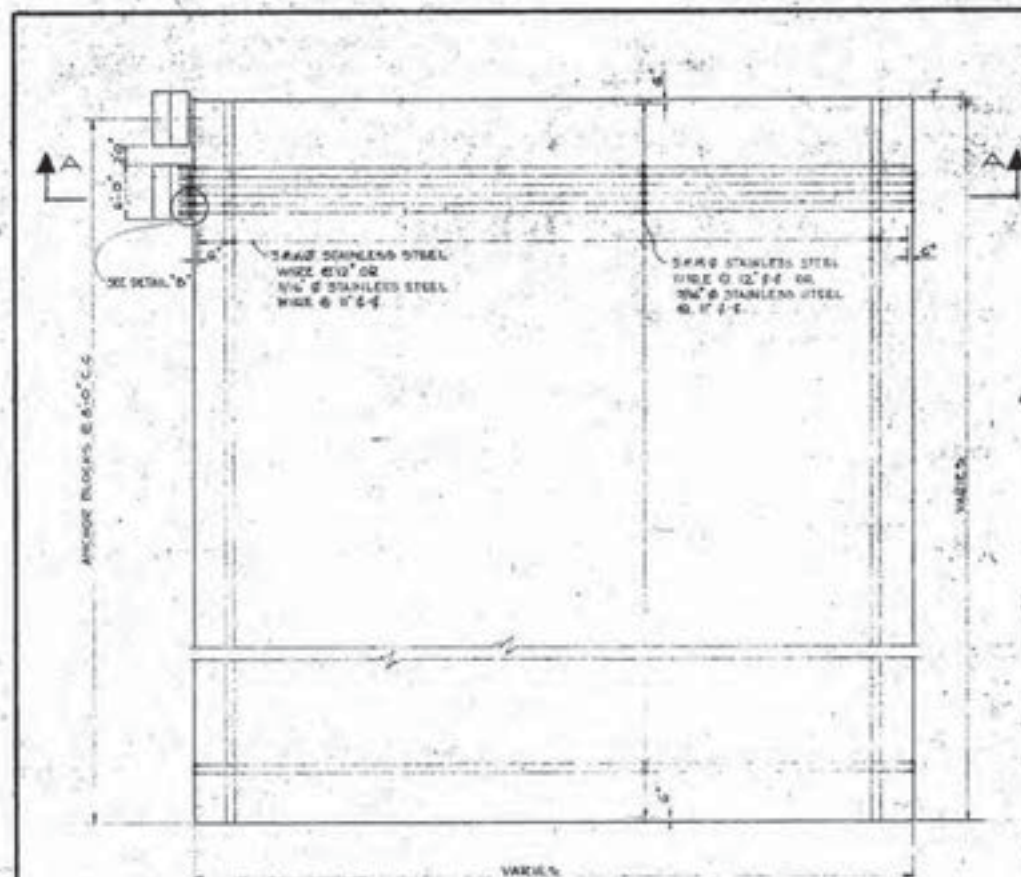
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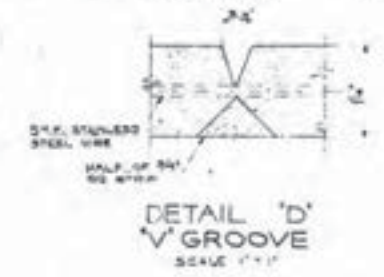
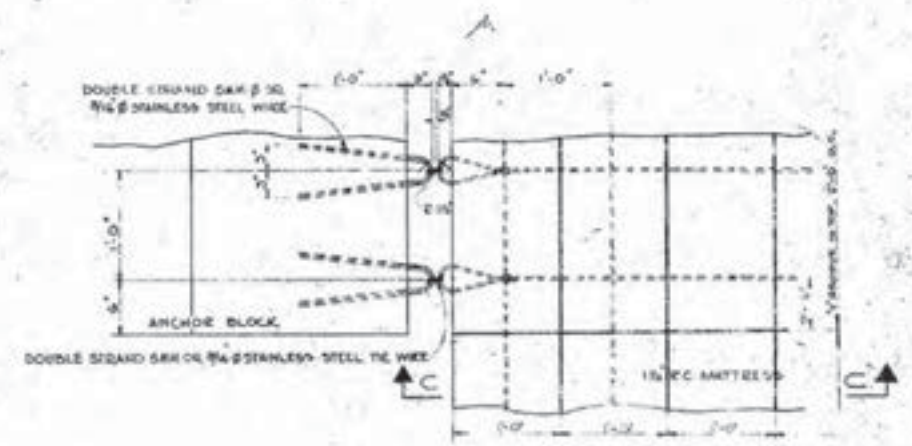
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BRITISH COLUMBIA TOLL HIGHWAYS AND BRIDGES AUTHORITY
 ERRIETANI & NIELSEN
 FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED
DEAS ISLAND TUNNEL
 EROSION PROTECTION SECTIONS
 D 300, D 500, U 500, U 700



PLAN
SCALE 1/4" = 1'-0"



AS BUILT

PROVEN FOR CONSTRUCTION
101461

| REFERENCE | DESCRIPTION |
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| 14-E-1014 | SECTION PROTECTION PLAN |
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NOTES

1. IF MATTRESSES ARE TO BE ROLLED UP FOR PLACING, GROOVES TO BE MADE ON TWO SIDES.
2. IF MATTRESSES ARE NOT ROLLED UP MAKE GROOVES ON ONE SIDE ONLY.
3. FOR LOCATION OF MATTRESSES SEE DWG. 14-E-1014

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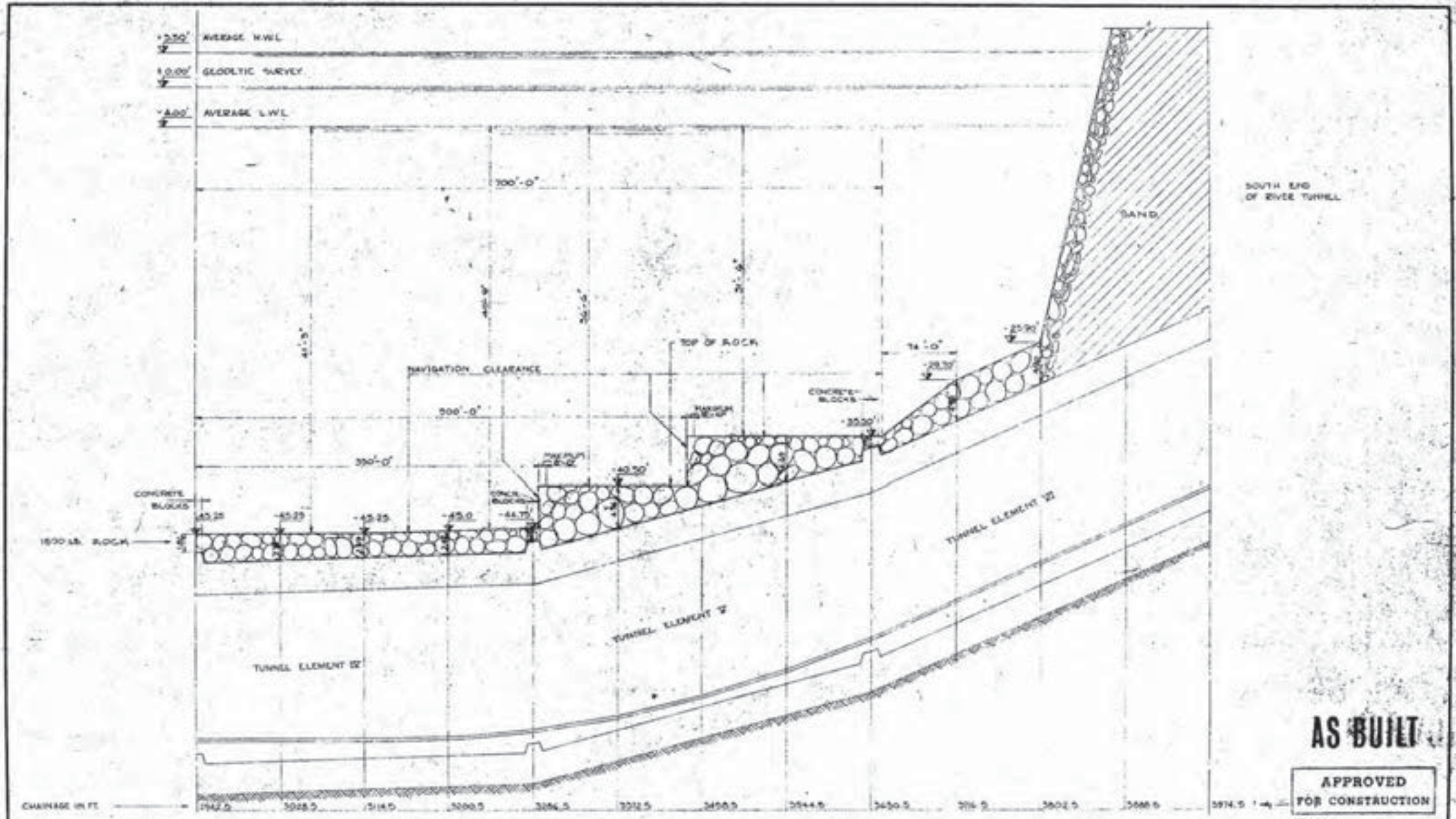
BRITISH COLUMBIA TOLL HIGHWAYS AND BRIDGES AUTHORITY

CROSTARI & NIELSEN FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED

DEAS ISLAND TUNNEL

EROSION PROTECTION MATTRESS DETAILS

14-E-1014



AS BUILT

APPROVED
FOR CONSTRUCTION

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NOTES
 1. CONCRETE BLOCK FILL TO BE PLACED SYMMETRICALLY WITH RESPECT TO C AT CHAINAGE 2942.5

| NO. | DATE | DESCRIPTION |
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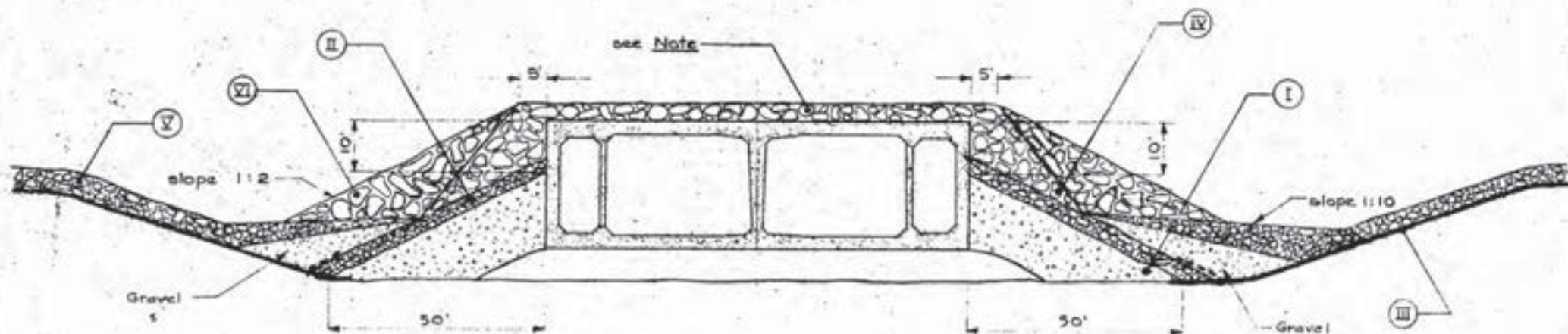
BRITISH COLUMBIA TOLL HIGHWAYS AND BRIDGES AUTHORITY

CHRISTIANI & NIELSEN FOUNDATION OF CANADA ENGINEERING CORPORATION LIMITED

DEAS ISLAND TUNNEL

ROCK PROTECTION (1500'±) ON TUNNEL ELEMENTS

14-E-1610



SEQUENCE OF OPERATIONS

- I Immediately after completion of sand jetting fill 5' minus gravel to lines and grades shown.
- II Follow 5' minus with 3 ft. layer of 500 lb rock.
- III Follow 500 lb rock with 1/2" articulated concrete mats.
- IV Place 1500 lb rock each side of Element.
- V Cover mats with 3'-6" layer of 500 lb rock.
- VI Adjust slopes to required grade with 1500 lb rock.

NOTE: Loading tops of elements with 1500 lb rock can follow between above operations.

| REFERENCES | |
|-----------------|-----------|
| DESCRIPTION | DWG. NO. |
| DIMENSIONS | 14-E-1615 |
| PROTECTION PLAN | 14-E-1614 |

AS BUILT

APPROVED
FOR CONSTRUCTION

101463

REVISED SEQUENCE OF
EROSION PROTECTION OPERATIONS

| BRITISH COLUMBIA TOLL HIGHWAYS AND BRIDGES AUTHORITY | | |
|--|-------------------|-------------------------------------|
| DEAS ISLAND TUNNEL B. C. CANADA | FENCO No. 1277 | CHRISTIANI & NIELSEN O. N. 25666 |
| SCALE: 1" = 20'-0" MADE: B.C. CHECKED: N.S.R. DATE: Mar. 26, 56 DWG. No. 14-J-1710 | | |

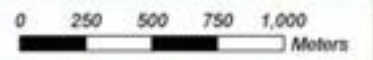
ATTACHMENT B

Historical Aerial Photograph Mosaics

1938



DATA SOURCES:
BACKGROUND - ESRI WORLD IMAGERY
AIR PHOTOS - UBC GIC



1949



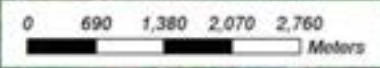
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AIR PHOTOS - USC GIC

0 250 500 750 1,000
Meters

1949



DATA SOURCES:
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1954



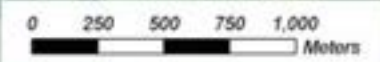
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1963



DATA SOURCES:
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1974



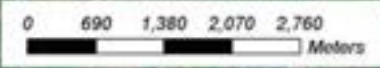
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Meters

1974



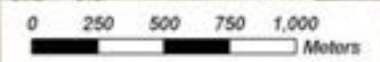
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1984



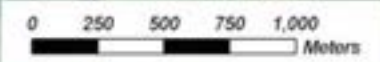
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1991



DATA SOURCES:
BACKGROUND - ESRI WORLD IMAGERY
AIR PHOTOS - USC GIC



2002



DATA SOURCES:
BACKGROUND - ESRI WORLD IMAGERY
AIR PHOTOS - USC GIC

0 250 500 750 1,000
Meters

2009



DATA SOURCES:
BACKGROUND - ESRI WORLD IMAGERY
AIR PHOTOS - UBC GIC

0 250 500 750 1,000
Meters

2009



DATA SOURCES:
BACKGROUND - ESRI WORLD IMAGERY
AIR PHOTOS - USC GIC

0 690 1,380 2,070 2,760
Meters

ATTACHMENT C

Model Development and Validation

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1.0 Purpose

This attachment provides a detailed description of the development, calibration, and validation of the numerical model used to investigate potential Project construction- and operation-related changes to the lower Fraser River hydraulic conditions (water levels, velocities, flow patterns) and morphology (sediment transport and riverbed profile). The model results that show the potential changes are provided in the main body of this report.

2.0 Numerical Models: TELEMAC-MASCARET System

The potential changes to river hydraulic conditions and morphology were investigated using the TELEMAC-MASCARET modelling system (TELEMAC system), which is described in the main body of the technical data report. The TELEMAC system is recognized throughout the world, with users that include HR Wallingford, BC Hydro, Hydro-Quebec, and the Canadian Coast Guard, which uses TELEMAC-2D to predict current speeds and patterns in the lower Fraser River, and to forecast available water depths for vessels navigating the Fraser River South Arm (see <http://www2.pac.dfo-mpo.gc.ca/>). The model output is published online on a weekly basis and available to river pilots, Port of Vancouver, and shipping companies to assist them in determining maximum draft and the best sailing times. All TELEMAC system modules were developed in accordance with the quality assurance procedures followed in Électricité de France's Studies and Research Division.

The various TELEMAC system modules use high-capacity algorithms based on the finite element method. TELEMAC discretizes space in the form of an unstructured grid of triangular elements, which means that the grid can be refined in areas of special interest. This approach avoids the need for systematic use of embedded models, as is the case with the finite-difference method.

For this study, two TELEMAC system modules were applied, with the TELEMAC-3D module used to compute the physical processes of tidal and river currents, while the SISYPHE module was used to compute sediment transport. These modules are described below.

2.1 TELEMAC-3D Hydrodynamic Model

TELEMAC-3D is a three-dimensional model that solves the Reynolds-Averaged Navier-Stokes equations in unstructured meshes obtained by superimposition of two-dimensional meshes of triangles. Its main outputs, obtained at each point in the resolution mesh in three dimensions, are velocity in all three directions, and the concentrations of transported quantities. TELEMAC-3D's prominent applications can be found in free surface flow, in both seas and rivers, and can take several processes into account, including the following that pertain to the Project study:

- Influence of temperature and/or salinity on density
- Bottom friction
- Influence of the Coriolis force

- Influence of air pressure and wind
- Consideration of the thermal exchanges with the atmosphere
- Sources and sinks for fluid moment within the flow domain
- Dry areas in the computational domain, in this case, tidal flats
- Current drift and diffusion of a tracer, with generation or disappearance terms

When drying occurs, the water depth falls to zero and the planes collapse to a zero inter-layer spacing. Finite-volume style numerical techniques are used to ensure that both water and a tracer can be well-conserved in the presence of drying and subsequent re-wetting.

2.2 SISYPHE Sediment Transport Model

SISYPHE is the sediment transport and bed evolution module of the TELEMAC system. SISYPHE can be used to model complex morphodynamic processes in diverse environments, such as coastal systems, rivers, lakes, and estuaries, for different flow rates, sediment size classes, and sediment transport modes. In SISYPHE, sediment transport processes are grouped as bed load, suspended load or total load, with an extensive library of bed load transport relations. SISYPHE is applicable to non-cohesive sediments that can be uniform (single-sized) or non-uniform (multiple-sizes), cohesive sediments (multi-layer consolidation models), as well as sand-mud mixtures.

A number of physically-based processes are incorporated into SISYPHE, such as the influence of secondary currents to precisely capture the complex flow field induced by channel curvature, the effect of bed slope associated with the influence of gravity, bed roughness predictors, and areas of non-erodible bed, among others. SISYPHE can be coupled to the depth-averaged shallow water module, TELEMAC-2D, or to TELEMAC-3D.

2.3 Model Framework

For this study, TELEMAC-3D and SISYPHE were internally coupled to simulate tidal and river currents, and local bed scour and deposition. The current field is first simulated by TELEMAC-3D, which then transfers the current velocity values and water depths to SISYPHE to compute scour and deposition of the riverbed. The new bed elevation computed by SISYPHE is fed back into TELEMAC-3D to re-compute the flow hydrodynamics. The model coupling flow diagram is shown in **Figure 1**.



Figure 1 TELEMAC Model Coupling Flow Diagram

The time step of the SISYPHE sediment transport model was the same as the time step of the TELEMAC-3D model. This allows the hydrodynamic variables to be transferred to SISYPHE at each time step, which in turn, sends the updated bed elevation back to the hydrodynamic model for the next time step.

2.4 Model Descriptions

Two TELEMAC models were developed for the study: (1) the Strait of Georgia/Lower Fraser River (SOG/LFR) model, and (2) the No.5 Road model¹. The SOG/LFR model mesh extends from Ballenas Island at its north boundary to Port Renfrew at its west boundary (**Figure 2**). The model also includes Fraser River up to km 42, downstream of Port Mann Bridge. The No.5 Road model mesh extends from 1,300 m upstream of the Tunnel to 700 m downstream of the Tunnel (**Figure 3**).

¹ The local region model is referred to as the No.5 Road model in reference to the name commonly used for the reach of Fraser River at the Tunnel.

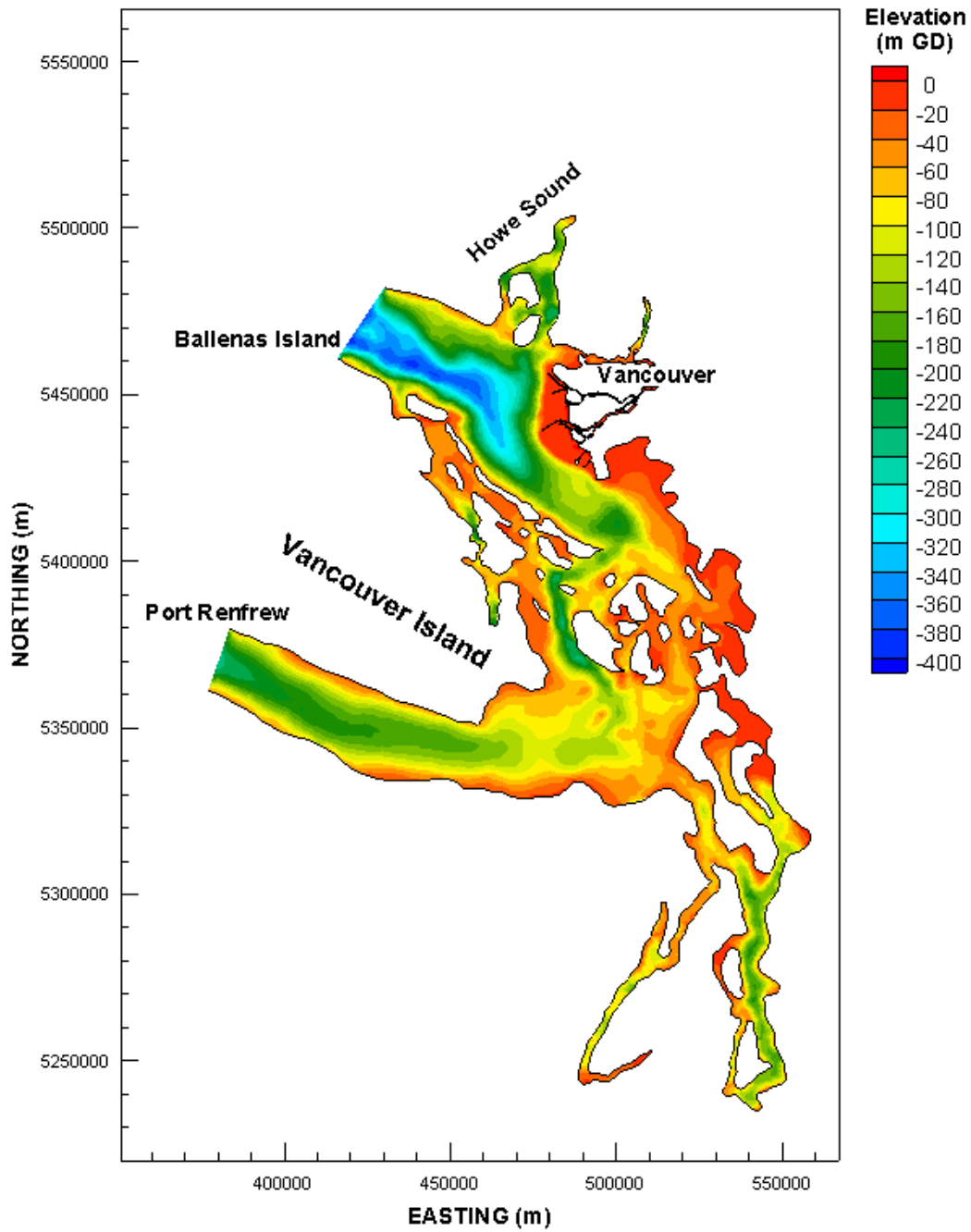


Figure 2 TELEMAC Strait of Georgia / Lower Fraser River Model Mesh Extent

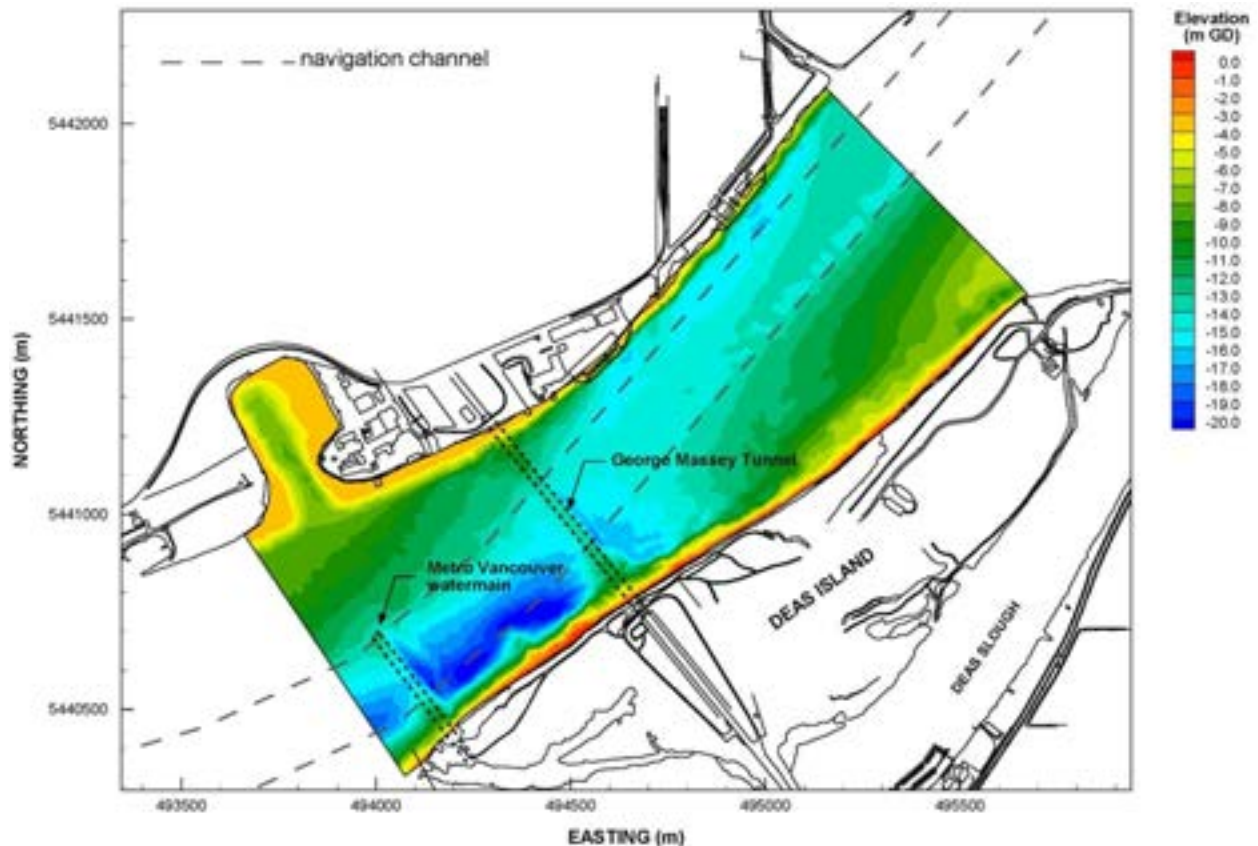


Figure 3 TELEMAC No.5 Road Model Mesh Extent

The SOG/LFR Model was used to evaluate far-field hydraulic impact and sedimentation associated with the proposed options. The model mesh has approximately 35,000 nodes, 63,000 elements and 10 levels in the vertical. The element lengths vary from approximately 3,000 m in the Strait of Georgia to about 50 m in the lower Fraser River. In the river reach near the Tunnel, the element lengths were further refined to about 30 m. The SOG/LFR model is driven at its open boundaries (Ballenas Island and Port Renfrew) by tidal levels obtained using WebTide Tidal Prediction model (Fisheries and Oceans) based on Foreman et al. (2000). Inflows to the Fraser River at Port Mann Bridge (km 42) were computed using a hydraulic model of the Fraser River that uses the MIKE11 one-dimensional hydrodynamic software developed by the Danish Hydraulic Institute. NHC prepared the Fraser River MIKE11 model for Fraser Basin Council in 2006 (NHC and Triton 2006) and updated it for B.C. Ministry of Environment two years later (NHC 2008).

The No.5 Road model was used to evaluate near-field hydraulic and sedimentation associated with the proposed options. The model mesh has approximately 11,000 nodes, 21,000 elements, and 10 levels in the vertical. The element lengths vary from approximately 20 m in the upstream to about 5 m in the vicinity of the Tunnel. This spatial resolution was used to better define the Tunnel geometry and hence better identify features in the flow field which could impact the local deposition pattern. The No.5 Road model is driven at its upstream boundary by a discharge and at its downstream boundary by a water level, both specified from the aforementioned Fraser River MIKE11 model.

2.4.1 Bathymetry

The model bathymetry was derived using the following datasets:

- Bathymetric survey data collected by CRA Canada Survey Ltd. on April 2, 2014. That survey extended approximately 500 m upstream and downstream of the Tunnel (**Figure 4**).
- For the Fraser River, 2014 bathymetric survey data from Public Works and Government Services Canada, and 2005 Fraser Basin Council LiDAR data were used.
- For Puget Sound, the Strait of Georgia, and Juan de Fuca Strait, the coarse dataset from the Canadian Hydrographic Service (CHS) bathymetry data was used.

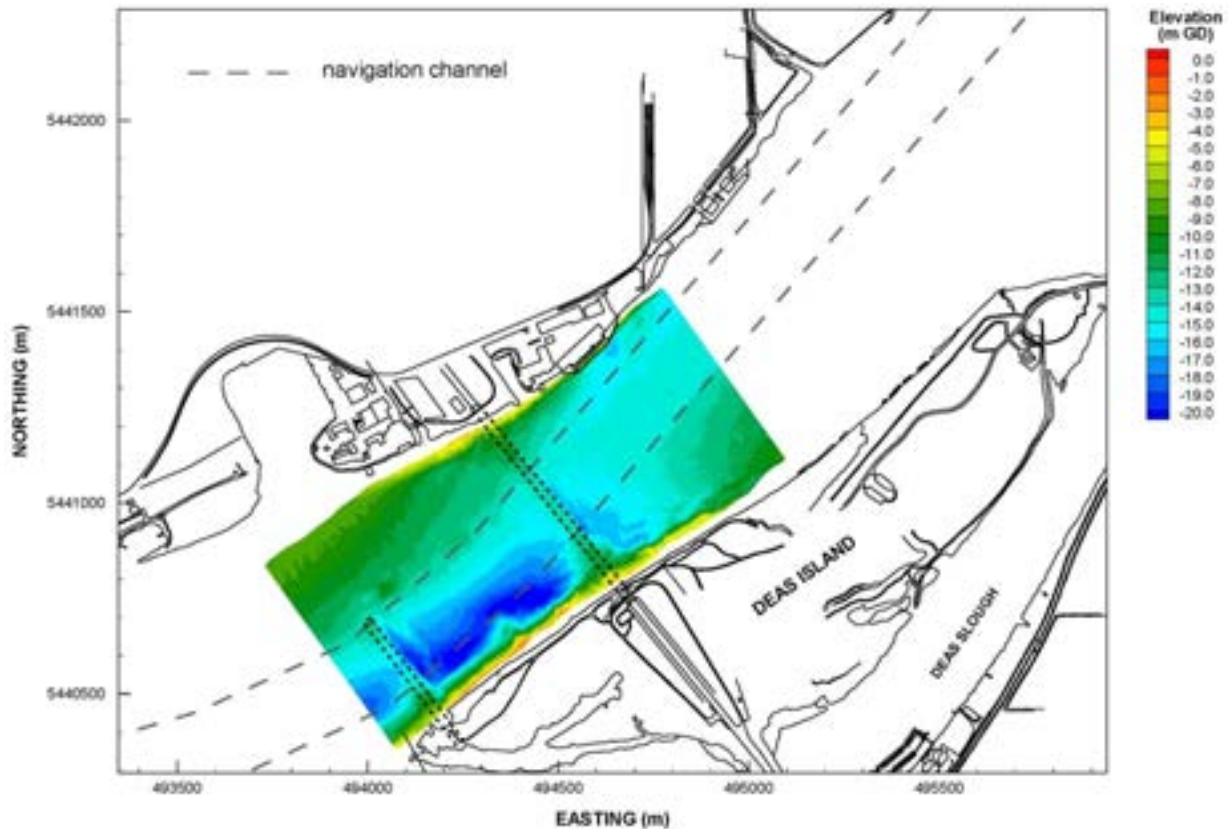


Figure 4 CRA Canada Surveys Ltd. April 2, 2014 Bathymetry Survey Result

2.4.2 Sediment Transport

The van Rijn formula (1993) was used to compute bed load and suspended transport. The formula distinguishes between sediment transport below the reference height, which is treated as bedload transport, and sediment transport above the reference height, which is treated as suspended load. Sediment is entrained in the water column by imposing a reference concentration at the reference height. The reference height is a function of effective roughness height, dune/ripple height and water depth.

The model incorporates transport of suspended bed materials as well as bed load. Sediment sizes in the model were based on known characteristics of Fraser River bed materials. Model sediment had a D_{50} (median diameter) of 250 μm and D_{90} (ninetieth percentile diameter) of 450 μm , based on surface samples collected by McLaren and Ren (1995) in the lower Fraser River between February 9 and April 7, 1993.

2.5 Model Limitation

Salinity was not incorporated in the model analyses; thus, the potential effect of the salt wedge on sediment dynamics is not represented. However, this is not expected to have a substantial effect on the model morphodynamics because approximately 80 percent of sediment discharge in the Fraser River occurs during freshet (Milliman 1980), when the salt wedge is forced to the mouth of the river. This relationship between discharge and sediment load can be better visualized in **Figure 5**.

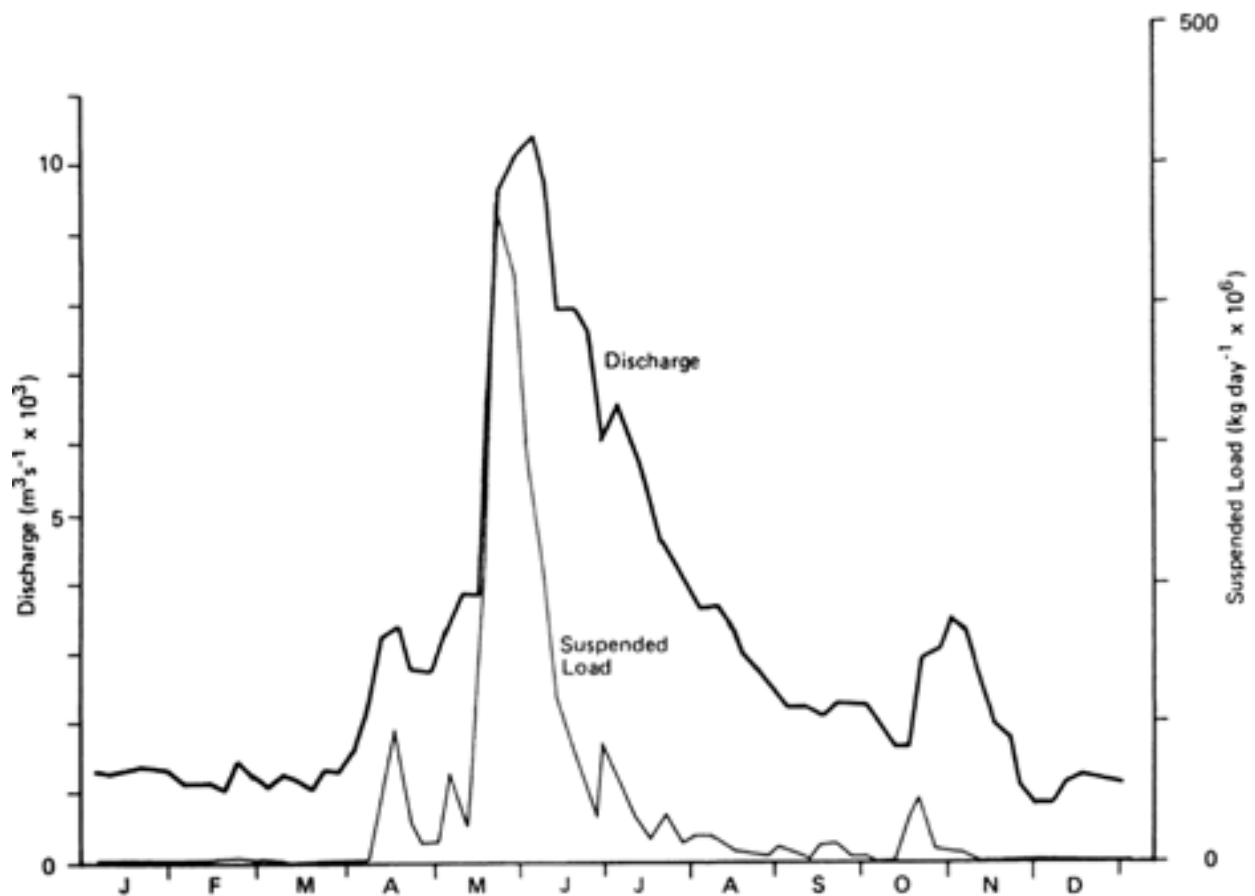


Figure 5 Mean Daily Discharge and Daily Suspended Sediment Load for the Fraser River at Mission during 1985 (data from Water Survey of Canada 1985)

Studies by Ward (1976) and Villard and Church (2003) stated that the salt wedge rarely extends farther than Steveston Bend when the Fraser River flow is greater than 5,000 m³/s. **Figure 6** shows the 2012 Fraser River flow at Hope and specific conductivity (function of salinity) measured from Environment Canada Fraser River Water located about three kilometres upstream of the Tunnel. The figure shows that limited saline water was detected at the buoy when the flows were greater than 4,500 m³/s.

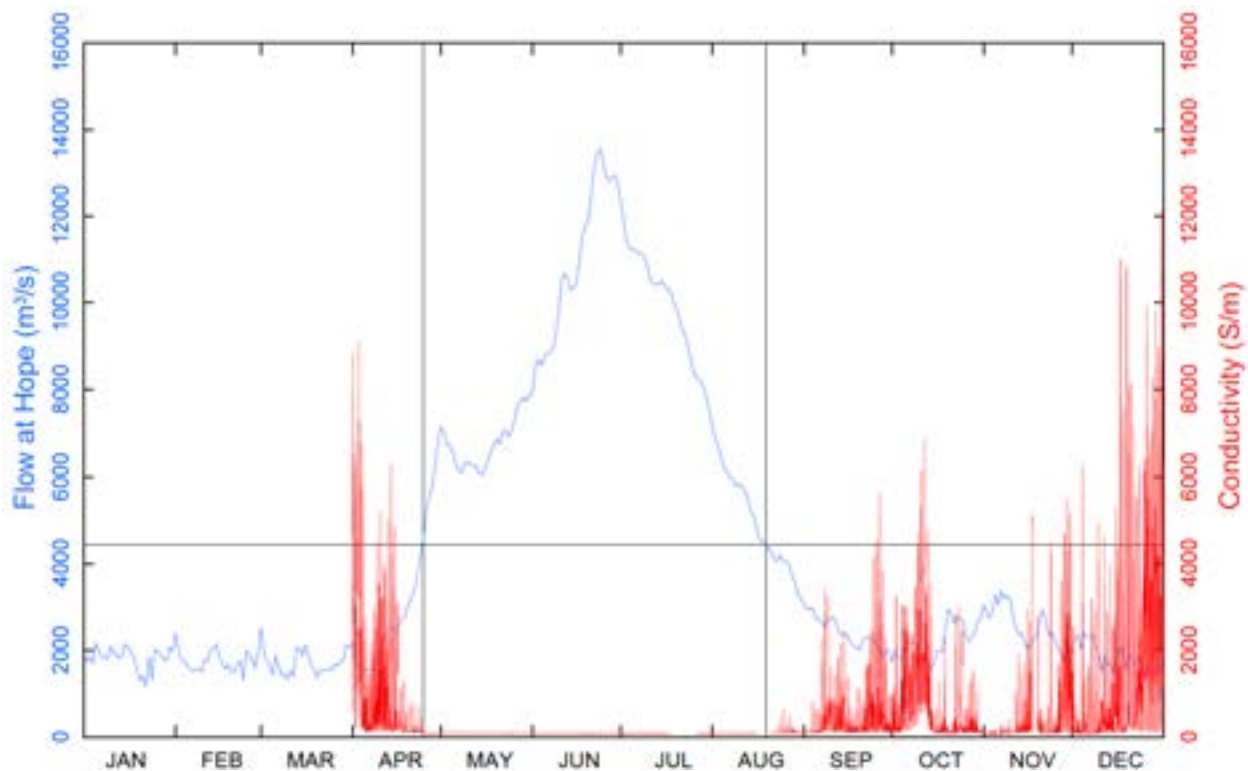


Figure 6 2012 Fraser River flow and Environment Canada Quality Monitoring Station

It is anticipated that the model could underestimate sediment shoaling in the lower reaches between Sand Heads and Steveston Bend, where the salt wedge persists during the freshet. Since the Tunnel is approximately 10 km upstream of the Steveston Bend, this simplification should not have a large influence on the modelling results during the freshet period.

During the non-freshet period, when the salt wedge could intrude over 30 km upstream of Sand Heads, the sediment load in the Fraser River is small compared to that during the freshet and the sediment movement is also small. Thus, not incorporating salinity into the model analyses should not have a large influence on the modelling results during the non-freshet period.

3.0 Model Calibration and Validation

A numerical hydrodynamic and sediment transport model requires adequate field data to perform calibration and verification of the model. For this study, both the hydrodynamic and the morphodynamic components of the model were validated using observed datasets collected from the study area and additional experimental data published in peer-reviewed literature.

To verify that both the SOG/LFR and No.5 Road models were subjected to the same hydraulic conditions, the modelled flow and water levels from the two models at km 18 and km 19 (near the Tunnel) of the Fraser River were compared and found to have good agreement (**Figure 7**). The root-mean-square error (RMSE) of the SOG model compared to the observed water levels at Deas Island was 0.23 m. The RMSE of the No.5 Road model compared to observed water levels was 0.22 m. The RMS deviation between the SOG and No.5 Road modelled water levels was 0.14 m.

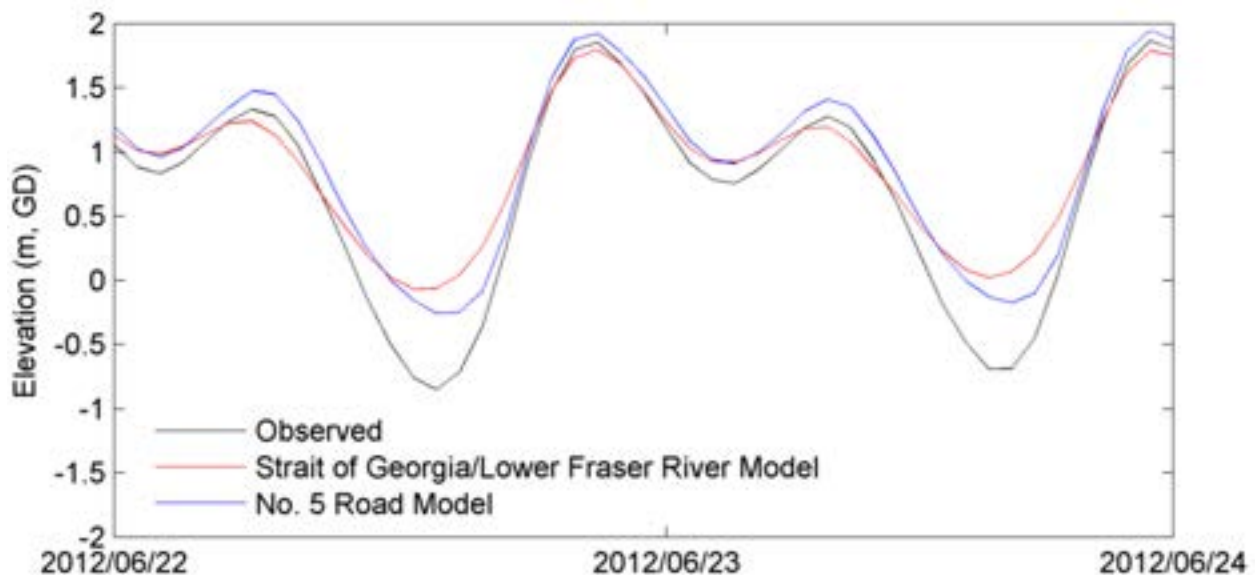


Figure 7 Comparison of Observed and Modelled Water Levels at Deas Island for the SOG/LFR and No.5 Road Models, during Peak of 2012 Freshet

3.1 Strait of Georgia/Lower Fraser River Model

The SOG/LFR model results were compared to the following observed datasets:

- Water levels at Steveston, the Tunnel, Port Mann Pumping Station, New Westminster, and Point Atkinson
- Discharge, flow split, and velocities from March 7 and March 27, 2014 Acoustic Doppler Current Profiler (ADCP) measurements
- Port of Vancouver dredging records from 2006 to 2012

3.1.1 Water Levels

Water Survey of Canada (WSC) operates three water level gauges along the Fraser River downstream of the Port Mann Bridge: at Steveston, the Tunnel, and Port Mann Pumping Station. In addition, Canadian Hydrographic Service (CHS) operates a tide gauge at New Westminster along the Fraser River. Beyond the mouth of the Fraser River, the closest CHS tide gauge is located at Point Atkinson.

The three WSC hydrometric stations and the two CHS tide gauges listed above were used to calibrate the SOG/LFR hydrodynamic model. **Figure 8** shows the location of the five stations used for the model calibration and **Table 1** lists the corresponding station information. The gauge locations extend from the upstream model boundary at Port Mann Pumping Station to Point Atkinson, beyond the influence of the Fraser River discharge.

Table 1 Water Level Gauges Used for Model Calibration

| Station | Latitude | Longitude | Station ID | Type |
|---------------------------|---------------|----------------|------------|------|
| Point Atkinson | 49° 20' 15" N | 123° 15' 14" W | 7795 | CHS |
| Steveston | 49° 07' 27" N | 123° 11' 06" W | 08MH028 | WSC |
| Tunnel | 49° 07' 30" N | 123° 04' 25" W | 08MH053 | WSC |
| New Westminster | 49° 12' 00" N | 122° 54' 37" W | 7654 | CHS |
| Port Mann Pumping Station | 49° 13' 04" N | 122° 49' 37" W | 08MH126 | WSC |

CHS – Canadian Hydrographic Service

WSC – Water Survey of Canada



Figure 8 Location of Water Level Gauges Used for Model Calibration

Observed and computed hourly water levels were compared for March, 2014 (**Figure 9**). This period was selected because data from two ADCP surveys were also available during this period. These data were used for the discharge, flow split, and velocity calibration (discussed below in **Sections 3.1.2, 3.1.3 and 3.1.4**).

Figure 9 shows that the model reproduces the observed characteristics of the water levels well. The tidal ranges, between the spring and neap tidal cycle, and times of high and low waters are well reproduced. The computed results generally had slightly lower peaks and higher troughs than the observed data, depending on the tidal conditions. For example, from March 21 to 24, 2014, the computed peak water levels are in very good agreement with the observed data, but the troughs are higher than the observed results. Whereas, from March 7 to 11, the troughs are in good agreement with the observed data, but the peaks are under-predicted.

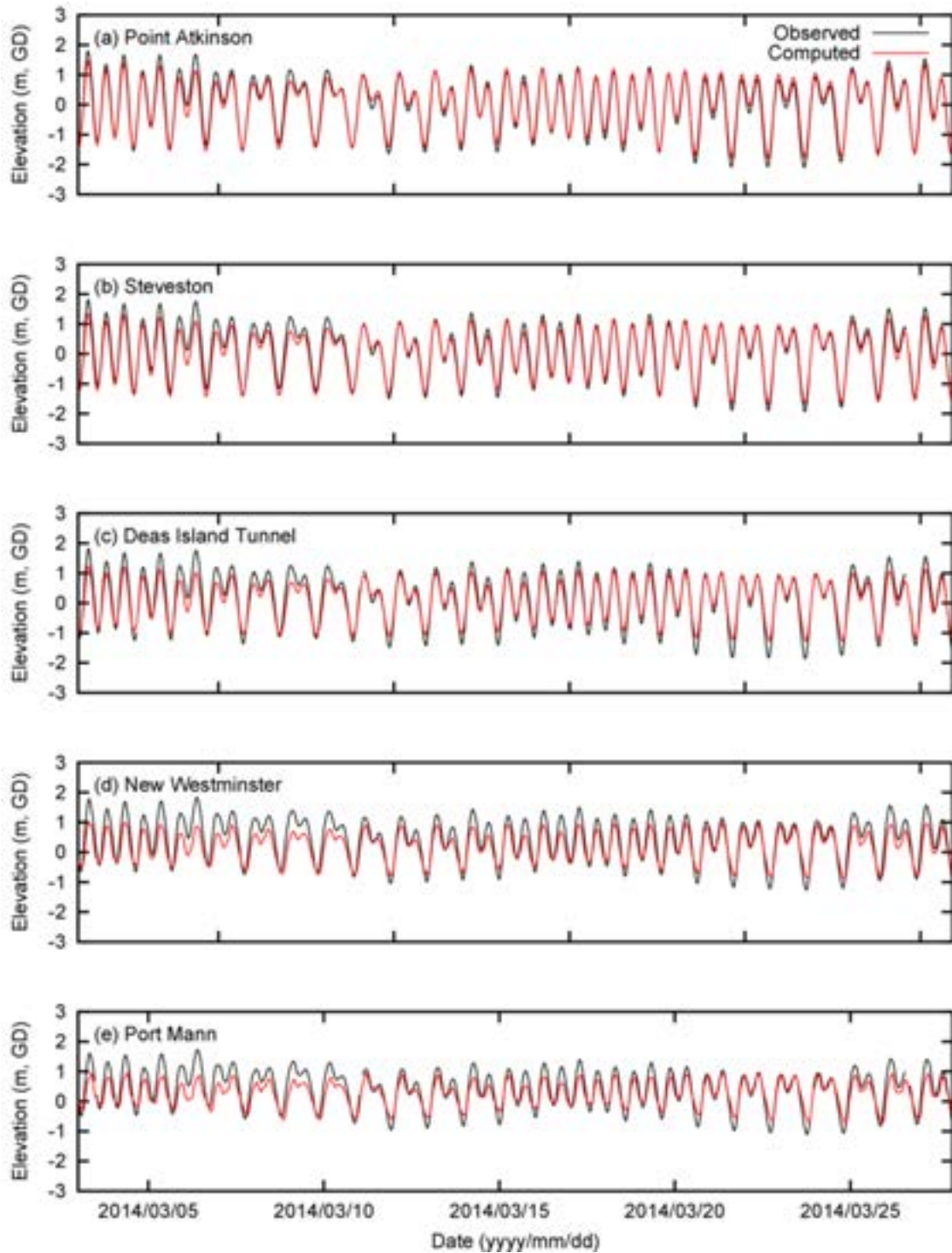


Figure 9 Observed and Computed Water Levels for March, 2014 at (a) Point Atkinson, (b) Steveston, (c) Tunnel, (d) New Westminster, and (e) Port Mann

Table 2 shows the RMSE between the computed and the observed water levels at the five stations used for model calibration (**Figure 8**). The results show that the closer the location is to the upstream boundary, the less accurate the computed water level is. Therefore, the upstream boundary condition is likely a main contributor to the difference between the observed and computed water levels. The source of this discrepancy is likely due to the use of the flow output from the MIKE11 model as input to the SOG/LFR model at the upstream boundary. The Fraser River MIKE11 model was developed for predicting flood levels on the Fraser River. Hence, the model was calibrated using peak flow conditions on the Fraser River. In March 2014, the freshwater Fraser River discharge at Hope ranged from 600 to 1,200 m³/s, whereas flood conditions can result in discharges in excess of 10,000 m³/s. Thus, the MIKE11 model may not perform as well for low river discharges such as are observed in March 2014.

Table 2 Comparison of Observed and Computed Water Levels for March 2014

| Station | RMSE (m) |
|-----------------|----------|
| Point Atkinson | 0.20 |
| Steveston | 0.24 |
| Deas Island | 0.28 |
| New Westminster | 0.39 |
| Port Mann | 0.36 |

At the Tunnel (**Figure 9c**), the agreement with the observed water levels is generally within ± 0.3 m (RMSE = 0.28 m). Note that the water level and discharge at the Tunnel are strongly influenced by tidal levels, and vary rapidly as the tide rises and falls. In March 2014, the observed data at Deas Island show that the water level varied as much as 0.25 m in 15 minutes.

It should also be noted that a portion of the discrepancy in elevations is the result of approximations made in the formulation of the elevation boundary condition at Port Renfrew and Ballenas Island. The predicted tide elevation is a function of the moon and sun, while the observed tide elevation includes the influence of the moon and sun as well as local atmospheric conditions, which can play a major role at a given location and time.

3.1.2 Discharge

ADCP surveys were conducted by NHC and CRA Canada Surveys Inc. on March 7 and 27, 2014. The Fraser River flows at Hope were 770 and 880 m³/s on these two days, respectively. The survey program was designed to capture the tide and flow dynamics between the Main Arm, Ladner Reach, Sea Reach, and Canoe Passage. Six transects were surveyed on each day and the locations of these transects are shown in **Figure 10**. The March 7 survey was conducted during the period of falling tide (**Figure 11a**) and the March 27 survey was conducted during the period of rising tide (**Figure 11b**).

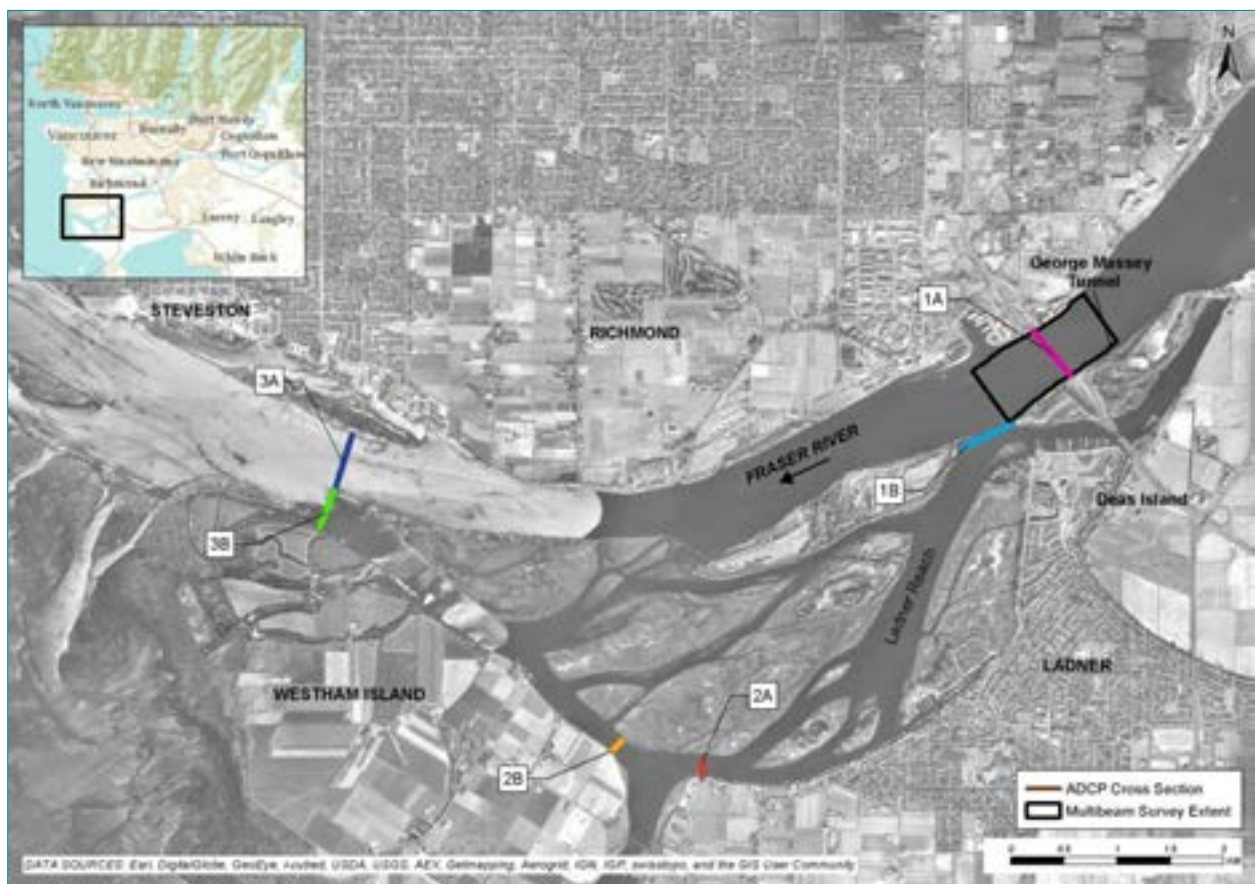


Figure 10 Location of ADCP Transects Conducted on March 7 and 27, 2014

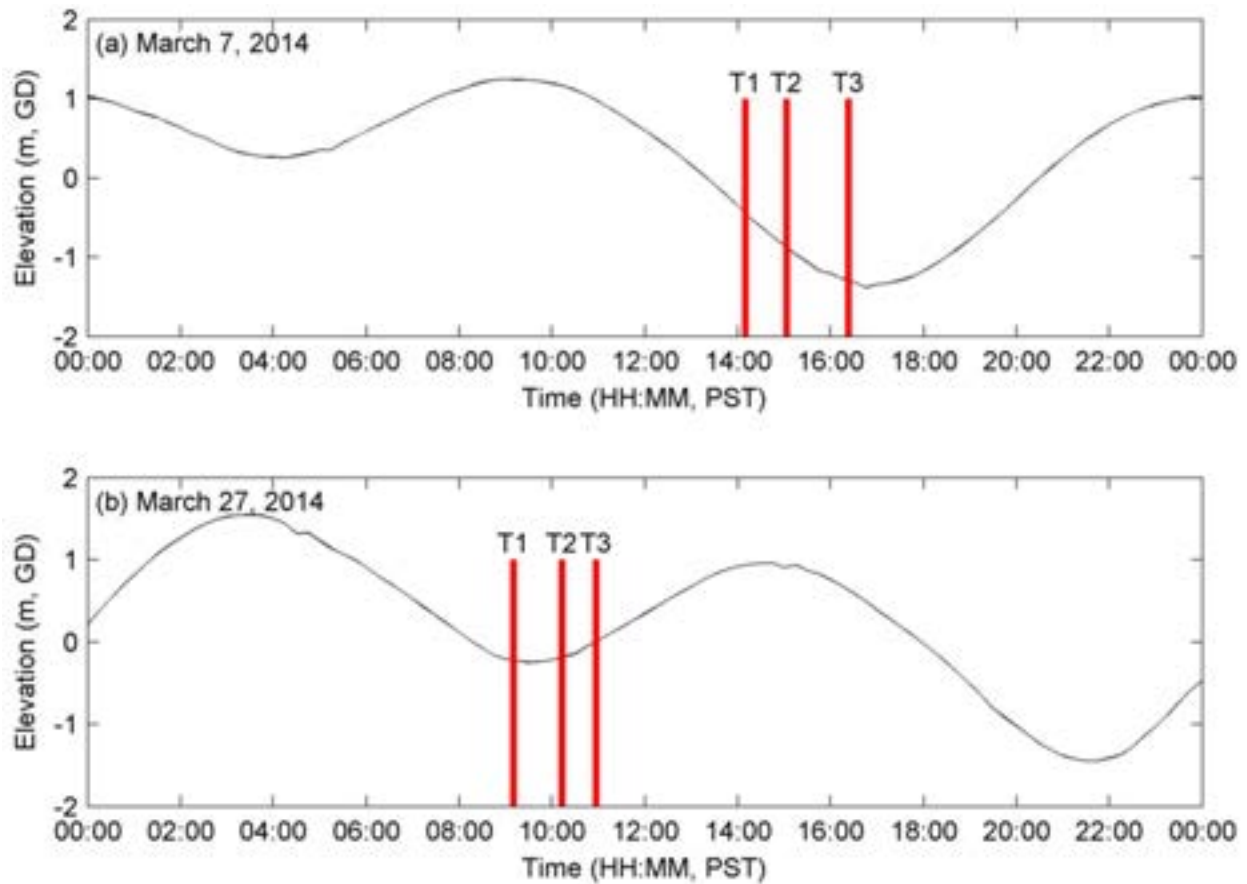


Figure 11 Observed Water Levels (black line) at the Tunnel for the Field Observations Conducted (a) March 7, 2014 and (b) March 27, 2014. The Time of Each Paired ADCP Transect is Marked T1 to T3.

The ADCP flow measurements and modelled results are compared in **Table 3**. The results show that the model under-predicted the discharge. This discrepancy is likely because the MIKE11 model was calibrated to peak flow conditions, whereas the ADCP measurements were taken during a low freshwater discharge (approx. 750 to 800 m³/s).

Table 3 **Modelled and Measured ADCP Flow Measurements**

| Transect | Date | Time (PST) | Measured Discharge (m ³ /s) | Computed Discharge (m ³ /s) |
|----------|------------|------------|--|--|
| 1a | 2014-03-07 | 14:09 | 7,525 | 5,919 |
| 1b | 2014-03-07 | 13:58 | 650 | 501 |
| 2a | 2014-03-07 | 15:02 | 788 | 659 |
| 2b | 2014-03-07 | 14:56 | 635 | 436 |
| 3a | 2014-03-07 | 16:22 | 7,765 | 6,152 |
| 3b | 2014-03-07 | 16:09 | 606 | 456 |
| 1a | 2014-03-27 | 9:10 | 6,366 | 4,643 |
| 1b | 2014-03-27 | 9:10 | 786 | 506 |
| 2a | 2014-03-27 | 10:12 | 549 | 414 |
| 2b | 2014-03-27 | 10:09 | 411 | 259 |
| 3a | 2014-03-27 | 10:57 | 2,596 | 2,880 |
| 3b | 2014-03-27 | 10:52 | 280 | 162 |

3.1.3 Flow Splits

A series of river training structures influence the flow conditions in the lower Fraser River and several large islands split the main channel. Also, as the Fraser River nears the ocean, several distributaries branch out from the Main Arm. Flow split data from the March 7 and March 27 ADCP survey was used to confirm model's ability to compute the distribution of flow around islands, training structures, and into distributaries. Measured and computed flow splits are compared in **Table 4**, **Table 5**, and **Table 6**.

Table 4 Modelled and Measured Flow Split at Main Arm and Ladner Reach

| Date | Measured | | Computed | |
|------------|-------------------------|--------------|-------------------------|--------------|
| | Main Arm Woodward Reach | Ladner Reach | Main Arm Woodward Reach | Ladner Reach |
| 2014-03-07 | 91% | 9% | 91% | 9% |
| 2014-03-27 | 88% | 12% | 89% | 11% |

Table 5 Modelled and Measured Flow Split at Ladner Reach, Sea Reach and Canoe Passage

| Date | Measured | | Computed | |
|------------|-----------|---------------|-----------|---------------|
| | Sea Reach | Canoe Passage | Sea Reach | Canoe Passage |
| 2014-03-07 | 81% | 19% | 62% | 38% |
| 2014-03-27 | 75% | 25% | 63% | 37% |

Table 6 Modelled and Measured Flow Split at Main Arm and Sea Reach

| Date | Measured | | Computed | |
|------------|-------------------------|-----------|-------------------------|-----------|
| | Main Arm Woodward Reach | Sea Reach | Main Arm Woodward Reach | Sea Reach |
| 2014-03-07 | 93% | 7% | 93% | 7% |
| 2014-03-27 | 90% | 10% | 95% | 5% |

The results show that there is good agreement between measured and computed flow splits from Main Arm (Transect 1a) into Main Arm – Woodward Reach, and Ladner Reach (Transect 1b) (**Table 4**).

At the split from Ladner Reach (Transect 2a) into Sea Reach (Transect 2b) and Canoe Passage (**Table 5**), the model predicts a greater fraction of the flow will exit through Canoe Passage than the observed data. Note that the observed flows in Ladner Reach (Transects 2a) were relatively small: 788 and 549 m³/s. The mouth of the Canoe Passage is strongly influenced by ocean conditions and the water levels and flows vary rapidly as the tide rises and falls. Thus, ADCP flow measurements are sensitive to the time they were taken and this could contribute to the difference between the observed and modelled flow split percentages. In addition, maintenance dredging took place in Ladner Reach in the spring of 2014. The model bathymetry did not

account for this recent event and this could have some effect on the flow split dynamics at Canoe Passage confluence. Measured and computed flows from Main Arm – Woodward Reach (Transect 3a) and Sea Reach (Transect 3b) into Main Arm – Steveston were in good agreement (**Table 6**).

The flow split results confirm that the model is, in most cases, accurately distributing the flow around islands, training structures, and into distributaries.

3.1.4 Velocity

Velocity measurements from the March 7 and March 27 ADCP survey were used to confirm model's ability to reproduce velocity distribution across the river channels. At each transect, the three-dimensional ADCP velocity measurements were depth-averaged over the water column. Depth-averaged transverse velocity profiles were extracted from the model results at the same locations and times as the ADCP measurements (**Figure 12** and **Figure 13**). The measured and computed velocities generally compared well, with the model tending to slightly under-predict velocities. The underestimate in velocity is likely a result of the underestimation in discharge imposed at the upstream boundary, predicted by the MIKE11 model as discussed in **Section 3.1.1**.

The velocity results show that the model reproduces the velocity distribution across the various river channels reasonably well. Exceptions are Transect 1b, where the flow enters Ladner Reach. A training structure extends upstream of Kirkland Island, which results in complicated flow patterns on its downstream side as the flow enters Ladner Reach. While the model does not capture these flow patterns particularly well, it does accurately predict the distribution of flow between the Main Arm and Ladner Reach (**Table 4**).

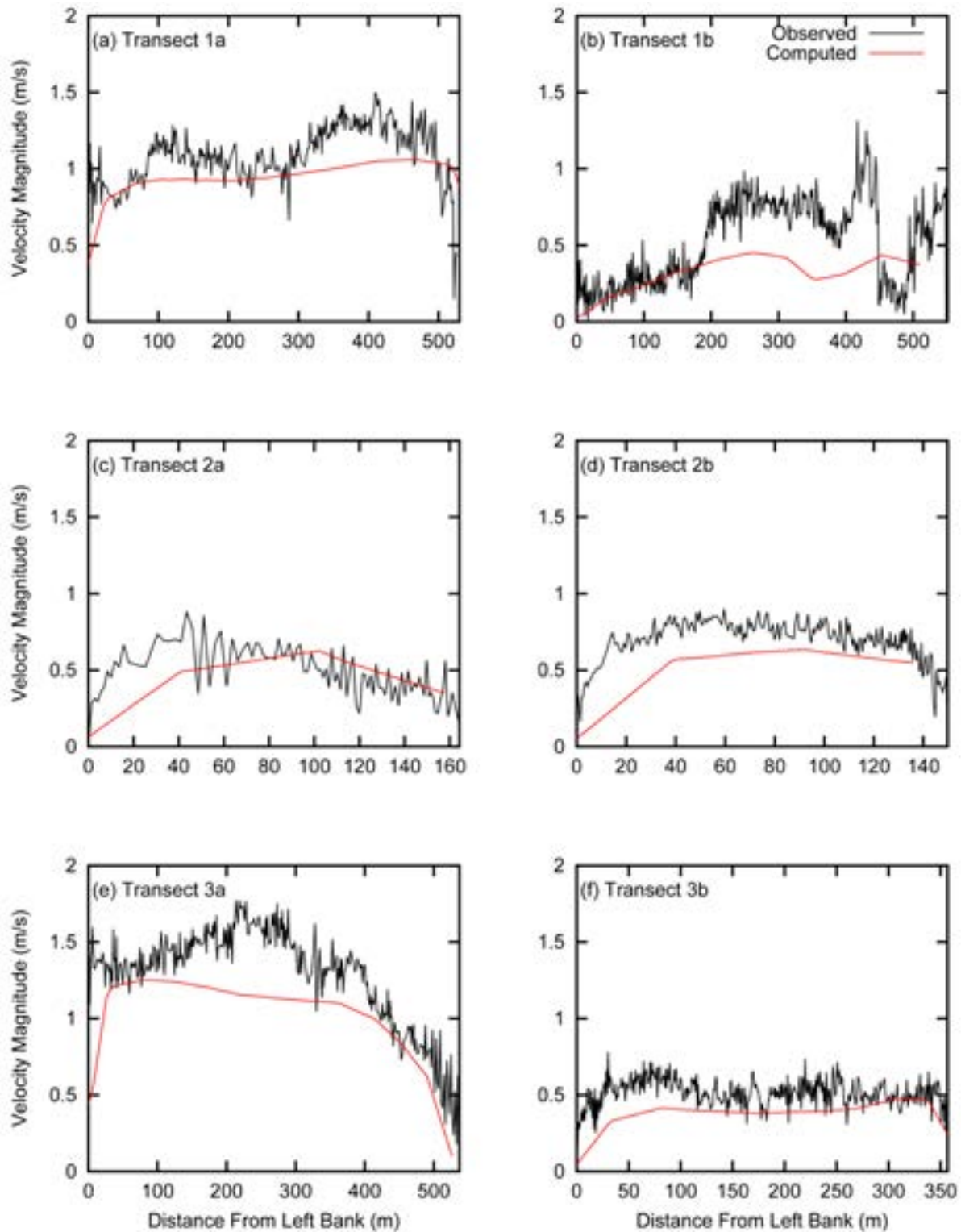


Figure 12 Depth-Averaged ADCP Velocity Measurements and Computed Results for March 7, 2014

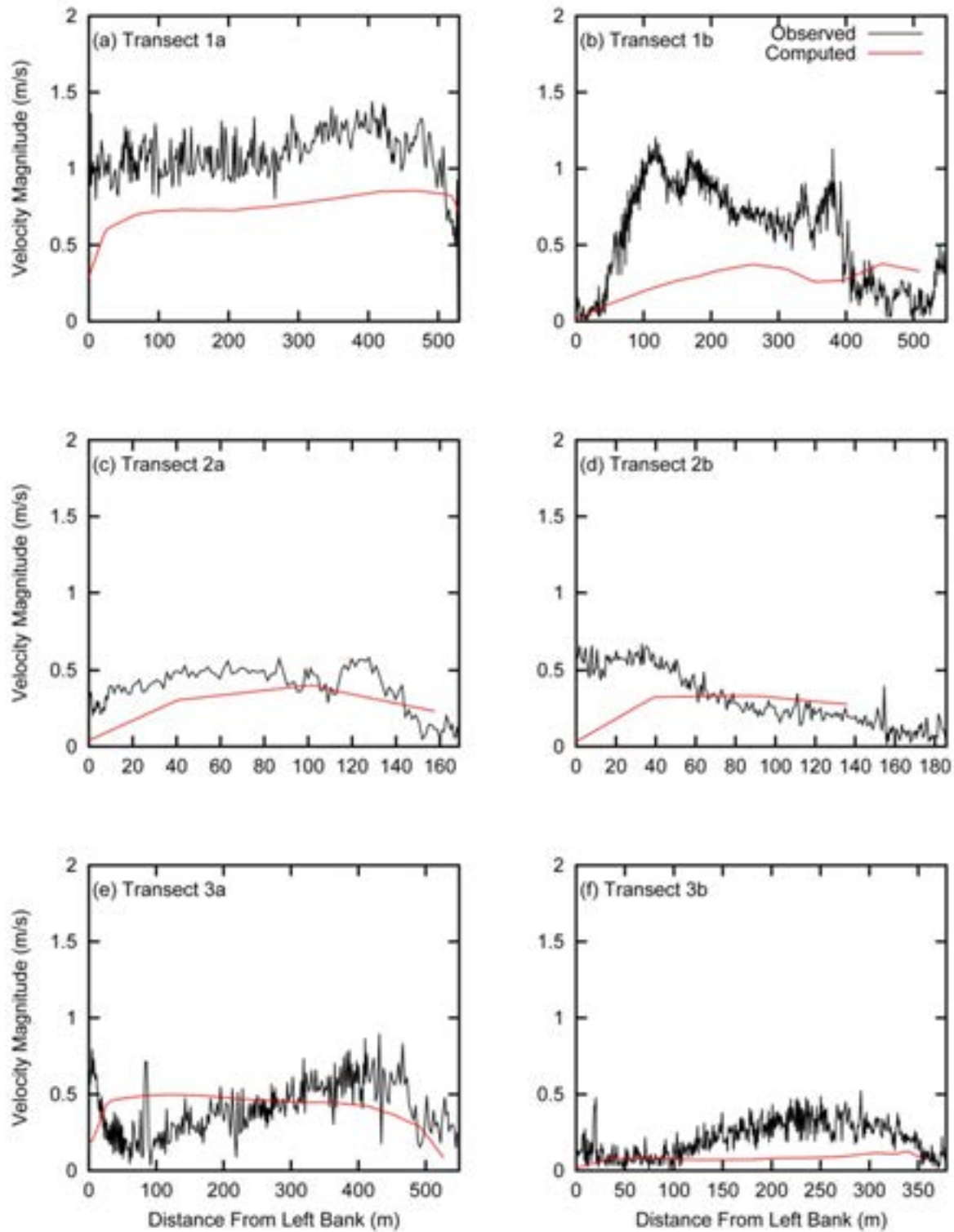


Figure 13 Depth-Averaged ADCP Velocity Measurements and Computed Results for March 27, 2014

3.1.5 Morphodynamic Model Validation

A coupled hydrodynamic–morphodynamic model was developed to provide hydraulic and scour/deposition information for lower Fraser River. TELEMAC's morphodynamic module, SISYPHE, computes changes in bed elevation by using the hydrodynamic information from the TELEMAC-3D model. The new bed elevations computed by SISYPHE are fed back into TELEMAC-3D to re-compute the flow hydrodynamics.

The coupled hydrodynamic–morphodynamic model results were compared to observed datasets to validate the morphodynamic component of the model. The model validation was divided into two parts. The first part was to demonstrate the ability of the model to predict the migration and infilling of a trench. The modelled results were compared to experimental data from van Rijn (1986). The migration and infilling of the trench, resulting from the Tunnel removal, is one of the key morphodynamic processes present in the study area. Therefore, the ability of the model to simulate trench migration is important in evaluating the potential effects of the Project. The second part of the morphodynamic model validation was to compare the modelled results to measured sediment loads and sedimentation patterns on the lower Fraser River.

3.1.5.1 Trench Migration Validation

Trench migration was simulated using TELEMAC's morphodynamic module, SISYPHE. The computed results were compared to experimental data presented in van Rijn (1986). The purpose of this modelling was to evaluate the performance of SISYPHE in simulating trench migration and infilling.

The results from the trench migration simulations were compared to the experimental data measured in a flume of length 30 m, height 0.7 m and width 0.5 m in the Delft Hydraulics Laboratory (van Rijn, 1986). The laboratory tests were carried out using sand of $D_{50} = 160 \mu\text{m}$, $D_{90} = 200 \mu\text{m}$ supplied at a rate of $q_s = 0.04 \text{ kg/s/m}$ (total load) to maintain equilibrium conditions in the upstream section of the trench. The mean flow velocity and water depth at that section were $u_0 = 0.51 \text{ m/s}$ and $h_0 = 0.39 \text{ m}$ during all tests. The trench dimensions were varied using initial side slopes of 3H:1V, 7H:1V, and 10H:1V. **Figure 14** shows a schematic of the numerical model setup based on the experiments by van Rijn (1986).

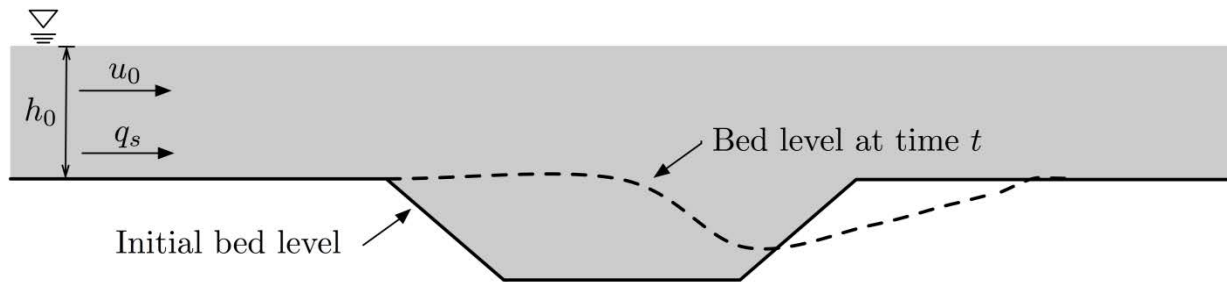


Figure 14 Problem Definition Sketch

Figure 15 shows the computed bed levels after 15 hours. The computed bed levels are in good agreement with the measured values. The maximum depth of the trench is predicted very well by the model. **Figure 15b** shows that the computed results slightly under-predict the infilling of the trench at the upstream end and that the trench does not migrate as far downstream as in the laboratory experiments. For all the trenches, the computed results slightly over-predict the infilling at the downstream end of the trench as it migrates downstream.

Overall, the model accurately predicts the migration and infilling of the trench over a range of trench geometries. This demonstrates the robustness of the model and suggests that it can be applied to problems with a range of geometries. The trench resulting from the Tunnel removal is expected to have initial side slopes of approximately 4H:1V on the upstream slope and 5H:1V on the downstream slope, as shown in the as-built drawings in **Attachment B**. These slopes are similar to those modelled in the trench migration validation simulations presented herein. While these flume experiments are not necessarily representative of the field conditions in the study area, the validation shows that the model is in agreement with the theoretical understanding of how an alluvial channel will respond to an excavated trench.

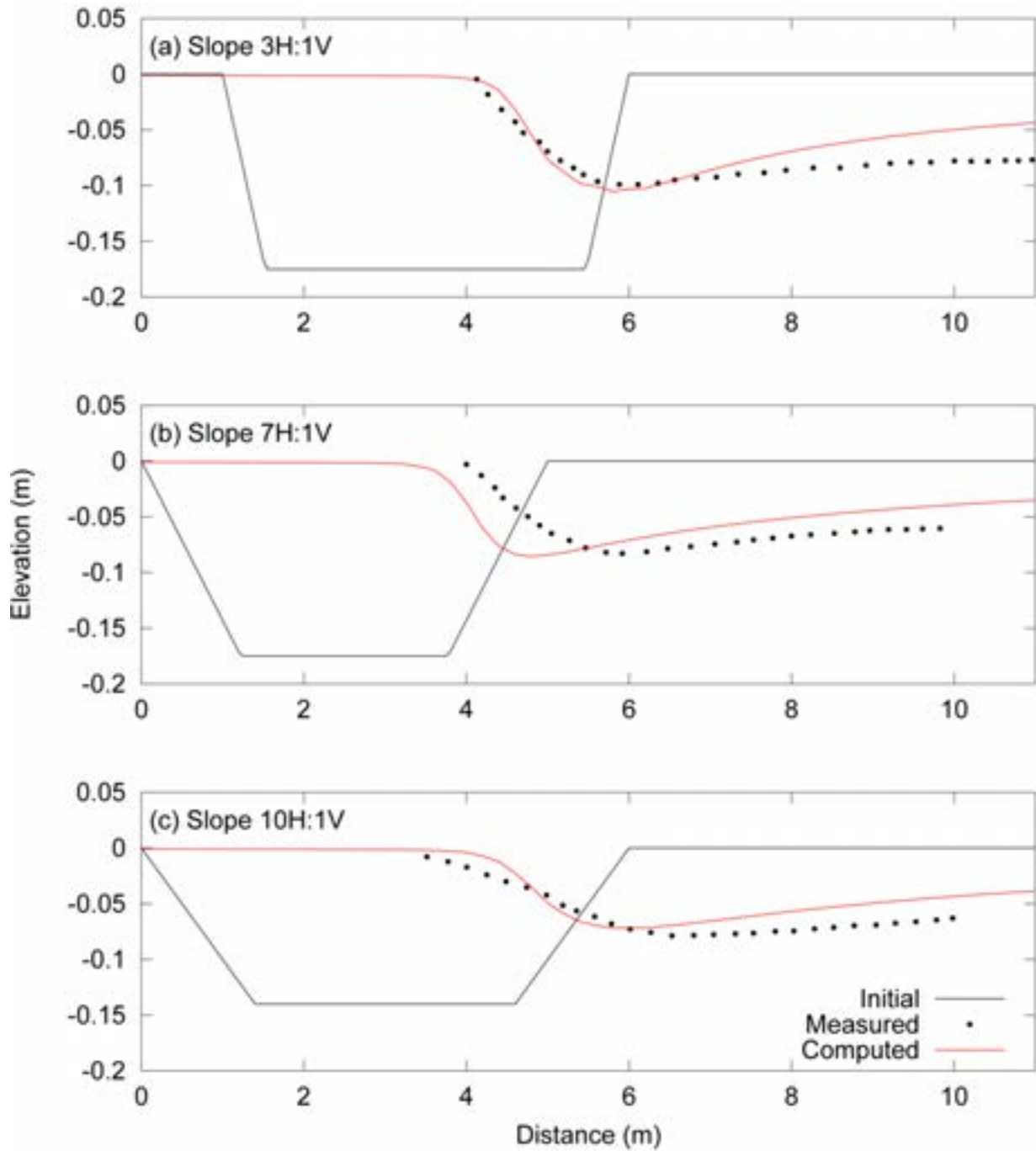


Figure 15 Computed and Measured Bed Level Profiles after 15 Hours for a Trench Initially Sloping at (a) 3H:1V, (b) 7H:1V, and (c) 10H:1V

3.1.5.2 Sediment Loads

In the lower Fraser River, fine sediments (also called washload) generally remain in suspension and therefore have little effect on sedimentation patterns. Of primary importance is the bed-material load, which is composed of the bed load and the fraction of sediment load capable of depositing in the river. This is the fraction of sediment that exerts an influence on river morphology and corresponds most closely with the modelled sediment sizes. Sediment loads on the lower Fraser River were measured by WSC at Hope, Agassiz, Mission, and Port Mann during the period 1965 to 1986. Based on that data, the bed-material load averaged 2.9 million tonnes/year, and ranged from 1.2 million to 8.9 million tonnes/year (NHC 2002).

Modelled sediment input over the course of the freshet period (May 26 to July 27) was 9.3 million m³ or about 15.3 million tonnes. This value is substantially larger than the long-term average bed material load of 2.9 million tonnes/year. However, the 2012 freshet was a large event with a return period of 20 years at Hope (WSC gauge 08MF005), and would have had a substantially higher than average sediment load. The largest measured bed material load occurred in 1972, and was 8.9 million tonnes. Peak flows and freshet timing and duration were comparable for 2012 and 1972, as shown in **Figure 16**.

In general, numerical models can be expected to predict sediment loads within an order of magnitude. The model has performed well by calculating a bed material load within approximately 70% of the measured value in a comparable year. This provides confidence that the morphodynamic model can be used for its intended purpose of analysing the effect of a particular change in the river (i.e. Tunnel removal); however, it should not be used to predict future sediment transport quantities or patterns.

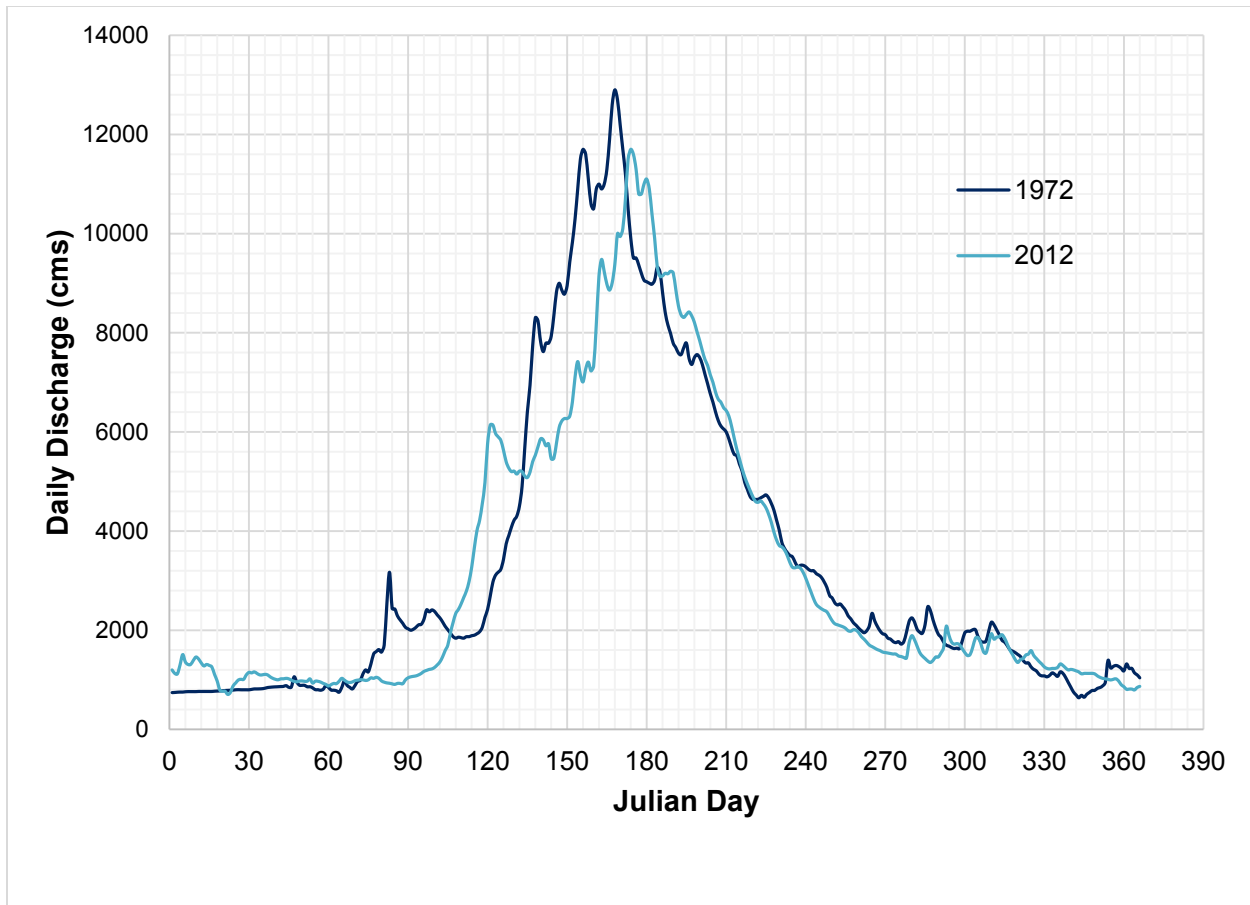


Figure 16 Fraser River Daily Discharge at Hope (WSC 08MF005) for the Years 1972 and 2012

3.1.5.3 Sedimentation Patterns

Model results were compared to observed sedimentation patterns on the lower Fraser River. The validation run began with 2013 PWGSC bathymetry (conditions as of March 2013) and used the 2012 freshet hydrograph. This period was selected because of availability of data for hydrodynamic model calibration and because of its relatively large freshet flow (1:20 year return flow). The freshet period during which the Hope flows were greater than 6,000 m³/s, an estimated threshold for significant sediment motion in the Fraser River, was chosen for the sedimentation analysis. For the 2012 freshet, this period was between May 26th and July 27th (**Figure 16**). **Figure 17** shows the sedimentation pattern in the lower Fraser River at the end of the simulation on July 27th.

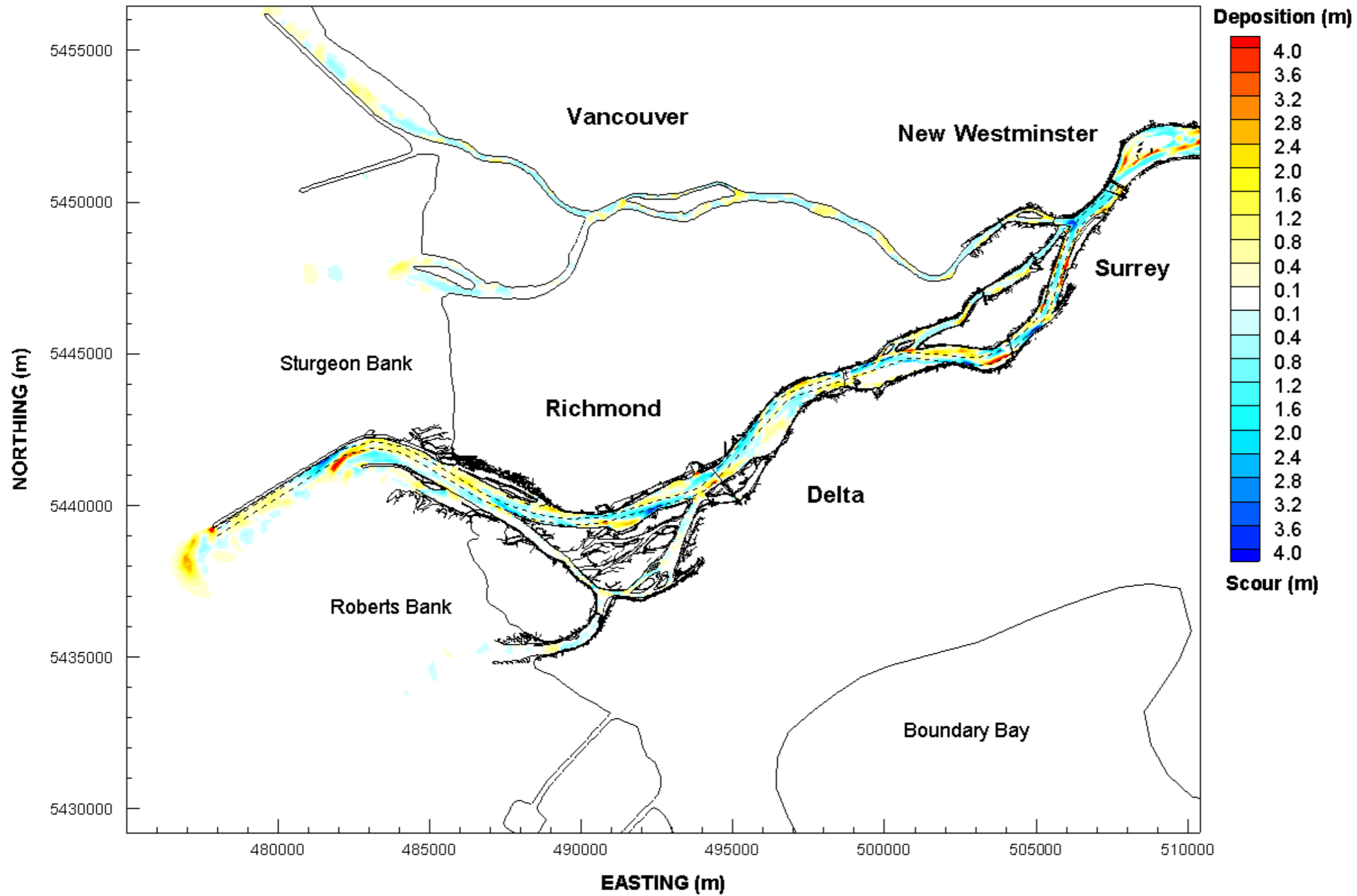


Figure 17 Scour/Deposition Map for 2012 Hindcast Simulation

The hindcast sedimentation pattern shows a good agreement with the established sedimentation patterns in the lower Fraser River, including the following attributes:

- Shoaling in the navigation channel in Sand Heads Reach between km 2 to km 4
- Shoaling on the south side of the navigation channel in Sand Heads Reach between km 4 to km 5
- Scour in the Steveston Jetty bend between km 5 to km 7
- Deposition along Steveston Cut between km 7 to km 12
- Scour along Kirkland Island between km 13 to km 14
- Deposition on the outer bend of St. Mungo's Bend between km 27 to km 30
- Deposition at the Fraser Surrey Dock (km 33)

Another approach to validating the morphodynamic model is through examining the shoaling rate in the system. Accurate shoaling rates for the lower Fraser River are expensive and time consuming to determine because of the necessity to conduct hydrographic surveys on a regular basis over an extended period of time. When no data on shoaling rates are available, it may be possible to substitute with dredge records. However, comparing the modelled dredge volume with the available dredge record from Port of Vancouver (PoV) was problematic. The PoV data are based on the dredging activity that takes place over the course of the standard calendar year (January to December), whereas the modelled dredge volume accounts for the volume required to be removed from the river in order to meet the design grade over the course of the dredging calendar (mid-June to mid-March). Spot dredging also takes place over the course of the freshet to keep the channel safe, but is not accounted for in the model simulation.

Despite the difficulties inherent in comparing the model results with the dredge record, the two should follow similar trends. Based on recent PoV dredge records (2006 to 2012), the annual dredging volume ranged between 2.4 and 3.1 million m³; the average annual dredging volume was 2.8 million m³. The modelled maintenance dredging volume² for 2012 was similar, at 2.5 million m³, providing confidence that the model adequately captures the sediment dynamics in the lower Fraser River.

² The current deep-sea shipping channel in the Fraser River is designed to accommodate vessels with a maximum draught of 11.5 m. Required maintenance dredging volume is computed by comparing the bed surface elevation at the end of the simulation to the design grade - the minimum dredge depth that allows an 11.5 m draft vessel to safely transit under the lowest high tide. If the modelled bed surface elevation is shallower than the design grade, then dredging is required.

3.2 No.5 Road Model Validation

The No.5 Road model results were compared to the following datasets:

- Observed water levels at the Tunnel
- Computed water levels at the Tunnel using the SOG/LFR model
- Velocity measurements from March 7th and March 27th, 2014 ADCP surveys

3.2.1 Water Levels

Within the extents of the No.5 Road model, WSC operates one continuous water level gauge at the Tunnel. This WSC hydrometric station was used to calibrate the No.5 Road model.

Observed and computed water levels were compared for March, 2014 (**Figure 18**).

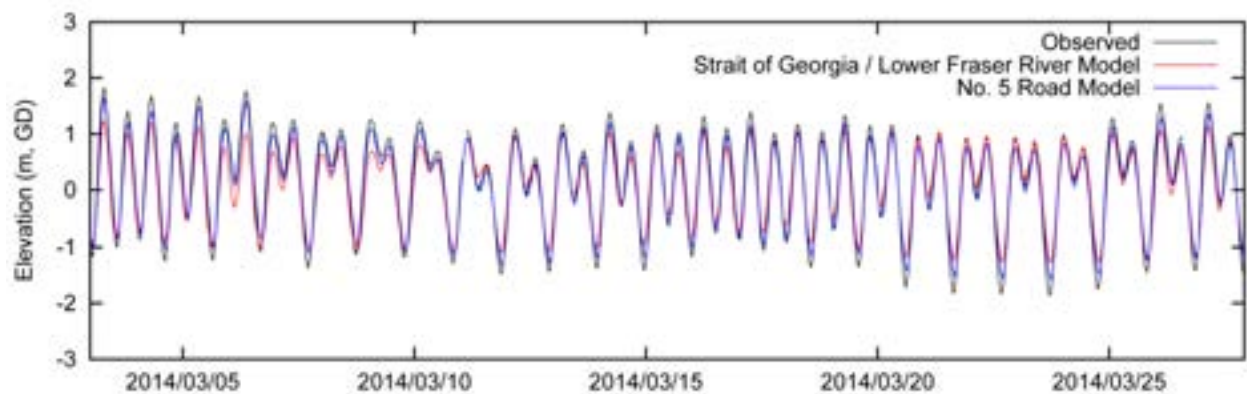


Figure 18 Observed and Computed Water Levels at the Tunnel for March 2014

Computed and observed water levels at the Tunnel were compared. Overall, the model reproduced the observed water levels well. The computed water levels were generally within ± 0.2 m (RMSE = 0.17 m) of the observed values, which is less than the error for the SOG/LFR model (RMSE = 0.28 m). This suggests that using the No.5 Road model, which has a smaller computational domain, will not result in an increased level of error compared to the larger SOG/LFR model. Thus, the No.5 Road model can be used to investigate the local conditions in the vicinity of the project site with a higher resolution than would be practical using the SOG/LFR model.

3.2.2 Velocity

Results from the No.5 Road model were compared to the observed velocity measurements along Transect 1a for the ADCP surveys conducted on March 7 (**Figure 19**) and March 27 (**Figure 20**), 2014. The computed results capture the same features observed in the ADCP surveys; for example, the region of higher velocity in the north (right) half of the channel (**Figure 19**). The model tends to under-predict the velocity near the free-surface and over-predict the velocity near the bed. Possible reasons for the differences in the vertical velocity distribution include density stratification due to the Fraser River salt wedge (not considered in the model), wind action on the free-surface, or the model requiring a higher spatial resolution in the vertical direction. The depth-averaged velocity in **Figure 21** shows that while there are differences in the vertical velocity distribution, the depth-averaged velocity across the channel is well-represented.

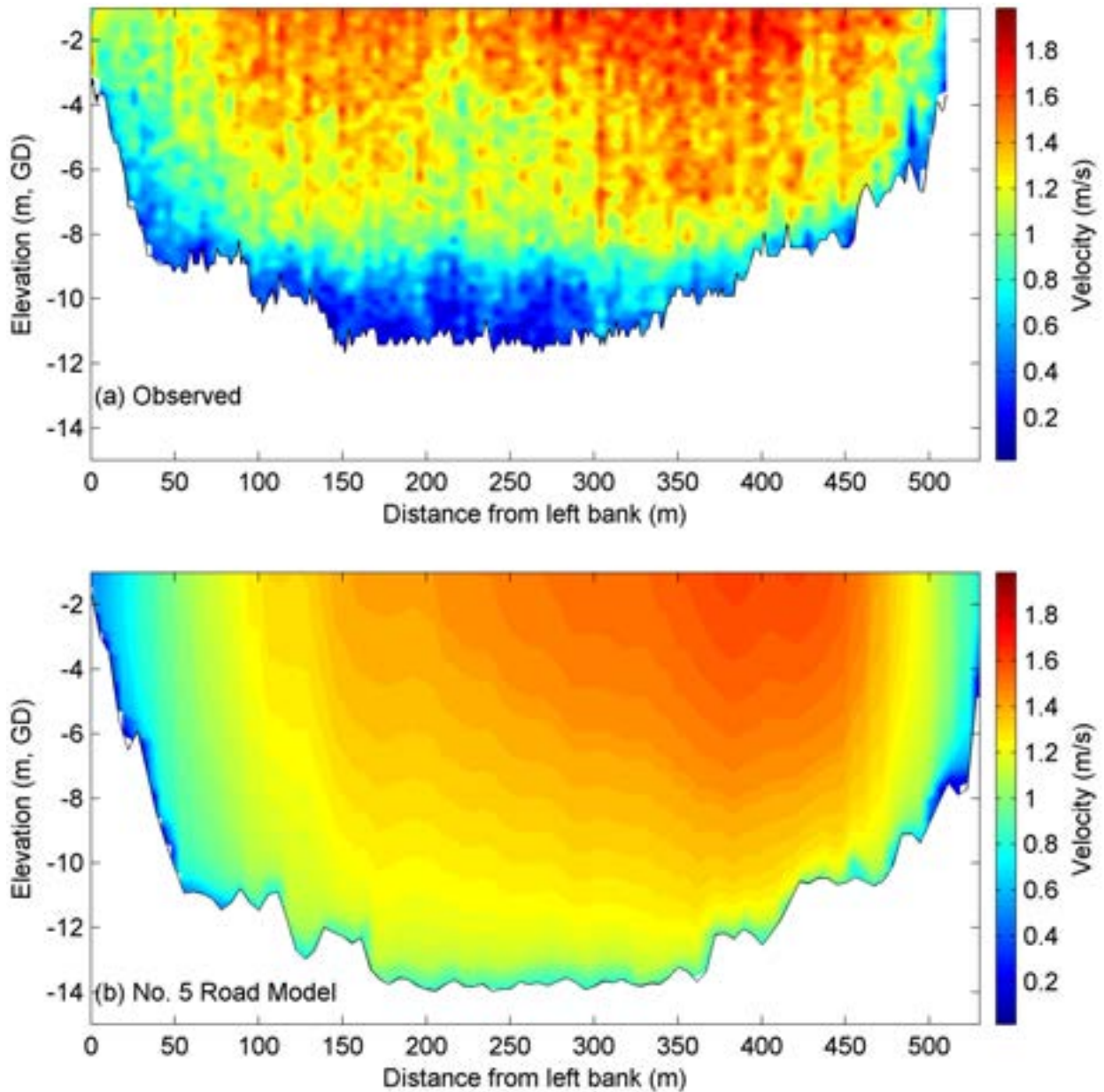


Figure 19 ADCP Velocity Measurements and Computed Results for March 7, 2014 at Transect 1a

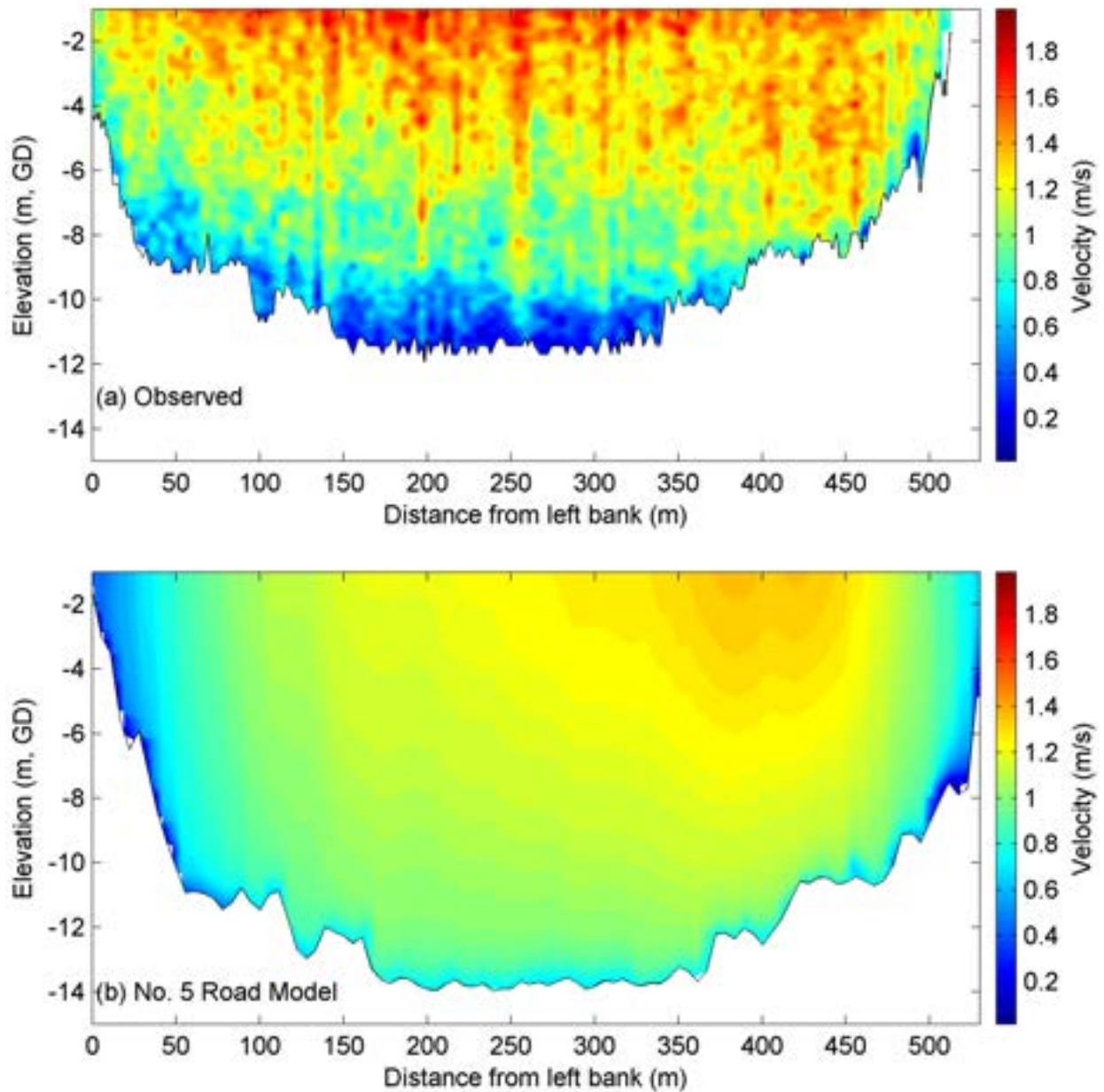


Figure 20 ADCP Velocity Measurements and Computed Results for March 27, 2014 at Transect 1a

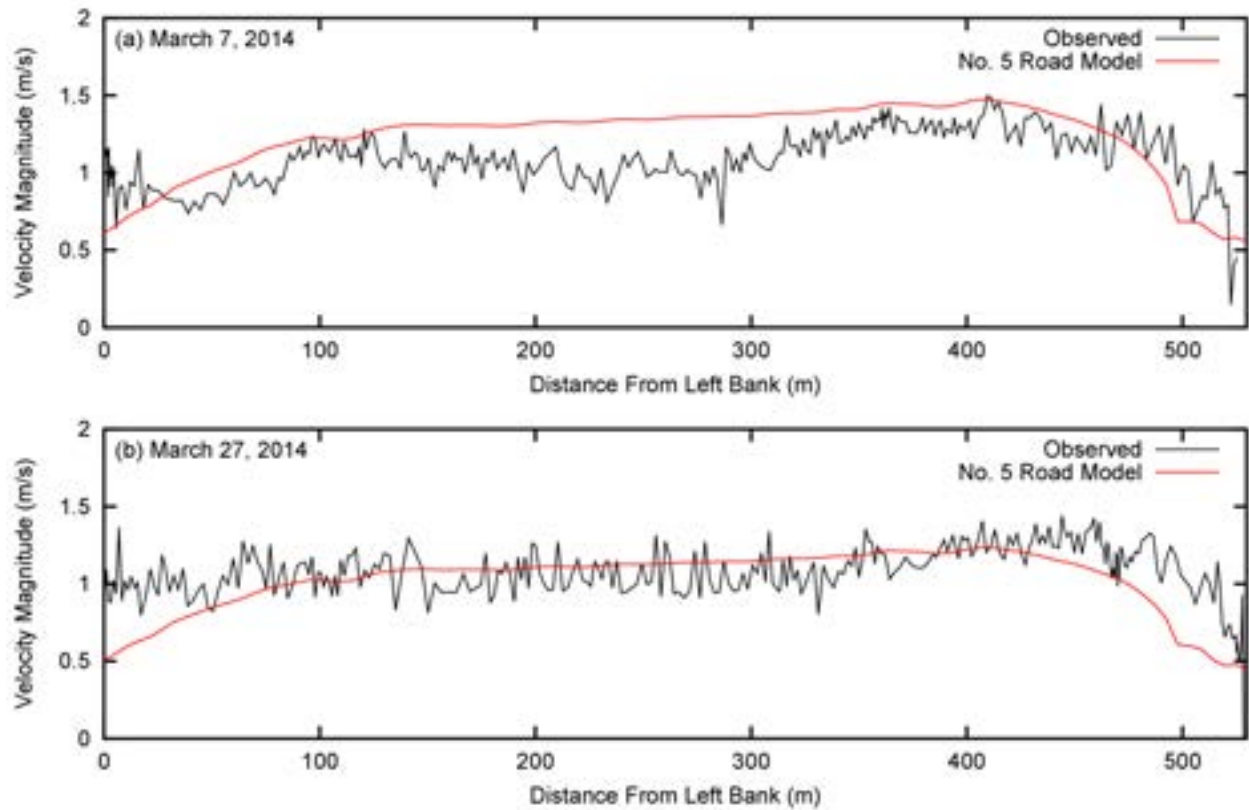


Figure 21 Depth-averaged ADCP Velocity Measurements and No.5 Road Model Computed Results for Transect 1a, March 7 and 27, 2014

4.0 Summary

A coupled hydrodynamic–morphodynamic model was developed to provide hydraulic and scour/deposition information for lower Fraser River. The model results were compared to observed water levels; discharge, flow splits and velocity measurements; laboratory experiments of trench migration; and sediment loads and dredging records on the lower Fraser River. The validation results demonstrate that the model is capable of reproducing the characteristics of the water levels, tidal conditions, river currents and sedimentation patterns.

5.0 References

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**George Massey Tunnel
Replacement Project**



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Ministry of
Transportation
and Infrastructure

Section 16.3

UNDERWATER NOISE MODELLING STUDY

Technical Volume

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1.0 Underwater Noise Modelling

Computational acoustic models were used by JASCO Applied Sciences Ltd. to predict the noise footprints of Tunnel decommissioning and bridge construction activities. The appendix presents the results of this modelling as well as the assumptions made regarding construction scenarios, equipment types, and source noise levels.

1.1 Modelled Construction Noise Scenarios

Acoustic modelling was conducted for six construction scenarios as summarized in **Table 1** to help predict Project-related changes in underwater noise levels within Fraser River South Arm, and Deas and Green Sloughs: impact pile driving; vibratory pile driving; vibrodensification; removal of sediment overlying the Tunnel; lifting one Tunnel segment; and Tunnel decommissioning involving simultaneous sediment removal, rip-rap removal, and lifting of a Tunnel segment. All modelling scenarios considered the influence of bathymetry and riverbed geoacoustics on waterborne sound propagation.

Table 1 Specifications of Modelled Construction Scenarios

| Scenario | Description | Noise Source(s) | Source Coordinates |
|----------|---|-----------------------|--------------------------------|
| 1 | Impact hammer driving of a cylindrical pile along the edges of Deas Slough | Impact hammer | 49° 6.911' N 123° 4.082' W |
| 2 | Vibratory hammer driving of a cylindrical pile along the edges of Deas Slough | Vibratory hammer | 49° 6.911' N 123° 4.082' W |
| 3 | Vibrodensification in Deas Slough | Vibrodensifier | 49° 6.911' N 123° 4.082' W |
| 4 | Cutter suction dredging at Tunnel crossing | Cutter suction dredge | 49° 7.292' N 123° 4.562' W |
| | | Tug 1 (downstream) | 49° 7.318' N 123° 4.598' W |
| 5 | Tug and barge activity during crane lift of Tunnel segments | Tug 1 (downstream) | 49° 7.3179' N 123° 4.598' W |
| | | Tug 2 (upstream) | 49° 7.318' N 123° 4.430' W |

| Scenario | Description | Noise Source(s) | Source Coordinates |
|----------|--|-----------------------|-------------------------------|
| 6 | Simultaneous removal of sediment and rip-rap and crane lift of Tunnel segments | Cutter suction dredge | 49° 7.314' N 123° 4.581' W |
| | | Clamshell dredge | 49° 7.306' N 123° 4.459' W |
| | | Tug 1 | 49° 7.329' N 123° 4.601' W |
| | | Tug 2 | 49° 7.298' N 123° 4.561' W |
| | | Tug 3 | 49° 7.244' N 123° 4.513' W |
| | | Tug 4 | 49° 7.226' N 123° 4.492' W |
| | | Tug 5 | 49° 7.212' N 123° 4.467' W |
| | | Tug 6 | 49° 7.195' N 123° 4.447' W |
| | | Tug 7 | 49° 7.240' N 123° 4.355' W |
| | | Tug 8 | 49° 7.259' N 123° 4.379' W |
| | | Tug 9 | 49° 7.274' N 123° 4.340' W |
| | | Tug 10 | 49° 7.292' N 123° 4.422' W |
| | | Tug 11 | 49° 7.290' N 123° 4.439' W |
| Tug 12 | 49° 7.320' N 123° 4.479' W | | |

1.1.1 Construction Activities Excluded from the Model

The modelling focused on construction activities expected to generate underwater sound levels that would exceed the existing background ambient noise. Activities such as separation of the bulkhead connections between Tunnel segments may require the use of specialized equipment. Potential effects of underwater noise generated by such equipment will be assessed using sound data collected during Tunnel decommissioning and mitigation measures will be put in place to manage such effects as appropriate.

1.2 Source Noise Levels for Construction Activities

1.2.1 Impact and Vibratory Driving of Cylindrical Piles

Underwater acoustic sound generated from impact and vibratory driving at the pile wall was predicted using JASCO's pile driving source model (MacGillivray 2013). The forcing function (the applied force from the hammer versus time) at the top of the pile is related to the proposed hammer type and hammer energy. The forcing function was modelled with the GRLWEAP 2010 model (Pile Dynamics Inc. 2010), which includes a large database of various hammers and associated manufacturers' specifications.

The predicted forcing function was coupled to a one-dimensional finite-difference model to account for the vibrational coupling between the pile and the surrounding water and sediments. The pressure radiating from the pile wall was computed using a vertical array of individual sources (monopoles) distributed along the pile to account for the boundary condition between the pile wall and surrounding water. A typical impact hammer for the two-metre diameter steel pipe piles was selected based on a review of existing hammers and on a discussion with the Project engineers. The impact hammer type that was modelled (a Delmag D100-13 with a rated energy output of 360 kJ) was chosen based on communication with the Project engineers and a review of existing hammer types used in North America for the proposed pile diameter, length, and pile materials. Based on the manufacturer's specifications, the impact hammer was assumed to operate at 35 blows per minute at the maximum hammer energy (Hammer & Steel 2014). The vibratory hammer type that was modelled was an APE-400B with a rated power output of 738 kJ. **Table 2** shows the pile dimensions and hammer specifications that were used in the GRLWEAP and JASCO pile driving models to compute source levels for both impact and vibratory pile driving.

Table 2 Engineering Specifications of Pile Driving Equipment

| Hammer Method | Pile Size (diameter x length) | Hammer Type | Hammer-Energy (kJ) | RAM Mass (tons) | Blows Per Minute |
|---------------|-------------------------------|----------------|--------------------|-----------------|------------------|
| Impact | 2 m x 85 m | Delmag-D100-13 | 360 | 10.01 | 35 |
| Vibratory | 2 m x 85 m | APE-400B | 738 | 0.35 | - |

Sound levels were computed for distances of up to 100 m from the source (i.e., far-field source levels) by propagating the pressure field of each individual monopole source from the pile driving source model out to 100 m range using JASCO’s Full-Waveform Range-dependent Acoustic Model (FWRAM; see **Section 1.3.1**). The 1/3-octave band received levels were then back-propagated to the standard one-metre reference range using transmission loss that was computed with JASCO’s Marine Operations Noise Model (MONM; see **Section 1.3.2**). Sound levels from the pile-driving scenarios described in **Table 1** were then modelled with MONM using the far-field source levels.

The 1/3-octave band far-field source levels for the impact hammer are shown in **Figure 10**. The broadband source level for this activity is 220 dB re 1 $\mu\text{Pa}^2\text{s}$ at 1 m. The forcing function modelled with GRLWEAP for this hammer, and the monopole source spectra for impact pile driving sampled at three different depths, are shown in **Figure 11** and **Figure 12** respectively.

The 1/3-octave source levels for the vibratory hammer are shown in **Figure 13**. The estimated broadband source level for this activity is 217 dB re 1 μPa at 1 m. The forcing function with GRLWEAP for this hammer is shown in **Figure 14**. The monopole source spectra for vibratory pile driving sampled at three different depths are shown in **Figure 15**.

1.2.2 Vibrodensification

Source levels for vibrodensification were obtained from measurements taken by JASCO at the Roberts Bank Terminals, B.C. (Austin 2007). The maximum of the two measurements in each 1/3-octave band between 10 Hz and 40 kHz were used. Source levels above 40 kHz were extrapolated using the trend between 20 and 40 kHz. The broadband source level for the vibrodensifier used in this modelling study was 182 dB re μPa at 1 m. The modelled 1/3-octave band source levels are shown in **Figure 13**. The modelled source depth for vibrodensification was taken to be at mid-water column (2.5 m).

1.2.3 Sediment Removal to Facilitate Tunnel Decommissioning

Source levels for cutter suction dredging operations to remove sediment overlying the Tunnel were derived from measurements of a cutter suction dredge obtained by JASCO for the Deltaport Third Berth project (Zykov et al. 2007). Source levels were extrapolated above the maximum measured frequency of 40 kHz using the trend between 20 and 40 kHz. Sounds below 1 kHz were assumed to originate from inside the dredge hull, whereas sounds above 1 kHz were assumed to originate from the cutter head at the riverbed (Robinson et al. 2011). The source depth for the dredge hull was modelled at 2.14 m below the water surface; the source depth of the cutter head was modelled at one metre above the riverbed. The modelled broadband source level of the cutter suction dredge was 182 dB re 1 μ Pa and **Figure 13** shows the modelled 1/3-octave band source levels.

Source levels for clamshell dredging associated with Tunnel decommissioning were based on published measurements of two dredges (Miles et al. 1987, Dickerson et al. 2001). Where measurements were presented as received levels at a specified distance rather than source levels at a reference of one metre, source levels were back-propagated using environment-based transmission loss modelling. Averaged 1/3-octave band source levels were then selected for the dredge. The source depth for the clamshell dredge was set to half the local water depth since losses due to bottom and surface interactions will be less for a source at mid-depth than for a source near the seafloor or surface. The modelled broadband source level of the clamshell dredge was 176 dB re 1 μ Pa. **Figure 13** shows modelled 1/3-octave band source levels.

1.2.4 Tug and Barge Operations

Tugs and barges will be used to support cranes and dredging operations during Project construction. The river tug *Seaspan Venture* was identified as a representative barge-towing vessel, based on a discussion with the Project engineers and a review of similar vessels currently operating in the Fraser River. Source levels for the river tug were estimated from measurements, performed by JASCO, of a harbour tug transiting at 7.5 kts near Roberts Bank terminals (Warner et al. 2013). Source levels for the river tug were reduced by 5.7 dB to account for the difference in total engine power between it and the larger, measured harbour tug (**Table 3**). **Figure 13** shows the modelled 1/3-octave band source levels for river tugs. The broadband source level was 166 dB re 1 μ Pa at one metre. Source levels were extrapolated below 20 Hz using a constant value equal to the 20 Hz 1/3-octave band level.

Table 3 Tugboat Specifications

| Type | Length | Width | Draught | Source depth | Total engine power (kW) |
|-------------|--------|-------|---------|--------------|-------------------------|
| Harbour tug | 30 m | 13 m | 3.17 m | 1.47 m | 4.476 |
| River tug | 19.5 m | 7 m | 3.17 m | 1.47 m | 1.268 |

It was assumed that all construction barges will be towed by tugs. Barges might, however, have vibrating machinery onboard that could conduct a small amount of underwater sound into the river through the barge’s hull. When sound from tug and barge operations was modelled, it was assumed that the barge contribution was not substantial compared to sound generated by the tugs’ propulsion systems.

1.3 Sound Propagation Model

1.3.1 Full-Waveform Range-Dependent Acoustic Model

JASCO’s Full-Waveform Range-dependent Acoustic Model (FWRAM) was used to simulate pulse propagation to produce synthetic waveform traces of the impact pile driving pulses. These calculations were used to determine the rms and peak pulse pressure as a function of range from the source, and consequently the range-dependent conversion factor between SEL and rms SPL.

FWRAM computes synthetic pressure waveforms at receiver locations on a range-depth grid using Fourier synthesis to generate full-waveform sound field predictions in finely spaced frequency bands at the individual frequencies. Environmental inputs for FWRAM include bathymetry, water sound speed profiles, and physical properties of the riverbed (geoacoustic profiles).

1.3.2 Marine Operations Noise Model

Sound levels were modelled using MONM, which predicts underwater sound propagation in range-varying acoustic environments. MONM computes acoustic fields in three dimensions by modelling transmission loss (TL) along evenly spaced two-dimensional (2-D) radial traverses covering a 360° swath from the source, an approach commonly referred to as $N \times 2$ -D. The model fully accounts for depth and range dependence of several environmental parameters, including bathymetry and sound speed profiles for the water column and the sub-bottom sediments. It also accounts for the additional reflection loss at the riverbed that is due to partial conversion of incident compressional waves to shear waves at the riverbed and sub-bottom interfaces through a complex density approximation (Zhang and Tindle 1995).

The acoustic environment is sampled at a fixed-range step along radial traverses. MONM treats frequency dependence by computing acoustic TL at the centre frequencies of 1/3-octave bands. Broadband received levels are summed over the received 1/3-octave band levels, which are computed by subtracting band TL values from the corresponding source levels. MONM's predictions have been validated against experimental data from several underwater acoustic measurement programs (Aerts et al. 2008, Funk et al. 2008, Ireland et al. 2009, O'Neill et al. 2010, Warner et al. 2010, Hannay et al. 2013). For this study, MONM was used to compute TL for 1/3-octave bands centred between 10 Hz and 5 kHz. To model non-pulsed sources such as vibrodensification, tugs, dredgers, and vibratory pile drivers, MONM was used to predict the SPLs on the $N \times 2$ -D grid. For impact pile driving, MONM was used to model the single-strike SELs.

The transmission loss computed by MONM was further corrected to account for the attenuation of acoustic energy by molecular absorption in water. The volumetric sound absorption is quantified by an attenuation coefficient, expressed in units of decibels per kilometre (dB/km). The absorption coefficient depends mainly on the sound frequency, but also on the temperature, salinity, and hydrostatic pressure of the water. In general, the absorption coefficient increases with the square of frequency. The absorption of acoustic wave energy has a noticeable effect (>0.05 dB/km) at frequencies above 1 kHz. At 10 kHz, the absorption loss over 10 km can exceed 10 dB.

Transmission loss was approximated for bands between 6.3 and 50 kHz by using the TL computed at 5 kHz and applying the correct frequency-dependent absorption coefficient in each band. In this study, the absorption coefficients were calculated based on water temperature at 10°C and salinity of 0.5 parts per thousand and a water depth of 2.5 m.

Sound levels were modelled at eight different receiver depths from 2.5 m to the riverbed, distributed vertically in the water column. Modelled received levels were gridded separately in each horizontal plane (i.e., at each modelled receiver depth). To generate a conservative estimate, the modelled results were obtained by collapsing the stack of grids into a single plane using a maximum-over-depth rule, which means that the sound levels at each planar point are taken to be the maximum value from all modelled depths in the water column for that point.

1.3.3 Calculation of Peak SPL, rms SPL, and SEL for Impact Pile Driving

For pulsed sound sources, MONM computes per-pulse SEL in 1/3-octave bands, but does not directly predict the 90 per cent rms SPL or peak SPL. Although the 90 per cent rms SPL and peak SPL are easily measured in situ, these metrics are generally more difficult to model than per-pulse SELs. In addition, the adaptive integration period to model rms SPLs, implicit in the definition of the 90 per cent rms SPL, is highly sensitive to the specific multipath arrival pattern from an acoustic source and can vary greatly with distance from the source or with receiver depth. Nonetheless, per-pulse SEL and SPL are related, and SEL can therefore be used to estimate SPL.

In this study, FWRAM was used to calculate peak SPL and rms SPLs for impact pile driving. The pressure field from the pile driving source model was modelled at frequencies from 10 Hz to 2 kHz in 0.5 Hz steps to generate synthetic pressure waveforms along a single transect. These waveforms were then analyzed to determine peak SPL and rms SPL as a function of range from the source. The representative transect, which extended 1.2 km from the source, heading 268 degrees west, was chosen for its uniform bathymetry.

The FWRAM pulse length and waveform predictions were used to derive a range-dependent conversion function between SEL and rms/peak SPL. The resulting conversion functions were applied to the per-pulse SEL predictions from MONM to compute the rms SPLs and peak SPLs. The conversion functions for per-pulse SEL to rms SPL and peak SPL are shown in **Figure 16** as a function of source-receiver offset.

Long-term exposures to high-intensity anthropogenic noise can temporarily or permanently reduce an animal's hearing sensitivity. Cumulative sound exposure is generally measured as the total sound energy an organism receives over some period. The cumulative SEL for impact pile driving was computed for sequences of pile driving blows that could occur over 24 hours. The number of strikes required to drive each pile is not known, so three durations of pile driving activity were modelled over a 24-hour period for each scenario (see **Table 1**): one minute, 10 minutes, and 100 minutes.

1.3.4 Calculation of Sound Level Contours

The predicted received SPLs and SELs were contoured to show the estimated acoustic footprint for each scenario. Sound level contours were converted to GIS layers, visible on maps of the study area. For each duration scenario, the 95th percentile radius ($R_{95\%}$) and the maximum radius (R_{\max}) for each sound threshold level were tabulated.

1.4 Environmental Parameters

1.4.1 Bathymetry

High-resolution bathymetry data within several kilometres of the Tunnel, collected as part of the river hydraulics and river morphology study for the Project, were used to develop a bathymetry model for the study area. Water depths in the Fraser River vary depending on tidal cycle and time of year. High-water conditions are most conservative with respect to the distance that sound propagates in the water because sound energy is more rapidly absorbed by bottom sediments in shallow water. Therefore, the data were adjusted to a high-water datum of 2.0 m to accommodate high-water stands during the fall and winter months. Maximum water depths in the study area are less than 30 m. Bathymetry data were re-projected onto a 10 m x 10 m grid in UTM zone 10 N for use with MONM.

1.4.2 Water Depth

Water depths in the river vary depending on the tides and the time of year (seasonal variations). High-water conditions are most conservative with respect to the distance that sound propagates in the water. Therefore, the data were adjusted to a high-water level of 2.0 m to accommodate high-water stands during the fall and winter.

A water depth of five metres, which corresponds to a high high tide, was assumed for modelling pile driving along the edge of Deas Slough. Much of the actual Project-related construction along the edge of Deas Slough would occur under lower water conditions or in the dry with low tide. Effectiveness of construction pads with granular fills as a way to mitigate underwater noise was investigated, subsequent to completion of modelling. Propagation through the granular fill and the underlying soils is expected to attenuate sound levels generated by pile driving and reduce underwater noise emissions. Given these considerations, levels of underwater noise emissions generated by the actual construction are expected to be somewhat lower than the results of the modelling presented in this document.

1.4.3 Geoacoustic Properties

Sound propagation is influenced by the physical properties of the river bottom sediments, including the density, compressional wave (P-wave) speed, shear wave (S-wave) speed, compressional wave attenuation, and shear wave attenuation of the riverbed sediments. The main riverbed sediment types in the study area are water-saturated silts and silty sands, based on borehole and penetration data (Puar 1996). The geoacoustic properties for these types of sediments (**Table 4**) were estimated on empirical formulas presented by Hamilton (1980).

Table 4 Geoacoustic Parameters used for Modelling the Riverbed Sediments

| Depth below seafloor (m) | Sediment type | Density (g/cm ³) | P-wave speed (m/s) | P-wave attenuation (dB/λ) | S-wave speed (m/s) | S-wave attenuation (dB/λ) |
|--------------------------|---------------|------------------------------|--------------------|---------------------------|--------------------|---------------------------|
| 0–3 | Clayey silt | 1.5 – 1.4 | 1537 – 1523 | 0.18 | 180 | 2.0 |
| 3–29 | Silty sand | 1.4 – 1.6 | 1523 – 1529 | 0.18 – 0.20 | | |
| >29 | Sandy silt | 1.6 | 1529 | 0.20 | | |

1.4.4 Sound Speed Profile

The sound speed profile in the water column was derived using the empirical Marczak equation (Marczak 1997) or fresh water. The estimated sound speed in water at the study location is approximately 1,457 m/s based on the average water temperature of 10°C from late summer to early spring. Average seasonal water temperature values were obtained from the DFO Fraser River Environmental Watch Report (DFO 2013).

2.0 Noise Source Modelling Results

It was assumed that impact pile driving would operate at 35 blows per minute, totalling one minute (35 blows), 10 minutes (350 blows), and 100 minutes (3,500 blows) during a 24-hour period. Under that assumption, 15.4 dB, 25.4 dB, and 35.4 dB were added to the single-pulse SEL to yield 24-hour SEL results. **Table 5** presents the 95th percentile contour radii of 24-hr (one-, 10-, and 100-minute piling) SEL unweighted and M-weighted (pinnipeds) contours for impact pile-driving (scenario 1). Corresponding contour maps of unweighted and M-weighted SEL are provided in **Figure 1** through **Figure 3**. The M-weighting curves reduce sound at low and high frequencies; however, the pinniped M-weighting curve is nearly flat over the frequency range generated by the impact hammer. In **Table 5** and **Table 6**, $R_{95\%}$ is the radius of a circle centred at the source that encompasses 95 per cent of the area ensounded to the threshold value; R_{max} is the maximum distance from the source to the given noise threshold in any direction.

Table 5 Radii (95%), of 24-hr (1-, 10-, and 100-minute Piling) Unweighted SEL and M-weighted SEL Contours for Impact Pile Driving (Scenario 1)

| SEL (dB re 1 $\mu\text{Pa}^2\cdot\text{s}$) | 1 min | 10 min | 100 min |
|--|-------|--------|---------|
| FHWG threshold fish < 2 g (183 dB) ¹ | 91 | 286 | 698 |
| FHWG threshold fish \geq 2 g (187 dB) ¹ | 69 | 169 | 602 |
| Southall M-weighted pinniped threshold (186 dB) ² | 66 | 180 | 618 |

Notes: radii measured in metres

¹Source: (FHWG 2008)

²Source: (Southall et al. 2007)

The broadband (10 Hz to 50 kHz) rms SPL radii for the NMFS injury threshold (190 dB re 1 μPa) was computed with 53 m, based on the estimated offset curves described in **Section 1.3.3**. The corresponding contour map of rms SPL is provided in **Figure 4**, including the contours for the ZAA for the 50th (L_{50}) and 95th (L_{95}) exceedance percentiles. **Table 6** presents the peak SPL radii to injury thresholds for scenario 1. The 95th percentile radius for the ZAA extends to 7,460 m for both L_{50} and L_{95} .

Table 6 Radii (Rmax) of Peak SPL Injury Thresholds for Impact Pile Driving (Scenario 1)

| Acoustic Injury Criteria | Peak SPL (dB re 1 μPa) |
|--|------------------------------------|
| FHWG Fish < 2 g (206 dB) ¹ | 53 |
| B.C. MPDCA Threshold Fish (210 dB) ¹ | 42 |
| Southall M-weighted Pinniped Threshold (218 dB) ² | 27 |

Notes: radii measured in metres

¹Source: (FHWG 2008)

²Source: (Southall et al. 2007)

Table 7 presents 95th percentile and maximum contour radii for vibratory pile driving (scenario 2), vibrodensification (scenario 3), cutter suction dredging (scenario 4), tug and barge activity during crane lift of Tunnel segments (scenario 5), and simultaneous dredging at Tunnel crossing and crane lift of Tunnel segments (scenario 6). Corresponding contour maps for unweighted maximum-over-depth broadband (10 Hz to 50 kHz) rms SPLs in dB re 1 μ Pa are shown in **Figure 5** to **Figure 9**. The grey and black contours indicate the ZAA for L_{50} and L_{95} . The 95th percentile radii at 120 dB re 1 μ Pa rms SPL are 951 m in Deas Slough, and 2,746 m in the Fraser River South Arm. The maximum radii for the ZAA extend to 5,500 m and 6,250 m for L_{50} and L_{95} , respectively (**Table 8**).

Table 7 Radii (95%) of Unweighted rms SPL Contours for Scenarios 1 through 6 (All Distances in Metres)

| rms SPL (dB re 1 μ Pa) | Scenarios | | | | | |
|-------------------------------|-----------|-----|-----|------|-----|------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| 120 | 3043 | 593 | 951 | 2726 | 441 | 3447 |
| 130 | 2956 | 346 | 319 | 980 | 79 | 1275 |
| 140 | 2939 | 228 | 52 | 230 | 27 | 357 |
| 150 | 2742 | 88 | 21 | 52 | <10 | 52 |
| 160 | 1233 | 58 | <10 | 11 | n/a | 10 |
| 170 | 741 | 37 | n/a | <10 | n/a | <10 |
| 180 | 104 | 22 | n/a | n/a | n/a | n/a |
| 190 | 53 | 9 | n/a | n/a | n/a | n/a |
| 200 | 30 | <5 | n/a | n/a | n/a | n/a |

Note: n/a = indicates levels were not reached.

Table 8 Radii (Rmax) of Unweighted SPL Contours for the Zone above Ambient Levels for Scenarios 1 through 6 (All Distances in Metres)

| rms SPL (dB re 1 μ Pa) | Scenarios | | | | | |
|----------------------------|-----------|-------|-------|-------|-------|-------|
| | 1 | 2 | 3 | 4 | 5 | 6 |
| ZAA (L_{50}) | 7,460 | 5,503 | 3,540 | 5,512 | 5,299 | 5,502 |
| ZAA (L_{95}) | 7,460 | 6,256 | 3,545 | 5,515 | 5,548 | 5,565 |

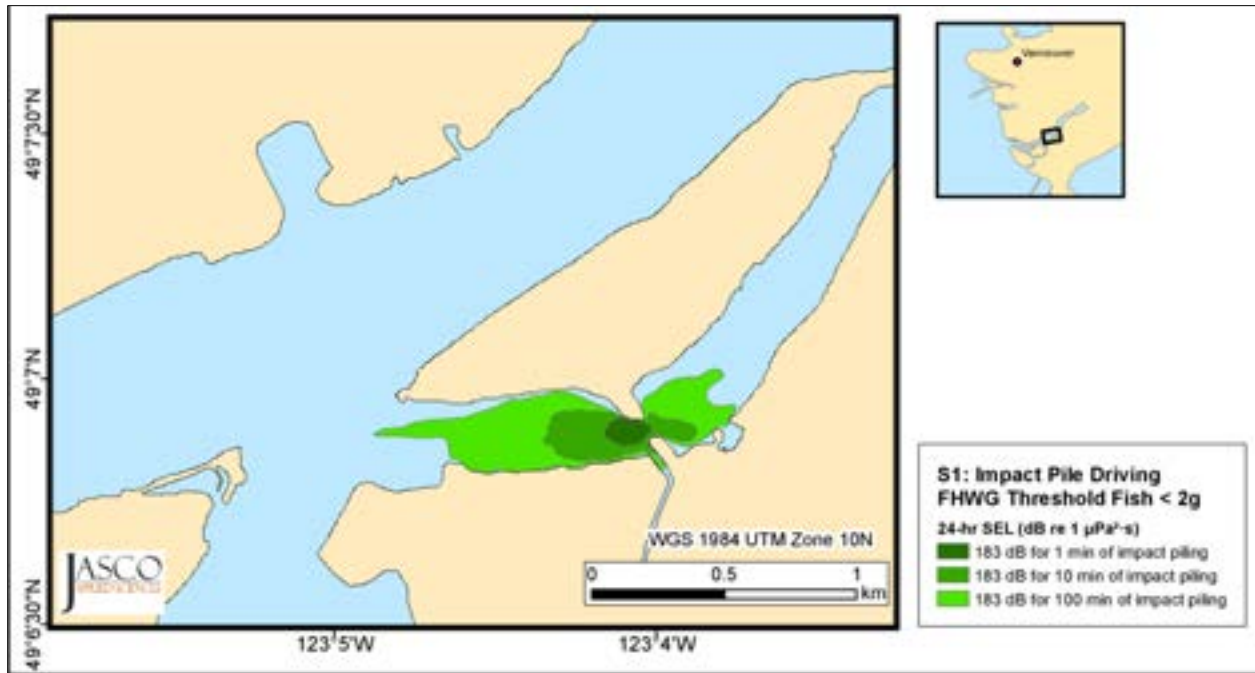


Figure 1 Contour Map of FHWG SEL Threshold for Fish Weighing Under Two Grams for 1, 10, and 100 Minutes of Impact Piling at Deas Slough.

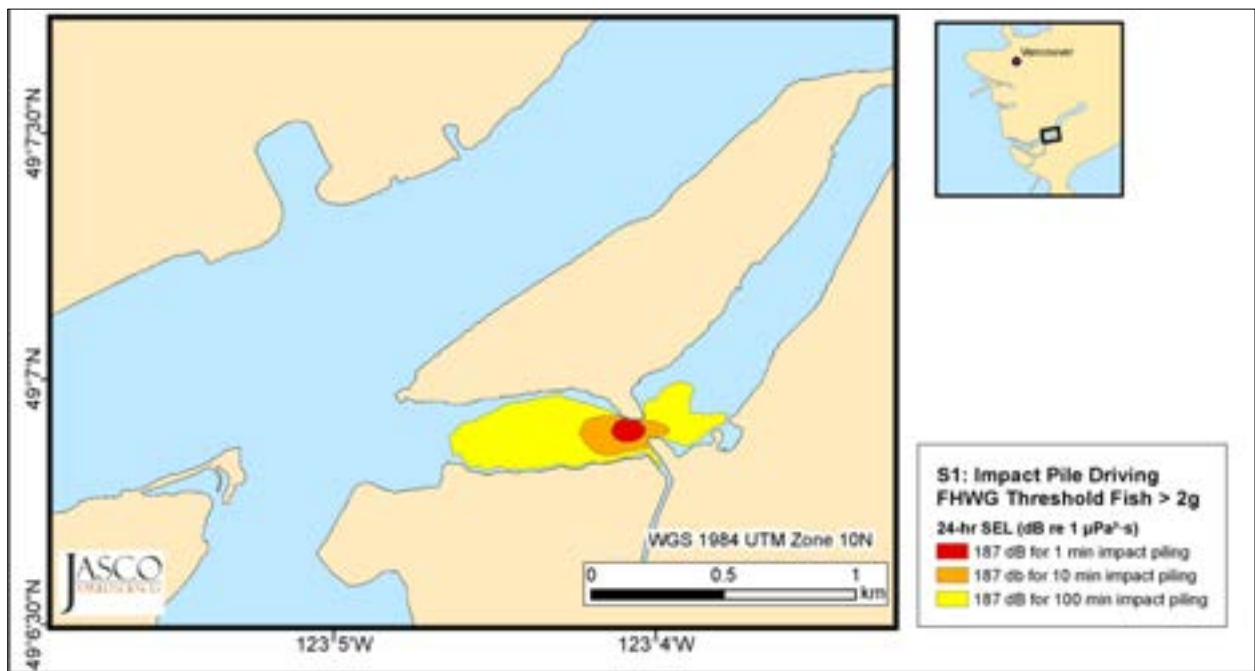


Figure 2 Contour Map of FHWG SEL Threshold for Fish Weighing Over Two Grams for 1, 10, and 100 Minutes of Impact Piling at Deas Slough.

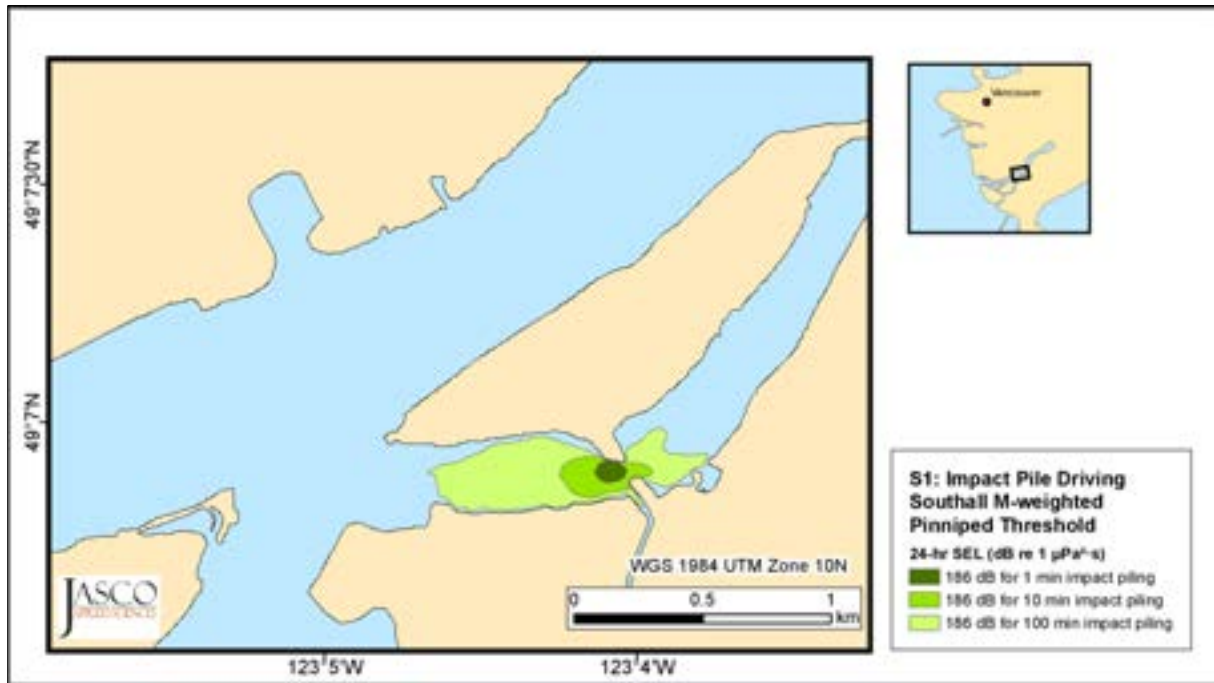


Figure 3 Contour Map of Southall et al. (2007) Pinniped M-weighted SEL Threshold for 1, 10, and 100 Minutes of Impact Piling at Deas Slough.

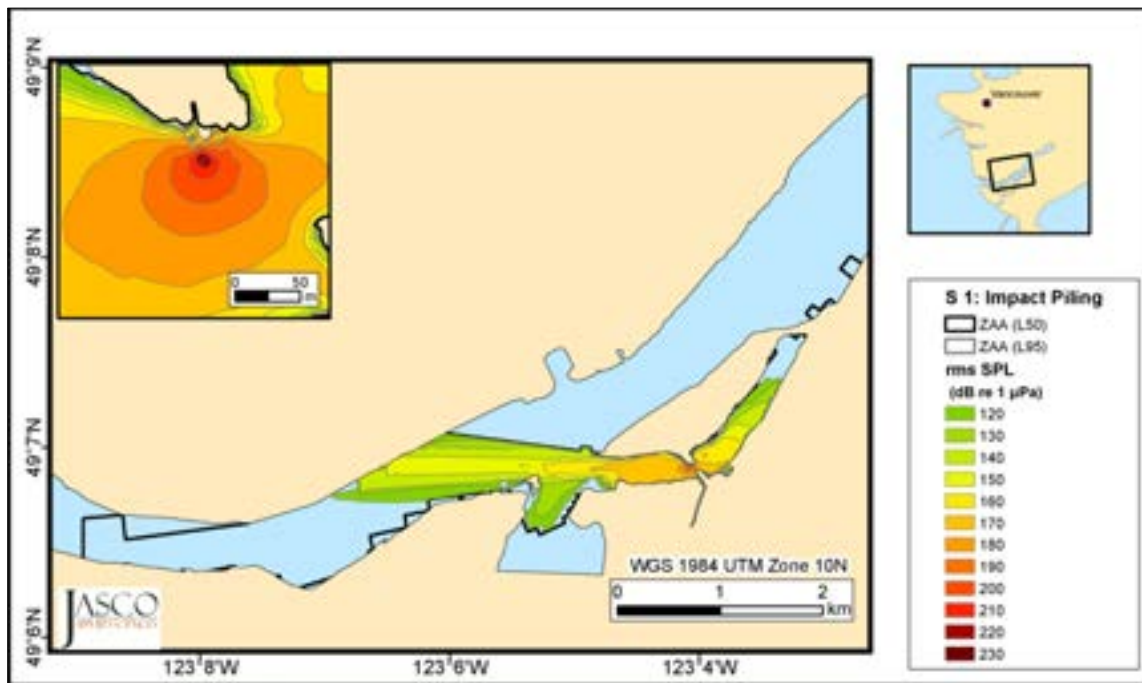


Figure 4 Broadband Contour Map of rms SPL for Impact Piling at Deas Slough (Scenario 1).

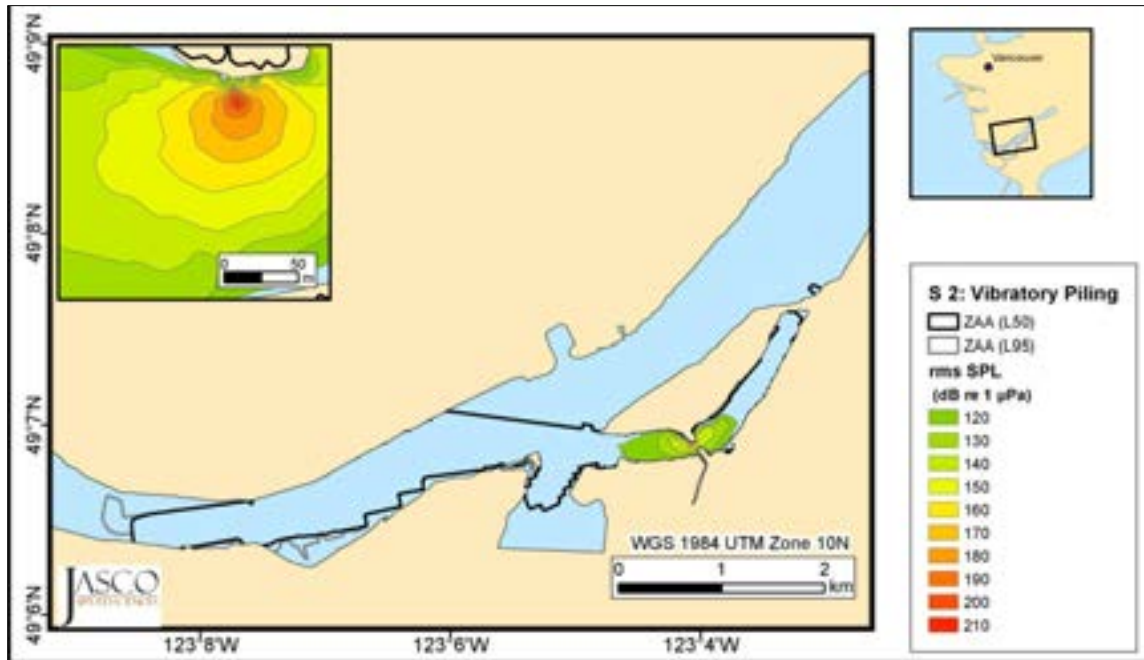


Figure 5 Broadband Contour Map of rms SPL for Vibratory Piling at Deas Slough (Scenario 2).

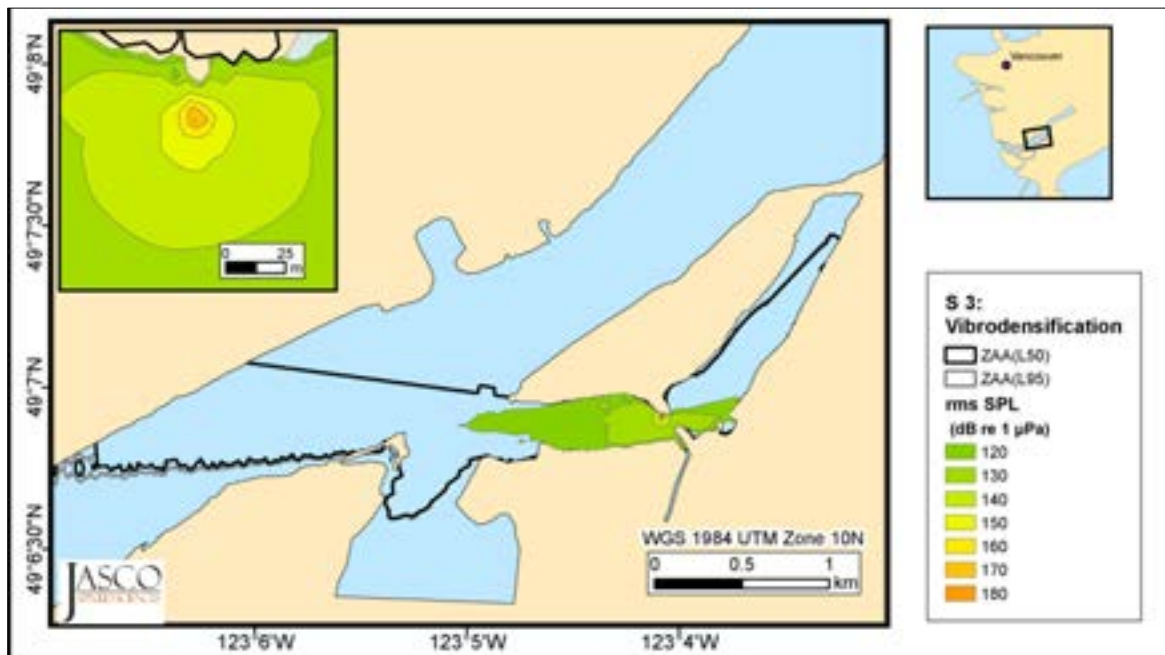


Figure 6 Broadband Contour Map of rms SPL for Vibrodensification (Scenario 3).

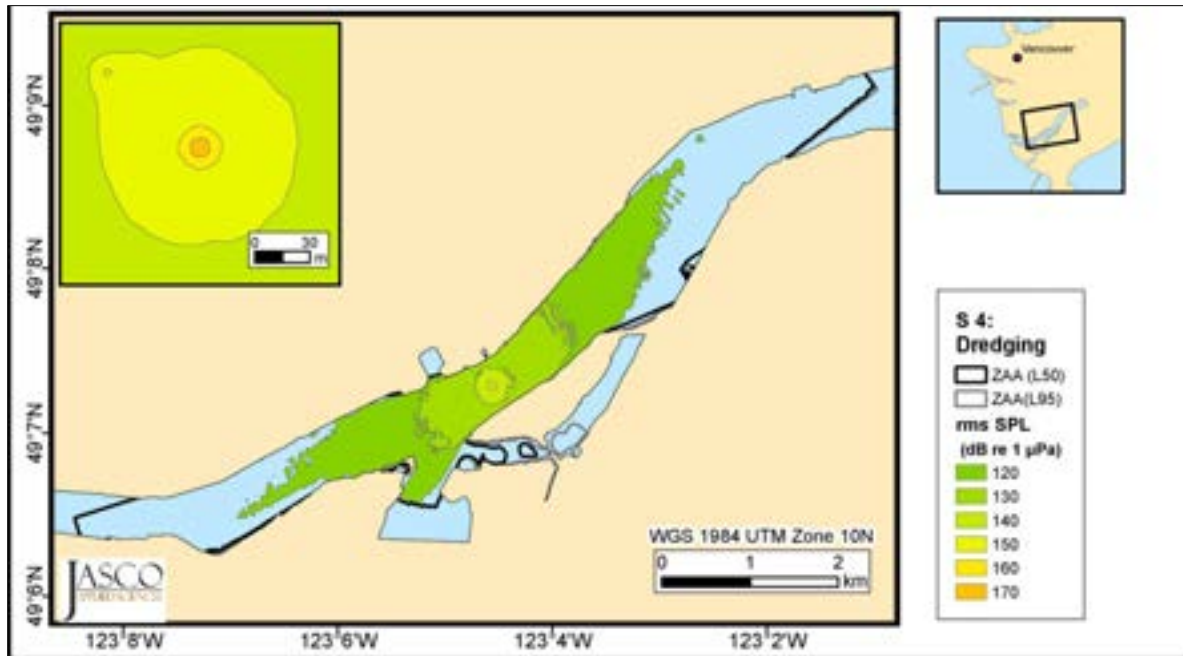


Figure 7 Broadband Contour Map for Unweighted rms SPL for Cutter Suction Dredge Operations (Scenario 4).

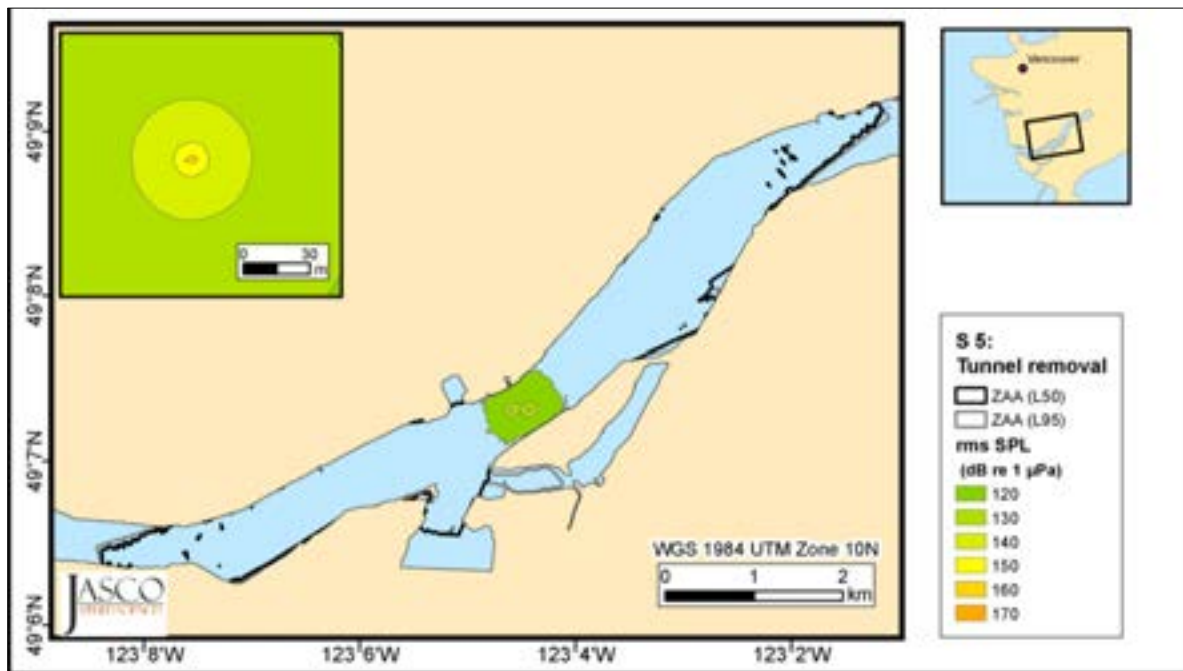


Figure 8 Broadband Contour Map of rms SPL for Tug and Barge Activities During Crane Lift of Tunnel Segments (Scenario 5).

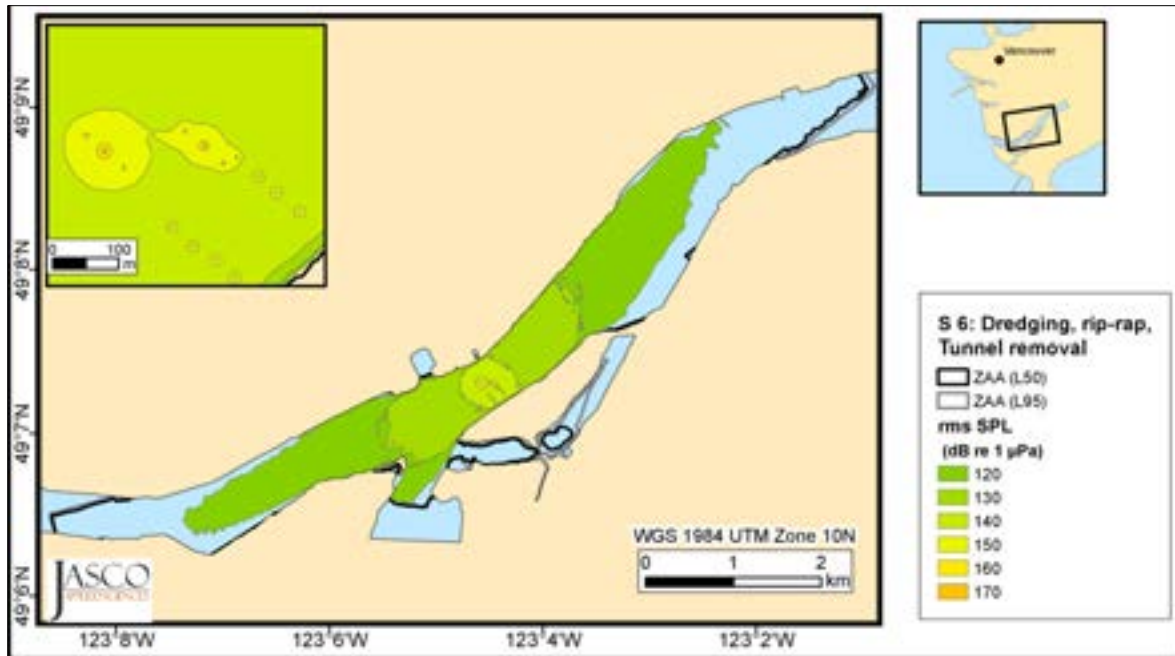


Figure 9 Broadband Contour Map of rms SPL for Simultaneous Crane Lifting and Dredging Activities (Scenario 6).

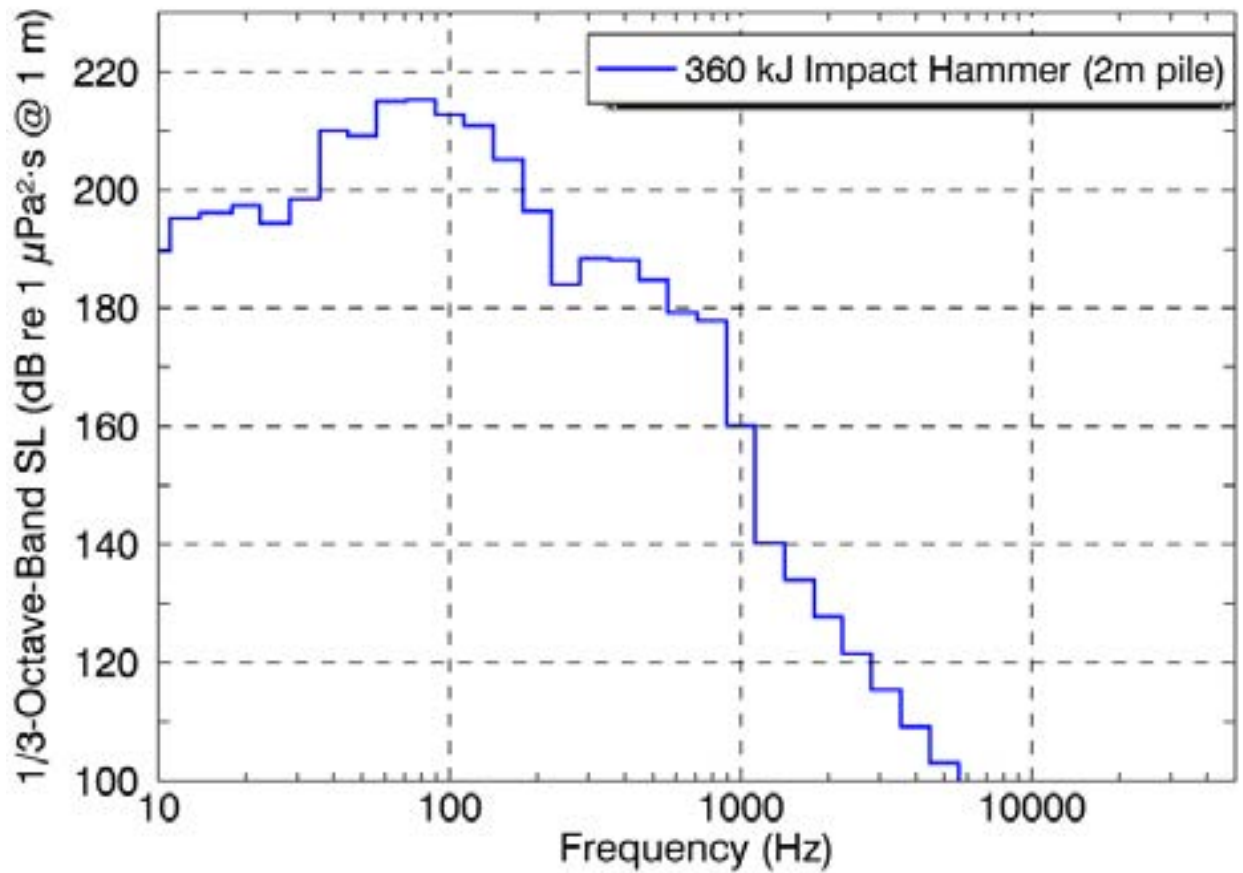


Figure 10 Modelled 1/3-octave Band Source Levels for Impact Pile Driving.

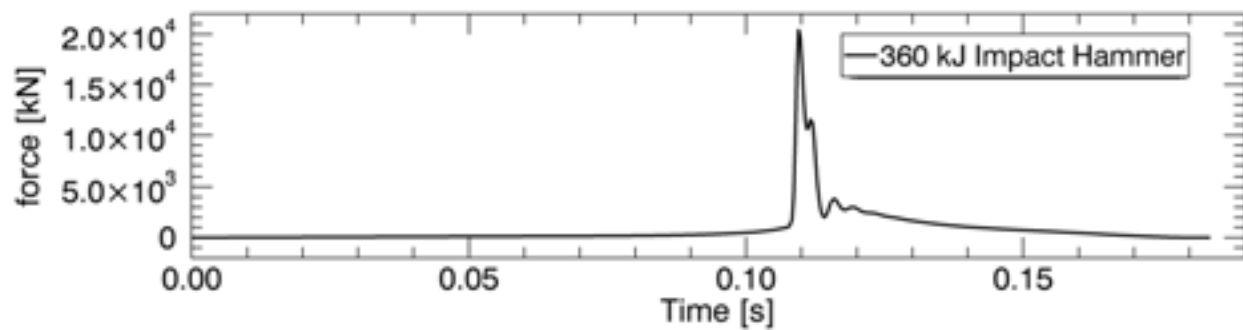


Figure 11 Modelled Forcing Function at the Top of the 2 m x 85 m Pile, Generated by Delmag D100-13 Impact Hammer.

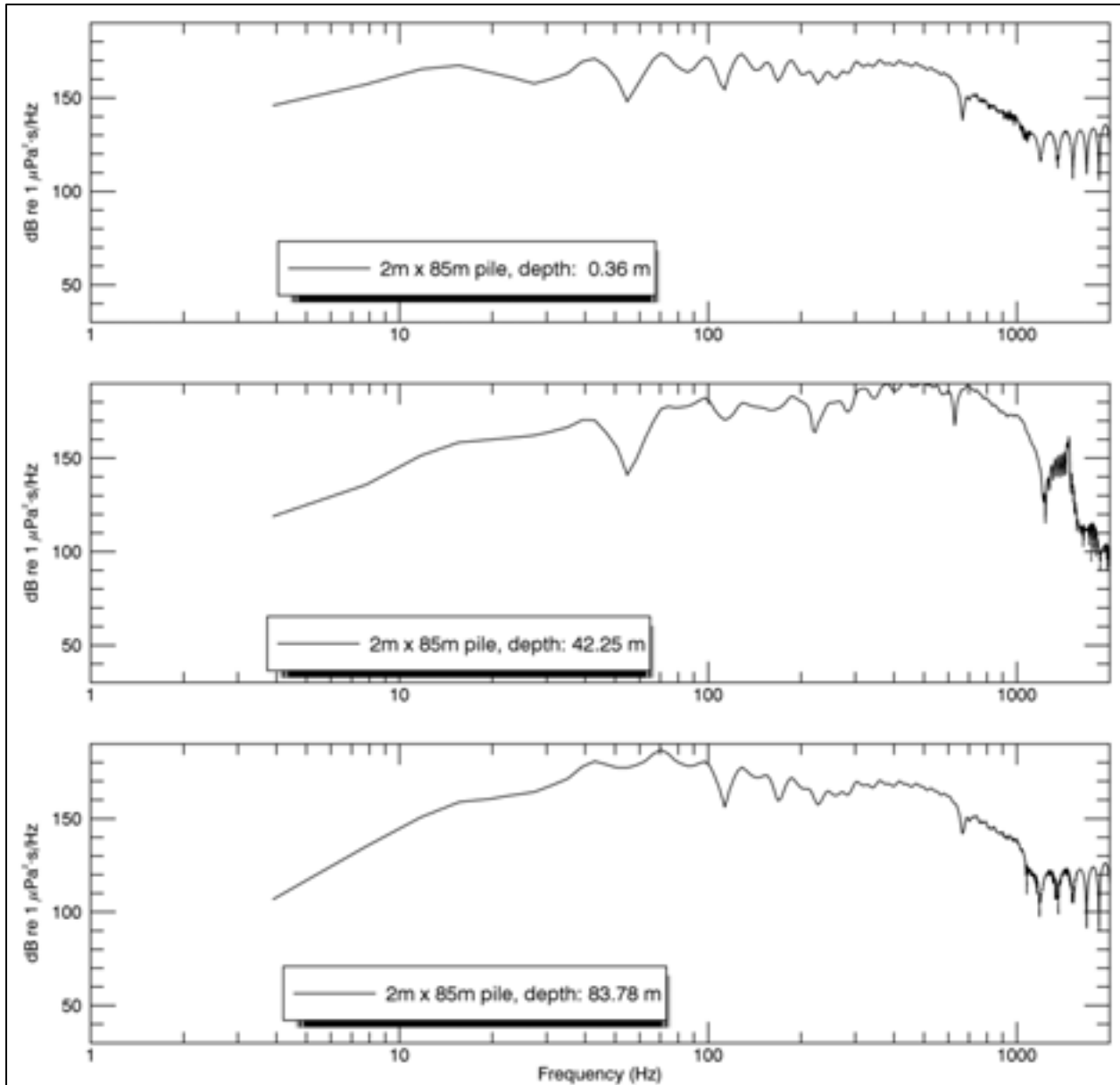


Figure 12 Modelled Monopole Source Spectra, Sampled at Three Depths Along the Pile, for Impact Hammering of the 2 m x 85 m Pile.

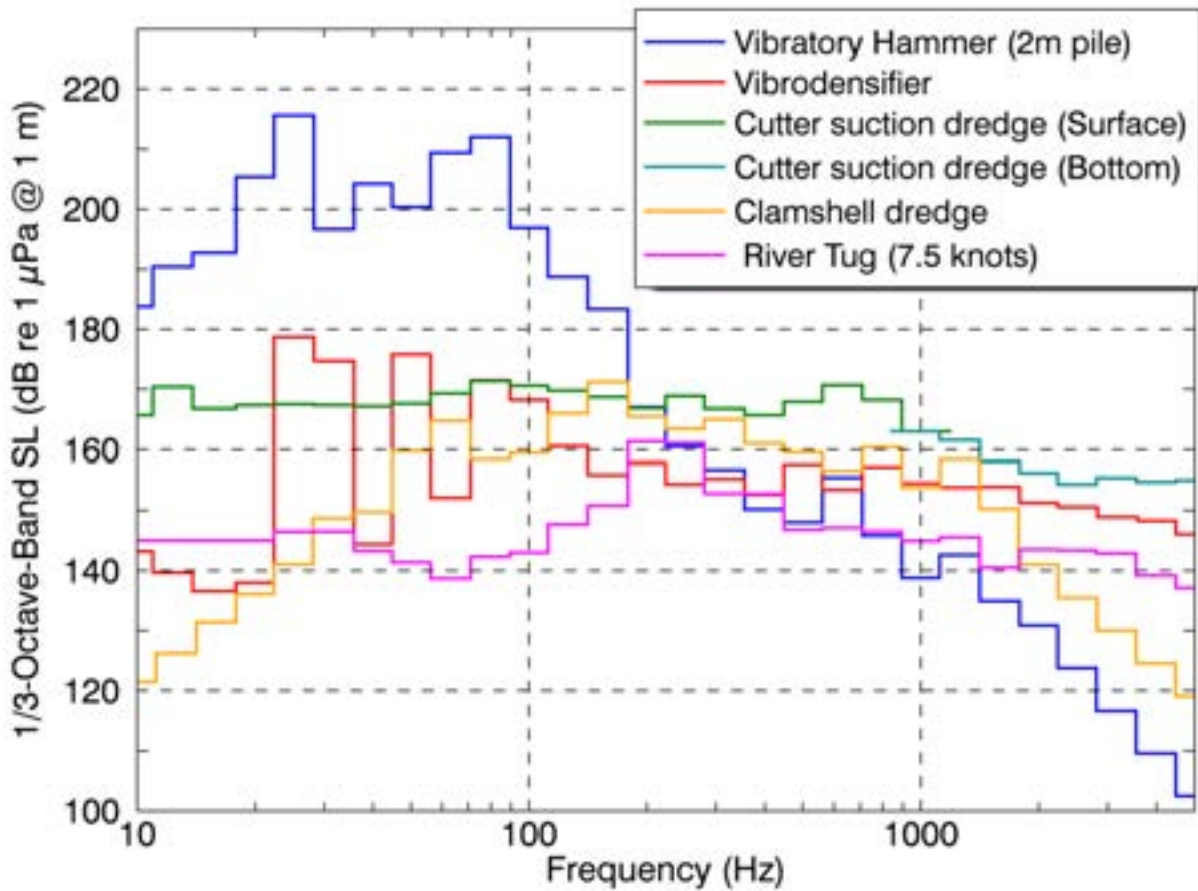


Figure 13 Modelled 1/3-octave Band Source Levels for Non-pulsed Noise Sources.

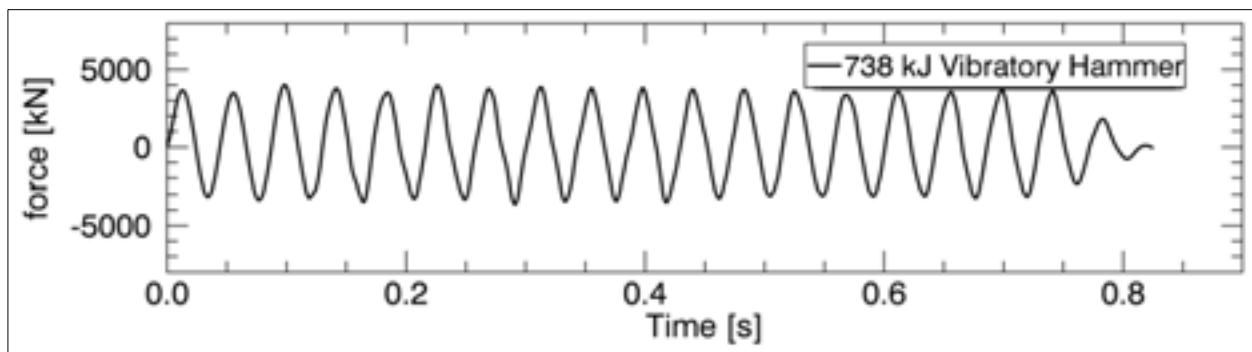


Figure 14 Modelled Forcing Function at the Top of the 2 m x 85 m Pile, Generated by APE-400B Vibratory Hammer.

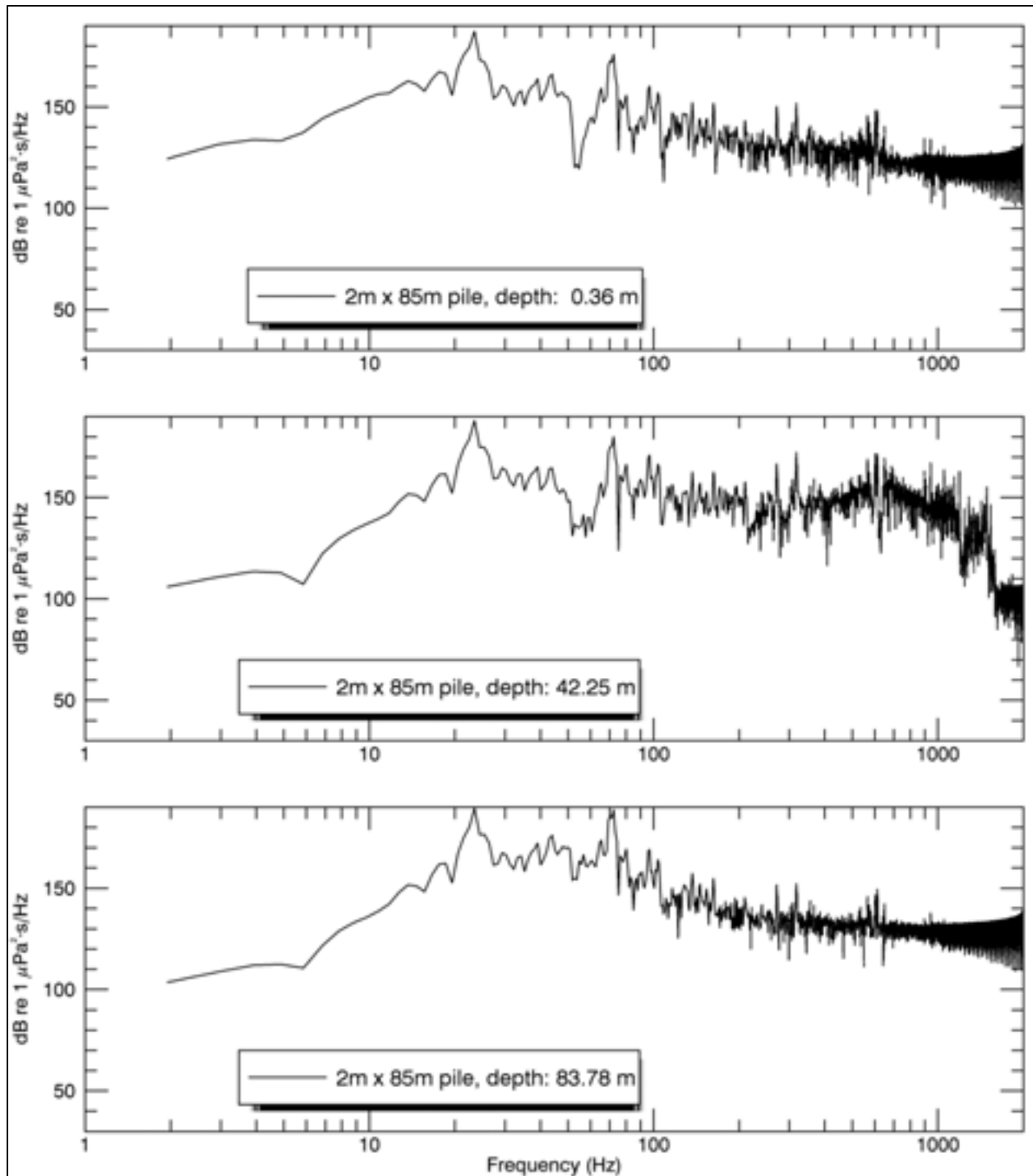


Figure 15 Modelled Monopole Signature Spectra, Sampled at Three Depths along the Pile, for Vibratory Hammering of the 2 m x 85 m Pile.

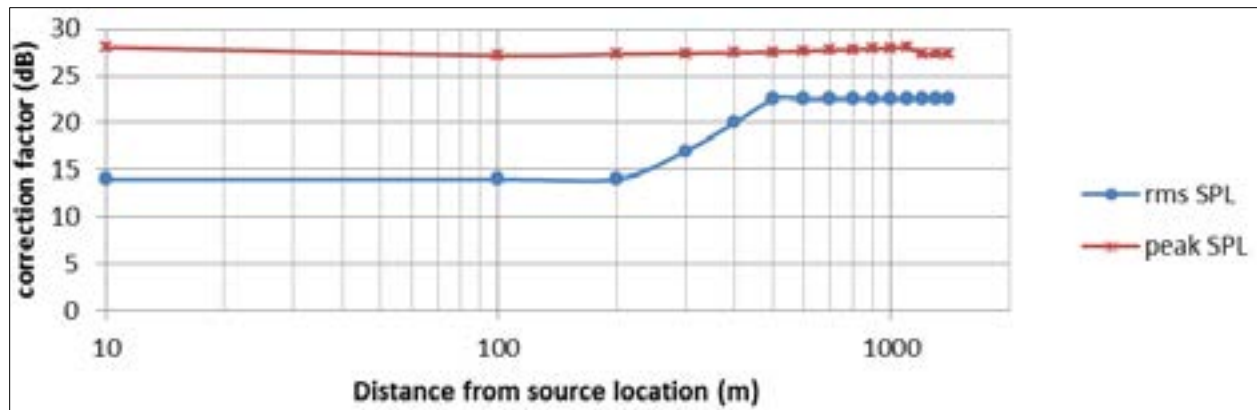


Figure 16 Per-pulse SEL to rms SPL and Peak SPL Conversion Function Versus Distance from Source (m).

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**George Massey Tunnel
Replacement Project**



**BC JOBS
PLAN**



Ministry of
Transportation
and Infrastructure

Section 16.4
FISH AND FISH HABITAT STUDY
Technical Volume

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| Attachment B | Tables (1 through 8) Summarizing Historical Fish Presence, Field Water Quality, and Fish Capture Results for the Project |
| Attachment C | Photographs of Watercourses Assessed during the Fish Field Program for the Project |

Abbreviations and Acronyms

| Term | Definition |
|--------------------------|---|
| $\mu\text{S}/\text{m}^1$ | microsiemens per metre |
| B.C. WQG | British Columbia water quality guidelines |
| BIEAP | Burrard Inlet Environmental Action Program |
| cm/km | centimetre per kilometre |
| COSEWIC | Committee on the Status of Endangered Wildlife in Canada |
| CRA | commercial, recreational, or Aboriginal (refers to fisheries) |
| DFO | Fisheries and Oceans Canada |
| DO | dissolved oxygen |
| ESA | environmentally sensitive area |
| FISS | Fisheries Information Summary System |
| FREMP | Fraser River Estuary Management Program |
| GIS | geographic information system |
| m/s | metres per second |
| m/year | metres per year |
| m^3/s | cubic metres per second |
| m^3/year | cubic metres per year |
| mg/L | milligrams per litre |
| Ministry | Ministry of Transportation and Infrastructure |
| RISC | Resources Information Standards Committee |
| ROW | right-of-way |
| SARA | <i>Species at Risk Act</i> |
| SFPR | South Fraser Perimeter Road |
| Tunnel | George Massey Tunnel |

Glossary

| Term | Definition |
|---------------------|---|
| alevin | A newly hatched salmonid that is still attached to the yolk sac. |
| anadromous | Migrating from sea to freshwater to spawn. |
| bed material load | Sediment that is transported by river flow along the river bottom and comprises particles found in appreciable quantities in the channel bed. |
| Blue-listed | The B.C. CDC designation for species considered to be of special concern (formerly vulnerable) in British Columbia. |
| crown closure | The proportion of the sky hemisphere obscured by vegetation when viewed from a single point. |
| detritus | Organic matter produced by the decomposition of organisms. |
| epibenthic | Living above the bottom (also demersal). |
| escapement | The number of salmon arriving at their natal river or stream to spawn (or the number of salmon that have escaped fisheries and are available to spawn). |
| fecundity | The potential reproductive capacity of an organism (e.g., the number of eggs a fish produces during each reproductive cycle). |
| fry | A young fish at the post-larval stage. |
| Highway 99 corridor | The right-of-way owned by the Province of B.C. for Highway 99 from the Peace Arch Canada–U.S. border crossing in Surrey to the Oak Street Bridge in Richmond. |
| intertidal | Aquatic habitat between the mean lowest low water level and the mean highest high water level. |
| mesohabitat | Basic structural features of a river or stream such as pools, backwaters, runs, glides, and riffles. |
| Project alignment | The spatial extent within which Project components and related activities are proposed. |
| Red-listed | The B.C. CDC designation for species considered extirpated, endangered, or threatened. |
| salt wedge | Freshwater from a river floats on top of seawater in a layer that gradually thins toward the sea. The denser seawater moves upstream along the bottom of the river estuary, forming a wedge-shaped layer that is thinner as it moves upstream. A difference in velocity occurs between the two layers that acts against the mixing tendency of tide- and wind-induced turbulence. |

| Term | Definition |
|-----------|--|
| smolt | A young salmon that first migrates from freshwater to the sea. |
| thalweg | From a longitudinal view, the deepest part of a riverbed from the source to the mouth; the deepest point in any given river cross-section. |
| wash load | Sediment that moves in suspension in the river flow but is not represented in the bed of the channel. |

1.0 Scope of Study

This technical volume presents the objectives, methods, and findings of the fish and fish habitat study undertaken to support the environmental assessment of the George Massey Tunnel Replacement Project (Project).

A review of the available information and the state of knowledge pertaining to fish and fish habitat in the study area was undertaken. Field studies were undertaken in 2014 to supplement and update existing information. This appendix provides a synthesis of the literature review and 2014 field studies. A summary of study components, objectives, and scope is provided in **Table 1-1**.

Table 1-1 Study Components and Major Objectives

| Component | Objective | Scope |
|--------------------------|--|---|
| Literature review | Determine fish habitat values and freshwater fish species' use of watercourses within the study area. Supplement and update existing information within the study area. | Comprehensive information review of available fish and fish habitat inventory information within the study area. |
| Freshwater fish sampling | Verify and update available information on freshwater fish species' use of watercourses within the study area. | Fish sampling in spring and autumn within a subset of sites, to supplement existing information. |
| Fish habitat assessment | Assess the quality of freshwater fish habitat in watercourses within the study area. | Assessment of physical fish habitat features and water quality in all watercourses and water features within the study area, with a focus on larger, higher-value watercourses. |

2.0 Review of Existing Literature and Data

Information on fish species occurrence and distribution, hydrology and hydraulics of major watercourses, and a description of fish habitat characteristics (i.e., riparian vegetation, streambed type, water quality) within the study area was compiled from the following literature sources:

- Fisheries Information Summary System (FISS 2014)
- B.C. Species and Ecosystem Explorer (B.C. CDC 2015)
- Species at Risk Public Registry (Government of Canada 2013)
- Committee on the Status of Endangered Wildlife in Canada (COSEWIC) (Government of Canada 2014)
- Fraser River Estuary Management Program – Burrard Inlet Environmental Action Program Habitat Atlas (BIEAP - FREMP 2014)
- Delta Watersheds: Fish and Amphibian Distributions Map (Delta 2003a)
- Delta Fish and Amphibians Study: 2000–2003 Sample Site Locations Map (Delta 2002)
- Delta Timing Schedules for Instream Works Map (Delta 2003b)
- Corporation of Delta Online Mapping System – DeltaMap (Delta 2012)
- City of Richmond Interactive Map (Richmond 2014)
- Consultant reports, e.g., Vancouver Airport Fuel Delivery Project EAC Application (VAFFC 2011a) and Addendum (VAFFC 2011b)
- Topographic and resource maps, air photos, and forest cover maps
- Biologists and habitat technicians from Fisheries and Oceans Canada (DFO), and B.C. Ministry of Forests, Land and Natural Resource Operations (MFLNRO)
- iMapBC (DataBC 2014)
- Government papers and technical reports sourced through the DFO Library online catalogue (WAVES), Canadian Science Advisory Secretariat publications, and the Government of B.C. Cross-linked Information Repositories
- Periodical journal articles and theses sourced using Google Scholar, ScienceDirect, Web of Science, University of B.C. cIRcle, JSTOR, and EBSCOhost

- Ongoing consultation with the following groups:
 - Aboriginal groups with an interest in the Project, based on asserted traditional territories or treaty settlement lands
 - Municipal and regional environmental staff who operate in the study area
 - Local naturalist groups, streamkeeper groups, salmon enhancement volunteers, streamside residents, and fishers
 - Parks staff and staff of other recreational organizations

3.0 Methods

3.1 Study Area

The study area includes all watercourses (e.g., rivers, streams, sloughs, and ditches) located adjacent to or that intersect Highway 99 and are within 30 m of the Project alignment, as well as other watercourses located within the same study area width within the broader Highway 99 corridor between Bridgeport Road in Richmond and Highway 91 in Delta. At the Fraser River South Arm, as well as Deas and Green sloughs, the study area extends to a width of 500 m on either side of the Project alignment (**Appendix A, Figure 1a**).

For major water features within the study area, information pertaining to fish presence and fish habitat, including basic water quality data, is relatively well-documented. Field sampling therefore focused on upland channelized watercourses (ditches) where fish presence and fish habitat values were largely unknown. Sampling occurred at representative sites at approximately one-kilometre intervals along ditches that parallel Highway 99, and in ditches that intersect the Highway 99 right-of-way (ROW). Given the relatively uniform nature of the typically low-gradient, channelized ditches, this sampling is representative to characterize fish species presence and to assess fish habitat values.

3.2 Temporal Scope

Fish and fish habitat sampling was undertaken in 2014 to document existing conditions in watercourses within the study area. Because water levels, water quality, and fish presence are expected to show appreciable variation seasonally, fish sampling was conducted in spring (March 31-April 1, April 15-16, and April 21-22) 2014 and autumn (October 15-16, 18-19, and 19-20) 2014 to capture the widest range of conditions. Sampling during these time periods also maximizes the potential to document fish species that might be present on a seasonal basis, given anticipated poor water quality conditions during the summer months due to, for example, high water temperatures coinciding with low dissolved oxygen levels. Habitat assessments were primarily conducted during low flows and low water level conditions in the summer (July 14-16), complemented with additional observations during spring and autumn sampling. Water quality measurements were taken during all spring, summer, and autumn field sampling events to provide further information on fish habitat values.

3.3 Study Methods

3.3.1 Literature Review of Major Water Features

Information on hydrology and hydraulics, biophysical characteristics (i.e., fish habitat values, including riparian zone features), and fish use was compiled for the entire length of major watercourses (i.e., river, streams, and sloughs) within the study area. Fish habitat information, including the state of riparian vegetation and water quality data for major watercourses within the study area was complemented with data collected during the 2014 field studies.

3.3.2 Field Habitat Assessment

Aquatic habitat assessments were conducted for major water features and upland watercourses within the study area. It was determined during a review of existing information, and confirmed during spring sampling, that upland watercourses within the study area are relatively uniform in nature. Detailed on-site habitat assessments were therefore conducted at watercourses that appeared to be of higher value to fish, and at a subset of other ditches considered representative of other watercourses within the study area. This approach is consistent with field methods applied to similar studies undertaken in support of linear infrastructure projects in the Lower Mainland. The remaining ditches were assessed based on photographs taken in the field and imagery available online through online mapping services for Richmond, and Delta (Delta 2012, Richmond 2014).

Habitat assessments (both detailed assessments and those based on field photographs and online imagery) were conducted in accordance with Resources Information Standards Committee (RISC) prescribed and standardized guidelines for collection of fish habitat data. For the detailed on-site assessments, data were recorded using RISC site cards, digital forms created in iForm (spring sampling), and FlowFinity (summer and autumn sampling) software installed on an iPad. Photographs were taken of all assessed watercourses.

Approximately 100 m of each watercourse were surveyed at each detailed habitat assessment site. Existing conditions such as water flow, channel and morphological characteristics, and the presence of barriers to fish passage, were visually assessed and recorded. In addition, mesohabitats (pools, riffles, runs, glides) were described. The following physical attributes were measured at each site to characterize watercourse conditions and fish habitat:

- Stream stage (the amount of water passing through the channel)
- Channel and wetted width (m)
- Extent and type of instream fish cover

- Type and width (m) of riparian vegetation, and crown closure (per cent)
- Dominant and subdominant streambed materials
- Channel morphology, pattern, and confinement

Field crews investigated the connectivity of watercourses within the study area, and within approximately 100 m outside the study area boundaries. Habitat assessments were conducted primarily during low flows in the summer, but also complemented with additional observations during spring and autumn sampling.

3.3.3 Field In Situ Water Quality Assessment

Basic in situ water quality information was obtained at the majority of sites where fish sampling or habitat assessment was conducted, to better understand habitat values and habitat suitability for different fish species. Water quality parameters were measured at 25 sites in the spring during lead-up to freshet (June 1 per Government of Canada 2014b); 15 sites in the summer, during low flows; and 35 sites in autumn, during the beginning of the rainy season. Water quality parameters were collected using a YSI multi-parameter meter and included temperature (°C); dissolved oxygen (DO, in mg/L), conductivity (µS/m), and pH. The meter was calibrated according to the manufacturer’s instructions prior to each round of field sampling. Digital photographs were taken at each site to document conditions at the time of assessment.

Water quality results for temperature, DO, and pH were evaluated against *B.C. Water Quality Guidelines for the Protection of Aquatic Life* (B.C. WQG; B.C. MOE 2006) (**Table 3-1**). The results were used to help determine habitat suitability and likelihood of fish presence, including the potential seasonality of use.

Table 3-1 Evaluation Criteria for Water Quality Parameters

| Parameter | B.C. Water Quality Guidelines | Reference |
|---|--|---------------|
| Temperature (°C) (range) ¹ | ± 1°C change beyond daily water temperature range of 9 to 16°C | B.C. MOE 2006 |
| Dissolved oxygen (mg/L), (instantaneous minimum) ² | 5 | B.C. MOE 2006 |
| pH | 6.5 - 9.0 | B.C. MOE 2006 |

Notes:

¹ Dependent on salmonid species and life stage. This criterion captures the temperature range for rearing stages of salmonid species that have been previously documented in upland watercourses within the study area (i.e., cutthroat trout).

² Dependent on fish life stage. The instantaneous minimum concentration of DO for protection of aquatic life is 9 mg/L for buried embryo/alevin life stages and 5 mg/L for all other life stages. Because upland water features typically do not provide suitable spawning habitat for salmonids, the 5 mg/L criterion was used.

3.3.4 Fish Sampling

Information regarding fish presence, distribution, and relative abundance was obtained by conducting a desktop literature review of historic fish sampling records from watercourses within the study area (DataBC 2014, FISS 2014) and fish sampling using gee-type minnow traps in accordance with *Fish Collection Methods and Standards* (RIC 1997), and *Reconnaissance (1:20,000) Fish and Fish Habitat Inventory Standards and Procedures* (RISC 2001). Fish sampling was undertaken within a subset of sites where the literature review identified a gap in fish distribution data. Sampling locations were limited to smaller ditches and lesser sloughs within the study area. Fish presence in major watercourses within the study area (e.g., Fraser River, Deas Slough, and Green Slough) was described using existing published information (e.g., FISS, technical and government reports).

Minnow traps were set at 26 sites during the spring sampling session and 35 sites in the autumn session. Two to four traps were deployed per site, depending on the size of the watercourse and its connectivity and proximity to adjacent sampling sites. Traps were soaked overnight, for a period of approximately 24 hours (range: 18.5 to 24.6 hours). Fish were identified to the species level using freshwater fish species field keys (e.g., McPhail and Carveth 1999). Fish total length was measured to the nearest mm. When non-salmonid species were captured, minimum and maximum fish total length was recorded.

Minnow trapping was selected over other fish sampling techniques (e.g., backpack electrofishing) given the morphology and water quality in the majority of watercourses in the study area. Characteristically high conductivity and turbidity, along with easily disturbed fine bottom sediments, would have substantially reduced the effectiveness of electrofishing sampling.

3.3.5 Incidental Observations

Incidental captures of non-focal aquatic organisms (e.g., amphibians and invertebrates) were identified, recorded in field notes, and released in accordance with RISC guidelines for capturing and handling of live animals (B.C. MELP 1998, RISC 1998, B.C. MOE 2008).

3.4 Data Analysis

Field data were recorded electronically using electronic equivalent of RISC fish collection and habitat assessment forms created in iForm (spring sampling) and FlowFinity (summer and autumn sampling) software installed on an iPad. Data were wirelessly downloaded into a data management system and imported directly into a Microsoft Access database developed for the freshwater fish study program. Data from hardcopy field forms were entered manually into that database.

Geomatics data management was supported by the use of ESRI’s geographic information system (GIS) mapping software, specifically ArcSDE SQL server database and ArcGIS server web mapping software. The database information was cross-referenced with photographs and geographic coordinates. Inconsistencies were identified and reviewed to determine the cause of the discrepancy and, if necessary, discrepancies were reconciled

All determination of fish habitat quality and likelihood of fish species occurrence was qualitative (did not involve statistical calculations or modelling). Watercourses were classified based on commercial, recreational, and Aboriginal (CRA) fisheries values, as described in **Table 3-2**. Where the existing classification for a watercourse was insufficiently assigned or missing, watercourses were coded in accordance with the classification system described in **Table 3-2** with consideration of fish access, historic and recent fish sampling data, physical habitat characteristics, and water quality.

Table 3-2 Fish and Fish Habitat Study Watercourse Classification System

| CRA Fish Habitat Value | Coding | Description |
|---------------------------------|------------|---|
| Potential for CRA fish presence | Red | Year-round habitat for CRA or listed fish species (e.g., salmonids, eulachon (<i>Thaleichthys pacificus</i>), white sturgeon (<i>Acipenser transmontanus</i>), or green sturgeon (<i>A. medirostris</i>)) |
| | Dashed-red | Seasonal habitat for CRA or listed fish species (e.g., overwintering habitat for juvenile salmonids) |
| No CRA fish presence | Orange | Significant upstream source of food or nutrients to red or dashed-red habitat |
| | Yellow | Non-CRA fish bearing, but with no value to CRA or listed fish species (e.g., resident fish only) |
| | Green | No value for fish (CRA, listed, or other fish species) |

Notes: Watercourse classification was built upon existing municipal mapping (Delta 2003a, 2012, Richmond 2014), along with previous classification conducted for the Ministry during baseline studies for the South Fraser Perimeter Road Project (Coast River 2006). Existing classifications from municipal mapping provide a varying amount of detail, ranging from a binary description of potential salmonid presence (Richmond 2014) to classification schemes similar to that described in **Table 3-2** (Delta 2003a, Coast River 2006).

4.0 Results

This section presents the main findings of the literature review and field studies, and briefly describes data gaps, potential biases, and incidental observations.

4.1 Information Review of Previous Fish Sampling

The FISS (2014) documents fish presence in major catchments and some ditches within the study area (**Appendix B, Table 1**). Additionally, the Corporation of Delta (2002, 2003a) has assessed fish presence in the major Delta catchment areas FA-5, FA-4, BBA-2, BBA-3, and BBA-1 that overlap with the study area (**Appendix A, Figure 2**). Past sampling efforts in the vicinity of the Project have resulted in the capture of native and introduced resident fish species. A complete list of these species is provided in **Appendix B, Table 2**.

4.2 Study Results

The results of the literature review and field studies are presented below. Habitat assessment, water quality, and fish sampling results within upland ditches are also summarized. Data from all detailed habitat assessments are provided in **Appendix B, Table 3**. Representative photographs of all watercourses are presented in **Appendix C, Photos 1 through 112**. Water quality data are presented in **Appendix B, Tables 4, 5, and 6**. Fish capture data are provided in **Appendix B, Tables 7 and 8**.

4.2.1 Fraser River South Arm

In addition to the Fraser River South Arm, the study area includes several upland watercourses (**Appendix A**), the existing conditions of which are described below.

4.2.1.1 Hydrology and Hydraulics

The Fraser River is the largest river on the west coast of Canada, draining approximately 250,000 km² of mountainous terrain in southern B.C. (Kostaschuk and Luternauer 2004). Downstream of Hope, the Fraser River divides into a gravel reach and a sand reach, as determined by the dominant bed-load type (Rosenau and Angelo 2007). The gravel reach extends from Hope downstream to the Fraser River's confluence with the Sumas River near Mission. The sand reach spans downstream of the gravel reach, from the Sumas River confluence to the river mouth at Sand Heads (Rosenau and Angelo 2007).

At the New Westminster trifurcation off the eastern tip of Lulu Island, the lower Fraser River splits into three branches: the South Arm, which extends approximately 35 km to Sand Heads; Annacis Channel, which rejoins the South Arm a short distance downstream; and the North Arm, which further divides into the Middle Arm at the eastern tip of Sea Island near its mouth (**Appendix A, Figure 1a**).

The South Arm is an estuarine ecosystem influenced by the presence of a tidally driven salt water wedge that flows near the river bottom underneath a freshwater surface layer (Kostaschuk 2002). Mean annual river discharge at Port Mann Bridge (approximately 25 km upstream of the study area) is about 3,600 m³/s (Gray and Tuominen 1999). River flows fluctuate on an annual basis. Heaviest flows occur between May and July during freshet, with normal maximum flows exceeding 8,000 m³/s in June (NHC 2009). From December through March, flows are lower at approximately 1,450 m³/s (NHC 2009). Although dependent on discharge, tide level, bathymetry, and local control from training structures, the South Arm discharges on average approximately 85 per cent of the total river flow (Schaefer 2004).

From the Sumas River confluence downstream to the Fraser River mouth, the riverbed displays a series of deep pools, typically in the river bends and at locations where the river channel narrows. The water surface drops fairly uniformly with no apparent gradient to the riverbed (NHC and Triton 2006). Even during extreme flood conditions, the river gradient is approximately 5 cm/km, indicating that the water level is affected strongly by downstream control, rather than local hydraulic conditions (NHC and Triton 2006). Downstream of New Westminster, the South Arm has deepened appreciably in response to dredging, river training, and confinement by bridges and dikes. On average, bed levels in the South Arm have lowered by 0.1 m/year since the 1970s (NHC and Triton 2006).

The Fraser River transports an average of 17.3 million tonnes of sediment annually (measured at Mission, 84 km upstream of the river mouth), consisting of 35 per cent sand, 50 per cent silt and 15 per cent clay (McLean et al. 1999). Most of the sediment is transported during freshet through the South Arm (McLaren and Tuominen 1999). Heavier sand particles settle on the riverbed during transport; however, finer silt and clay are carried in suspension and deposited in the estuary. About 30 per cent of the sediment is delivered to Sand Heads at the mouth of the Fraser River (Williams et al. 2009). The riverbed in the South Arm is composed almost entirely of sand with a mean particle size of 0.25 mm to 0.35 mm, with little seasonal variation (Kostaschuk et al. 1989). During freshet, sand dunes form on the river bottom from sediment transported by the river. As the flow increases, the dunes expand in height and length, and migrate along the river bottom producing scour or fill as they move (NHC 2009).

The river channel width at the Tunnel crossing is approximately 570 m, measured from top of bank to top of bank. Bed levels in the vicinity of the Tunnel crossing have formed as a result of natural scour and deposition, as well as maintenance dredging occurring annually in the river mainstem. The greatest bed level changes seem to have occurred from 1988 through 1989 and 2000 to 2001. Upstream of the Tunnel, the main channel at the dam on Deas Slough experienced about two to four metres of local deposition, while at Deas Island, the river bed lowered by about three to four metres due to scouring. Downstream of the Tunnel crossing, the thalweg impinges on the left bank to the upstream third of Kirkland Island and there is evidence of bank scour. Between the Tunnel and the Lulu Island Delta Main, there is a hole at the left bank that was scoured by four metres between 1988 and 2000, and by lesser amounts in subsequent years. Corresponding deposition occurred immediately downstream of the scour hole. Local deposition also occurred in Ladner Harbour between 2001 and 2009.

4.2.1.2 Physical Fish Habitat

The shoreline of the Fraser River South Arm is characterized by a variety of shore-based industries (e.g., lumber mill; grain, forest products, and rolled paper distribution) and shipping terminals (e.g., Fraser Wharves, Annacis Auto Terminals, Fraser Surrey Docks) (FREMP 2006). The New Westminster trifurcation training structure, which serves to decrease sedimentation, thus reducing dredging requirements, is within this river segment, approximately 15 km upstream of the Tunnel (FREMP 2006).

Despite channeling to minimize sedimentation, annual maintenance dredging (hopper and cutter suction) occurs at several locations within this segment (FREMP 2006, PMV 2014a). Within St. Mungo's Bend and Annieville Channel, upstream of the study area, regular dredging occurs to allow access by large vessel traffic (FREMP 2006). Infrequent and localized clamshell dredging also takes place to maintain boat and barge access, access to small craft harbours, and moorage (FREMP 2006).

Productive shoreline habitat in the Fraser River South Arm downstream of the trifurcation is generally confined to a narrow band of intertidal marshes, mud- and sandflats around Tilbury Island, along the north and south banks of Annacis Channel, and along the Fraser River banks on the southwest side of Annacis Island (BIEAP - FREMP 2014). Given the extensive industrial activity along the shoreline of the South Arm, a high proportion of habitat is classified as of low (green-coded) or moderate (yellow-coded) productivity (BIEAP - FREMP 2014).

Shoreline habitats along the South Arm and their respective FREMP (2014) designations within the study area include the following (also see **Appendix A, Figure 3**):

1. Low productivity (green-coded) riprap armouring is located on the north bank of the South Arm, upstream of the Tunnel crossing. A short section (approximately 55 m) of shoreline on the north bank just upstream of the Tunnel crossing was designated as high productivity (red-coded) habitat, following works to compensate for disturbance associated with riverbank erosion protection undertaken in 1987. Compensation works included the creation of an intertidal bench that was incorporated into a riprap slope. A narrow strip of upland deciduous woodland, dominated by black cottonwood (*Populus trichocarpa*), backs the armoured shoreline by the Tunnel crossing.
2. Riprap armouring offering habitat of moderate productivity (yellow-coded) is located on the north bank of the South Arm, downstream of the Tunnel crossing. A narrow strip of upland vegetated areas, consisting of grass and deciduous woodland dominated by black cottonwood, backs the armoured shoreline downstream of the Tunnel crossing. Compensation works have been undertaken also within this section of shoreline. Riparian habitat, intertidal marsh, and subtidal riverbed habitat were created in 2005 to compensate for disturbance of riparian and in-river habitat associated with the Deas Refit Complex Expansion Project.
3. Shrub and deciduous tree woodland, predominantly black cottonwood, fronted by moderate productivity (yellow-coded) sandflat habitat is located on the south bank of the South Arm (north bank of Deas Island), upstream and downstream of the Tunnel crossing. A small, narrow marsh also occurs downstream of the Tunnel crossing, within moderate productivity (yellow-coded) habitat on the south bank. Riprap armours intermittent sections of the shoreline.

4.2.1.3 Aquatic Resources

The food web of the lower Fraser River ecosystem is detritus-based, with much of the production derived by bacteria living on detrital organic material (Levings 2004). Sources of carbon in the food web include material from shoreline and riparian vegetation, as well as from benthic algae growing on the substrate (Kistritz et al. 1983, Levings 2004). Detritus is used by invertebrates such as chironomids, harpacticoid copepods, and amphipods for secondary production in the estuary, which are in turn consumed by fish (Levings 2004).

The lower Fraser River supports 42 species of fish, six of which are introduced from outside the Fraser River basin (Richardson et al. 2000). Of the native fish species, seven are anadromous and 10 are considered transient within the estuary and lower reaches of the river (Healey 1997). Anadromous species of high CRA importance that rely on aquatic habitats throughout the Fraser River estuary during different stages of their life cycle, include five species of Pacific salmon, i.e., chinook (*Oncorhynchus tshawytscha*), chum (*O. keta*), coho (*O. kisutch*), pink (*O. gorbuscha*), and sockeye (*O. nerka*), as well as coastal cutthroat trout (*O. clarkii*), and steelhead/rainbow trout (*O. mykiss*).

Other fish species that inhabit the lower Fraser River mainstem and its tidal sloughs, backwaters and tributaries include prickly sculpin (*Cottus asper*), peamouth (*Mylocheilus caurinus*), redbreasted shiner (*Richardsonius balteatus*), northern pikeminnow (*Ptychocheilus oregonensis*), starry flounder (*Platichthys stellatus*), lamprey (*Lampetra* sp.), and threespine stickleback (*Gasterosteus aculeatus*) (Richardson et al. 2000).

Introductions of non-native fish species have occurred in the lower Fraser River; however, no major shifts in the species composition, density, and biomass of the native fish community have been recorded (Richardson et al. 2000). Three non-native species that are well-documented to reside in the Lower Fraser River are carp (*Cyprinus carpio*), brown catfish (*Ameiurus nebulosus*), and black crappie (*Poxomis nigromaculatus*).

Life histories, biology and habitat requirements for Pacific salmon, sturgeon, eulachon, trout, and char species of the lower Fraser River are summarized below.

Chinook salmon

Chinook salmon is the largest in size of the Pacific salmon species that return to the Fraser River and its tributaries to spawn (DFO 2011). Spawning locations in the Fraser River watershed are widely distributed over 900 km from the mouth of the Fraser River (DFO 2011). More than 100 spawning sites have been identified in numerous tributaries of the Fraser River (Candy et al. 2002, DFO 2011).

Chinook salmon return to the Fraser River to spawn over an extended period from February to November, as three-, four-, or five-year-old fish (DFO 2011). Generally, stream-type chinook migrate upriver between March and September, while ocean-type chinook migrate between September and November, only a few weeks or even days before spawning (Fraser et al. 1982, Candy et al. 2002, Parken et al. 2008). Spawning occurs from August to December, depending on the stock (Candy et al. 2002).

In their natal streams, chinook spawn from August to December, depending on the stock (Candy et al. 2002). Adult chinook, like other Pacific salmon species, deposit their eggs in gravel and die after spawning. Chinook fry emerge in March through June (Fraser et al. 1982). After emergence from gravel in locations well upstream of the lower Fraser River's sand reach, stream-type juvenile chinook rear in freshwater for one or more years (Healey 1983, 1991) and migrate to sea as smolts between January and July (Healey 1991, Boehlert 1997). Ocean-type chinook migrate to sea during their first year of life between April and October, after spending only two to five months in fresh water (Healey 1983, 1991). On average, estuarine residence time of juvenile chinook likely ranges between one week to one month (Quinn 2005, Northcote

et al. 2007). Stream-type chinook generally do not occupy tidal channels; however, ocean-type chinook are found rearing in the tidal marshes of the Woodward Island complex and Ladner Marsh of the inner Fraser River estuary (Levy and Northcote 1982, Northcote et al. 2007). Their abundance peaks in May and June (Northcote et al. 2007). As they grow, chinook juveniles enter the ocean and begin their offshore migration. The diet of younger juvenile chinook in the inner estuary consists of epibenthic prey (harpacticoid and cyclopoid copepods) associated with the detrital food web (Northcote et al. 2007). Contribution of terrestrial insects and fish to the diet of juvenile chinook increases as they grow (Northcote et al. 2007).

Fraser River chinook are subject to numerous fisheries (DFO 2011). Lower Fraser River ocean-type chinook are commonly caught off the west coast of Vancouver Island, while the South Thompson ocean-type chinook are commonly caught in Alaska, northern, and central B.C. (Tucker et al. 2011). Fraser River chinook salmon stocks are not federally or provincially listed; however, they have experienced depressed production in recent years (DFO 2011). The lower Fraser River chinook stock is numerically dominated by autumn-returning, ocean-type fish originating from the Harrison River (DFO 2011). Over the last decade, Fraser River stream-type chinook escapements declined steeply between 2003 and 2009, with smolts that entered the ocean in 2005 and 2007 having fared particularly poorly (Pacific Salmon Commission 2013). Recent escapements indicate that the declining trend in stream-type chinook may have halted. The rebuilding process has been particularly slow, however, with fish exhibiting early maturation, smaller body size, and lower fecundity (Pacific Salmon Commission 2013). In contrast, escapements for ocean-type chinook have been increasing or showing no discernible trends (Pacific Salmon Commission 2013).

Limiting factors for chinook populations include fisheries-induced and natural (e.g., due to predation) mortality, climatic variability, habitat degradation, or combination. Fraser River chinook are subject to numerous coastal and offshore fisheries. Coastal catches are dominated by ocean-type fish, and fishing mortality exerts some pressure to ocean-type stocks (DFO 2011). Coastal fisheries to some extent, as well as offshore fisheries likely limit the recovery of stream-type chinook (Tucker et al. 2011). Other limiting factors include variability in climatic and oceanographic conditions. Shifts in ocean conditions influence prey availability and abundance, which in turn affect chinook growth rates, year class strength, and survival (Beamish and Mahnken 2001, Trudel et al. 2007, MacFarlane 2010, Duffy and Beauchamp 2011, Tucker et al. 2012). For example, good feeding conditions for rearing chinook that enter the marine environment may result in early rapid growth, which is thought to increase likelihood of survival (Percy 1992, Trudel et al. 2007). Natural mortality due to predation may also limit chinook recovery. For example, chinook salmon account for more than 80 per cent of the diet of

southern resident killer whales (*Orcinus orca*) from May to September, when southern resident killer whales are in their summer critical habitat (Hilborn et al. 2012a). Habitat degradation as a result of urbanization, resource extraction activities, and agricultural land use has also contributed to chinook population declines (DFO 1999).

Chum salmon

Chum salmon have the widest geographic distribution of all Pacific salmon, ranging in North America from Monterey, California to the Arctic coast (Salo 1991). Historically in the North Pacific Ocean, they may have constituted up to 50 per cent of the annual biomass of all Pacific salmon combined (Salo 1991). Chum salmon spawn in streams of various sizes, including the lower Fraser River mainstem between Chilliwack and Hope (Ryall et al. 1999).

Chum salmon are the last of the Pacific salmon to return to their natal streams. Returning chum salmon can be divided into early (summer) and late (fall) run stocks (Salo 1991). In the Fraser River, chum are fall run stocks that migrate upstream to spawn from September to December, with peak spawning migration occurring in October (Grant and Pestal 2009). The runs consist of three-, four-, and five-year-old chum, with four-year-olds dominating (Beacham and Starr 1982, Pauley et al. 1988, Salo 1991).

The majority of spawning locations for chum in the Fraser River watershed are located in tributaries of the lower Fraser River downstream of Hell's Gate, near Hope, as chum are reputed to be poor or unwilling leapers (Salo 1991). Chum rarely ascend fish ladders or other significant obstacles, and only few spawning locations occur in tributaries in the Fraser River canyon (Ryall et al. 1999, Holtby and Ciruna 2008). Most (>90 per cent) of the Fraser River chum production comes from about 10 tributary streams in the lower Fraser River that have natural spawning populations and, in some cases, major hatchery production facilities (Ryall et al. 1999, Holtby and Ciruna 2008). These include the Harrison, Chehalis, Chilliwack, and Stave rivers (Ryall et al. 1999, Holtby and Ciruna 2008).

Once chum salmon arrive at the mouth of their natal stream, they may spend several days milling before ascending. In Skagit Bay, located in Puget Sound, Washington, chum salmon have been reported to mill for about three weeks (Eames et al. 1981). The milling period becomes shorter as the spawning season progresses. Returning adult chum salmon stop feeding just before entering fresh water (Pauley et al. 1988).

After emergence, chum fry promptly migrate downstream to the estuary where they linger until they transition to higher salinity waters (Salo 1991). Outmigration occurs from February to June, and peaks between mid-March and the end of April (Beacham and Starr 1982, Salo 1991).

In the estuary and lower reaches of the Fraser River, chum fry prey mainly on harpacticoid copepods (Mason 1974, D'Amours 1987, Webb 1991, Levings et al. 1995). Other prey include gammarid amphipods, chironomid larvae and pupae, and adult insects (Mason 1974, Dunford 1975, Levings et al. 1995). In the estuary, residence time for chum fry has been recorded to range from 11 days to a few weeks (Healey 1982, Levy and Northcote 1982). Movement into the deeper waters of the Strait of Georgia occurs in June, and movement out of the Strait of Georgia occurs soon after, in July (Healey 1980). Migration of chum fry to salt water is obligatory within the first summer after hatching, as chum salmon juveniles lose their ability to tolerate brackish salinities (Pauley et al. 1988). At sea, immature chum salmon become widely distributed throughout the north Pacific Ocean (Pauley et al. 1988).

Chum salmon are harvested in CRA fisheries throughout B.C. (DFO 2012). Catches of inshore chum stocks have been fluctuating since the early 1950s (Ryall et al. 1999). Since the implementation of fisheries management tools in the 1980s, the Fraser River chum stock has exhibited moderate growth (Ryall et al. 1999, Pacific Salmon Commission 2014), with total escapement estimates consistently above the escapement goal from 1990 to the mid-2000s (Hilborn et al. 2012b). Although escapement levels declined from the mid-2000s, the trend appears to be reversing since 2011 (Pacific Salmon Commission 2014). In 2013, the Marine Stewardship Council certified the Fraser River commercial chum fishery as sustainable and well-managed (Marine Stewardship Council 2013).

Coho Salmon

In North America, coho salmon are distributed from Kotzebue Sound in northwest Alaska, to Monterey Bay in California (Sandercock 1991). In B.C., they can be found in nearly every accessible coastal stream. They also migrate some distance inland in large rivers and spawn in smaller tributaries of the Skeena, Bella Coola, Nass, and Taku rivers, and in the middle tributaries of the Fraser River. Coho is the most widespread of the Pacific salmon in B.C., with no one area being the dominant producer (Sandercock 1991).

Coho have the least variable life history of the Pacific salmon species. Adult coho typically return to spawn in the fall and early winter, and discrete seasonal runs do not generally exist (Holtby and Ciruna 2008). They migrate actively during daylight hours, with diel vertical migration also influenced by water turbidity, degree of sexual maturity, and run size (Sandercock 1991).

The eggs incubate during winter in the gravels of suitable spawning streams, with incubation timing generally ranging from six to eight weeks (Sandercock 1991). From mid-March to late June, free-swimming fry emerge and take up residency in the stream for a year or more (Fraser et al. 1982, Sandercock 1991). When they are about to transition physiologically into smolts, they begin moving downstream in aggregations of 10 to 50 fish. Outmigration generally occurs from mid-April to mid-June, with a peak observed in mid-May (Fraser et al. 1982). In the estuary, growth is rapid (Sandercock 1991). Similar to chinook, coho smolts remain in the estuary and lower reaches of the Fraser River for a few weeks while physiologically adapting to higher salinity conditions (Fraser et al. 1982).

Coho salmon are not federally or provincially listed; however, the Interior Fraser populations were designated as Endangered by COSEWIC (COSEWIC 2002). The status of the Interior Fraser Coho Salmon is anticipated to be re-assessed by COSEWIC and an updated status report is expected to be produced in 2015 (Decker and Irvine 2013). Coho are taken in net, as well as hook and line CRA fisheries; however, catches in south coastal B.C. have declined from 1.55 million fish in the mid-1980s, to virtually zero in the late 1990s, and have remained low since then (DFO 2002). This decline was largely attributed to overharvesting, and was followed by implementation of conservation measures, such as limiting the exploitation rate to three per cent or less, time and area fisheries closures, as well as non-retention (DFO 2012).

Pink Salmon

In North America, pink salmon is distributed from the Sacramento River, California, to the Beaufort Sea, east of Point Barrow, northwestern Alaska. In B.C., pink salmon distribution ranges from the Taku River on the north B.C. coast to the Fraser River (Heard 1991). Pink salmon have a fixed two-year life cycle resulting in 'even-year' and 'odd-year' brood lines that are reproductively isolated. In Puget Sound, the southeastern Vancouver Island, and the Fraser River, 'even-year' pink are either absent or quite rare (Holtby and Ciruna 2008).

Pink salmon have the shortest life cycle of all Pacific salmon since they always mature as two-year-old fish (Labelle 2009). In the Fraser River, pink salmon return in odd years (Labelle 2009). Return migration typically peaks from late July to early September (Heard 1991). Spawning occurs mostly in September and October, and is typically concentrated in the Fraser River tributaries below Hope, with significant spawning also occurring in the Thompson River (Labelle 2009). The eggs incubate in the gravel for five to eight months (Heard 1991). From mid-April to mid-May, free-swimming fry emerge at night and migrate quickly downstream using sections of the river mainstem characterized by fast-flowing water (Heard 1991). In the estuary, pink fry migrate quickly through the marshes of the lower Fraser River and rear in nearshore areas of the estuary and adjacent coastal waters of the Strait of Georgia (Godin 1981, Levy and Northcote 1982).

Pink salmon are not federally or provincially listed (B.C. CDC 2015). They are the most abundant salmon species in B.C. and the Fraser River is a major contributor to total pink salmon production. Fisheries catches increased from the 1950s to the late 1980s, when they exceeded 20 million fish, but subsequently declined in the 1990s (Labelle 2009). Since 1999, exploitation rates on Fraser River pink salmon have decreased substantially, averaging only eight per cent of the total return (Labelle 2009). Fisheries targeting Fraser River pink salmon are limited due to conservation constraints for stocks of concern of other salmonid species, such as the Cultus Lake sockeye, the Interior Fraser coho, and the Interior Fraser steelhead (Labelle 2009).

Sockeye Salmon

In North America, spawning populations of sockeye salmon have been reported from the Sacramento River, California, to the Chukchi Sea, northwestern Alaska (Burgner 1991). Sockeye salmon are found throughout B.C., especially in large river systems with an abundance of large nursery lakes, such as the Skeena and Fraser River systems (Burgner 1991, Holtby and Ciruna 2008). The Fraser River system contains 50 to 60 sockeye salmon stocks that spawn in tributaries of about 22 nursery lakes (Groot and Cooke 1987).

Sockeye salmon has three distinct life history types (Burgner 1991). Kokanee are not anadromous and spend their entire life in fresh water (Burgner 1991). Lake-type sockeye spawn in streams and rear for a year or more in freshwater nursery lakes. River-type sockeye spawn in streams, but rear in flowing water and may transition into smolts soon after emergence. Sea-type sockeye is a special variety of river-type sockeye that rear in the river for several months after emergence from the gravel and enter the ocean in their first year of life (Wood et al. 2008). Lake- and river-type sockeye are found throughout B.C., although river-type predominate northern glacial rivers, whereas lake-type predominate large river systems, such as the Fraser, Skeena, and Nass (Holtby and Ciruna 2008). In the Fraser River, the largest population of sea-type sockeye occurs in the Harrison River (Beamish et al. 2010).

Sockeye salmon are commercially the most valuable of Pacific salmon in the North Pacific region, comprising about 50 per cent of the Fraser River salmon fishery (Birtwell et al. 1987*b*). Fraser River sockeye salmon typically return as four-year-old adults and populations have characteristic timings of return, broadly classified into four groups or runs (Gable and Cox-Rogers 1993). The early Stuart run consists of populations that spawn in tributaries to Stuart, Takla, and Trembleur lakes of the upper Fraser River watershed (Gable and Cox-Rogers 1993). The three remaining runs, early summer, summer, and late, are not geographically discrete, and each contains populations from throughout the Fraser River drainage (Gable and Cox-Rogers 1993).

The peak arrival for early Stuart sockeye typically occurs in early July, followed by the early summer run in late July, the summer run in early August, and the late run about the third week of August (Gable and Cox-Rogers 1993). Late-run stocks may hold in the Fraser River estuary for several weeks before migrating upriver. Consequently, their spawning migration may peak in late September (Gable and Cox-Rogers 1993). At spawning grounds, eggs incubate during winter, and in spring free-swimming fry emerge that take up residency in a downstream nursery lake (Burgner 1991). After rearing for a year, sockeye smolts (age 1+) migrate downstream in fast flowing, mid-channel areas of the river and leave the estuary rapidly (Birtwell et al. 1987*b*). Smolt outmigration from nursery lakes generally occurs from mid-April to late-May (DFO 2014*a*). One notable exception is the Harrison sockeye that have a unique age structure and life history compared to all other stocks. Harrison sockeye fry migrate to the estuary shortly after gravel emergence and rear in sloughs of the inner Fraser River estuary, including Deas Slough, before entering the Strait of Georgia (Dunford 1975, Levy and Northcote 1981, 1982, Birtwell et al. 1987*b*). In Deas Slough, sockeye underyearlings have been caught from April to October, with peak abundance from late June to early July (Birtwell et al. 1987*b*). Upon entering the Strait of Georgia, sockeye smolts migrate primarily through the Johnstone and Queen Charlotte straits towards the North Pacific Ocean (Groot and Cooke 1987).

Sockeye salmon spawn in a variety of habitats, including headwater streams, small tributaries, river outlets, and lake beaches. Spawning occurs from early August to late November, with average spawning dates exhibiting considerable variability within regions (Linley 1993). Free-swimming fry emerge in spring and rear in freshwater habitats (Burgner 1991). After about a year or more, sockeye smolts (age 1+) migrate downstream in fast flowing, mid-channel areas of the river, and leave the estuary rapidly (Birtwell et al. 1987*b*). Smolt out-migration generally occurs from early April to the end of May (Beamish et al. 2010). One notable exception is the Harrison sockeye that have a unique age structure and life history compared to all other stocks. Sea-type Harrison sockeye fry migrate to the estuary shortly after gravel emergence and rear in Fraser River estuary habitats, including Deas Slough and Ladner Reach, before entering the Strait of Georgia (Dunford 1975, Levy and Northcote 1981, 1982, Birtwell et al. 1987*b*). In Deas Slough, sockeye underyearlings have been caught from April to October, with peak abundance from late June to early July (Birtwell et al. 1987*b*).

Residence time in the Strait of Georgia ranges from 45 to 59 days, with a mean of 54 days (Preikshot et al. 2012). Upon entering the Strait of Georgia, sockeye smolts disperse either as a result of innate behaviour, physical forcing in the marine environment, or both. Relatively large abundances of juvenile sockeye salmon migrate into the waters of the Gulf Islands (Preikshot et al. 2012). During rearing in the marine environment, juvenile sockeye diet is dominated by

amphipods, followed by tunicates and calanoid copepods (Beamish et al. 2010, Preikshot et al. 2010). Typically, sockeye juveniles migrate to the North Pacific Ocean in June or July through the Johnstone Strait (Preikshot et al. 2012). However, some Harrison sockeye may migrate later in the calendar year from October to December through the Juan de Fuca Strait (Beamish et al. 2010).

Sockeye salmon are not federally or provincially listed; however, the Cultus Lake population was designated as Endangered by COSEWIC in 2003 (COSEWIC 2003a). On average, sockeye is the most important of the Pacific salmon species in terms of commercial landed value, followed by chinook and chum (DFO 2012). Sockeye salmon is also caught in sport fisheries and in Aboriginal active food driftnet (i.e., gillnet) fisheries on the Lower Fraser River.

Most Fraser River sockeye stocks are recovering from collapse in the early 1900s as a result of river blockages and overfishing (Cass et al. 2000). Since the mid-1980s, efforts undertaken for rebuilding of the stocks have included setting of escapement targets, which were informed by results from historical catch reviews, stock-recruitment analyses, and spawning and lake rearing habitat capacity estimates. To increase escapement, average exploitation rates were also reduced (Cass et al. 2000). Sockeye spawning escapement to the Fraser River gradually increased from an average of 1.5 million fish per year in the 1950s to 10.7 million fish per year in the 1990s (Cass et al. 2000). Increases in escapement have mainly occurred in the large actively managed stocks and cycle lines (e.g., Early Stuart, Late Stuart, Quesnel and Late Shuswap), whereas escapements to less actively managed stocks (e.g., Cultus) have been highly variable since the 1950s (Cass et al. 2000). Recently, escapement variability has been particularly large, with the 2009 return (1.6 million) and 2010 return (28.3 million) among the lowest and highest, respectively, on record since 1952 (DFO 2014b).

White Sturgeon

White sturgeon are known to occur in the mainstems of large river systems of the Pacific coast of North America, such as the Fraser, Columbia, and Sacramento rivers. In the Fraser River, they are distributed from the river mouth upstream past the Morkill River, northwest of McBride. They also occur in the lower reaches of large tributaries, such as the Harrison, Nechako, and Stuart rivers, and in large lakes, such as Fraser, Takla, Trembleur, Stuart, Williams, and Harrison lakes (COSEWIC 2003b).

White sturgeon in the lower Fraser River are considered anadromous, with limited migration into marine waters and juvenile rearing in the estuary (COSEWIC 2003*b*). They are long-lived (>100 years), with delayed sexual maturity, and high first-year mortality (Hatfield et al. 2004). Spawning occurs in the meandering reach of the lower Fraser River from the confluence of the Sumas River upstream to the Coquihalla River; there is no evidence of spawning in the tidally influenced river mainstem (Levings and Nelson 2003). Spawning occurs during peak freshet (from May to July; COSEWIC 2003*b*, Hatfield et al. 2004) in side-channels and large tributary river fans, in low-velocity near-bed flows, over gravel, cobble, and sand (Levings and Nelson 2003, Perrin et al. 2003).

After hatching, larvae remain near the riverbed in close proximity to spawning habitat, where they feed on zooplankton and dipteran chironomids (Perrin et al. 2003). Juvenile white sturgeon disperse more readily into feeding, and overwintering habitats (Fraser River White Sturgeon Working Group 2005). They rear in the lower reaches of tributaries, large backwaters, side-channels, and sloughs throughout the lower Fraser River (Glova et al. 2008). Higher catches of juvenile white sturgeon have been reported from the Annacis Channel and Hatzic Slough, and to some extent from the Port Mann Bridge, Stave and Matsqui areas (Glova et al. 2008). Near the study area, white sturgeon have been reported from the BC Ferries Fraser Shipyards in the South Arm, the main river channel off Deas Island, immediately upstream of the Tunnel crossing, and upper Deas Slough (Levings and Nelson 2003, Glova et al. 2008). Juveniles rear in a wide range of water depths (1.3 to 6.0 m), but more commonly are found in slow-flowing areas less than five metres deep with fine substrates in side channels, side pools, backwaters and nearshore mainstem open channels (Glova et al. 2008).

Although adult white sturgeon may briefly move into shallower areas to feed during spring and summer, they are typically found in deep nearshore areas, adjacent to heavy flows, defined by deposits of sand and fine gravel with backwater and eddy flow characteristics (COSEWIC 2003*b*). Important spring and summer feeding areas include the Matsqui Channel and Hatzic Eddy upstream of Mission, as well as the mouth of the Pitt River, and the waters at the Port Mann Bridge, Barnston, Douglas, and Annacis islands (Glova et al. 2010). Adult white sturgeon are mainly piscivorous, and feed primarily on eulachon, salmon, and cyprinids (Lane and Rosenau 1995). As water temperatures decrease in the fall and winter, white sturgeon migrate to overwintering areas where they likely become sedentary and congregate in densely spaced groups (Neufeld et al. 2010, Ghilarducci and Reeve 2012). Overwintering habitats include areas of deeper, slow-moving water, widely scattered from Deas Island to the Sumas River confluence (Neufeld et al. 2010, Ghilarducci and Reeve 2012).

The lower Fraser River population of white sturgeon was down-listed to Threatened by COSEWIC in 2012 from the 2003 designation of Endangered (COSEWIC 2003b). It is provincially Red-listed (B.C. CDC 2015). White sturgeon in the lower Fraser River underwent historic fishery removals in the early 1900s, which significantly reduced the population (Walters et al. 2005). However, the population appears to be recovering as a result of ongoing fisheries management (Walters et al. 2005). A commercial fishery in the lower Fraser River no longer exists (Fraser River White Sturgeon Working Group 2009). Since 1994, commercial gill net fisheries are not permitted to take sturgeon, and First Nations are discouraged from taking sturgeon unless the fish died in their nets. Also since 1994, sturgeon caught recreationally in the tidal and non-tidal waters of the lower Fraser River must be released (Fraser River White Sturgeon Working Group 2009).

Green Sturgeon

Green sturgeon (*A. medirostris*) in B.C. span the entire coast (Scott and Crossman 1973). The extent of freshwater habitat use is unknown (COSEWIC 2004). Since 1985, there have been about 15 to 20 reports of green sturgeon in the lower Fraser River, from the river mouth to 90 km upstream. There is no evidence that spawning has ever occurred in Canadian rivers (COSEWIC 2004). Green sturgeon are long-lived, slow-growing, and reach sexual maturity at an advanced age (Houston 1988). They spend their first one to four years in freshwater, and gradually adjust to estuarine conditions as they grow older. They enter the marine environment as sub-adults but maintain estuarine holding areas (COSEWIC 2004). When in the marine environment, green sturgeon are thought to undergo a northern migration. Green sturgeon in B.C. are thought to originate from spawning populations in the U.S. (COSEWIC 2004). Green sturgeon have been caught incidentally in large bottom-trawl hauls in the Strait of Georgia, and in salmon gill nets at the mouth of the Fraser River (COSEWIC 2004). Habitat requirements in brackish environments are thought to resemble those of white sturgeon (COSEWIC 2004).

COSEWIC re-assessed the status of green sturgeon in 2013 and maintained its designation as species of Special Concern (COSEWIC 2014). The species is listed as Special Concern under Schedule 1 of the *Species at Risk Act (SARA)* (Government of Canada 2006), and is provincially Red-listed (B.C. CDC 2015). A comprehensive population size and trends analysis has not been done for the green sturgeon population in Canada. However, catch information, which is largely anecdotal prior to 1996, may indicate that the green sturgeon population has suffered a decline over the past few decades (COSEWIC 2014).

Eulachon

A small, schooling, anadromous fish species, eulachon return to the lower Fraser River to spawn when they are three to four years of age (Cambria Gordon Ltd. 2006). Spawning migration spans from mid-March to mid-May (Hay and McCarter 2000, LGL and Terra Remote Sensing 2009). Spawning occurs in the river mainstem and occasionally in large tributaries, from Deas Island to Mission, but spawning locations vary among years (Hay and McCarter 2000, Hay et al. 2002). Due to inter-annual variation in spawning locations, the entire lower Fraser River is considered to contain suitable spawning habitat for eulachon (B. Ennevor, Fisheries Resource Manager, DFO, personal communication, January 6, 2014).

Preferred spawning habitat is located in areas of relatively slow current (<0.7 m/s), on plateaus or edges composed of stable fine-medium and coarse sand, pebbles, and gravel, in depths of less than seven metres (LGL and Terra Remote Sensing 2009). To reach spawning habitat, eulachon transit through areas of relatively slow current that are five to 12 m deep and with stable sandy substrates (LGL and Terra Remote Sensing 2009). Immediately after hatching, larvae are rapidly flushed to sea, where they remain in low-salinity surface waters of the Fraser River estuary and rear for several weeks or longer (Hay and McCarter 2000). Juvenile, sub-adult, and adult eulachon exhibit schooling behaviour and live near the ocean bottom at depths of 20 to 150 m (Hay and McCarter 2000). When eulachon reach maturity, and prior to entering the river, they hold in brackish water while making physiological changes that allow them to survive in fresh water.

Eulachon (Central Pacific Coast and Fraser River populations) were designated in 2011 by COSEWIC as Endangered (COSEWIC 2011), and are provincially Blue-listed (B.C. CDC 2015). The Fraser River and Central Pacific Coast populations of eulachon are currently being considered for listing as Endangered under SARA (DFO 2014c). Although historically very abundant, eulachon returning to the lower Fraser River began declining steadily in the mid-1940s, and exhibited a steeper decline in the 2000s (Moody 2008, Schweigert et al. 2012). Commercial and recreational harvesting of eulachon in the Fraser River have been suspended since the early 2000s, and only a very small Aboriginal ceremonial fishery continues today (Schweigert et al. 2012).

Coastal Cutthroat Trout

Coastal cutthroat trout are found in a wide range of habitats. In B.C., they inhabit low-elevation lakes and rivers along much of the coast, including streams in the Fraser River basin. Inland penetration is generally less than 150 km (Costello 2008). Their relatively small size at maturity allows them to use smaller streams than other salmonids (Slaney and Roberts 2005).

The Fraser River, including its tributary streams, supports all cutthroat life history forms. These include resident forms in headwater streams that exhibit little instream movement, river-run forms that move between small spawning-rearing tributaries and large river mainstem foraging areas, lake-run forms that migrate between lakes and foraging/spawning areas instream, and anadromous (sea-run) forms that migrate to the estuary or the ocean for less than a year before returning to fresh water to spawn (Slaney and Roberts 2005). Sloughs and backwaters along the lower Fraser River mainstem provide rearing, overwintering, and migratory habitat for anadromous, river-run, and (potentially) lake-run cutthroat trout.

Unlike Pacific salmon, but consistent with other trout and char, coastal cutthroat trout are able to spawn multiple times in successive years. Spawning usually occurs from late winter to spring (McPhail 2007), though sea-run populations have also been known to spawn during the fall (McPhail 2007). Spawning typically occurs in small, low-gradient streams (Hartman and Gill 1968), in pool tail-outs with gravel substrate ranging from 5 mm to 50 mm (Slaney and Roberts 2005). Newly hatched alevins remain in gravel until fry emerge, usually between March and June (Trotter 1997). Fry initially occupy microhabitats with low flow levels, gradually moving into deeper microhabitats with higher flow and more cover, such as large woody debris, streambank root masses, instream and overhanging vegetation (Solazzi et al. 2000, Slaney and Roberts 2005).

Depending on the life-history form, adults either remain in the natal stream, or migrate to lakes or larger river systems to forage before returning to spawn. Sea-run cutthroat stay in freshwater systems for one to five years before migrating to the ocean (Trotter 1997, Slaney and Roberts 2005), between the months of March to June (Slaney and Roberts 2005). While at sea, coastal cutthroat trout remain close to shore before returning to fresh water in the spring (Trotter 1989). Generation time for coastal cutthroat trout is three to five years (Peterson and Fausch 2008).

Coastal cutthroat trout are primarily carnivores, though their diet varies by life form and life history stage. Fry feed on small prey, particularly chironomid larvae (Glova 1984). Resident form adults feed primarily on insects, whereas lacustrine form adults tend to feed on a wider variety of prey, including zooplankton and small fish (McPhail 2007). In the ocean, sea-run cutthroat feed on small fish, and invertebrates including amphipods, isopods, decapods, and euphausiids (Trotter 1989, Brodeur and Pearcy 1990).

Coastal cutthroat trout (ssp. *clarkii*) are provincially Blue-listed (B.C. CDC 2015). Population sizes of coastal cutthroat trout are typically in the order of tens to hundreds of individuals, even in the largest systems. As a result, cutthroat populations are susceptible to disturbance (e.g., logging, resource extraction, urban development, stream channelization), particularly

when it leads to impairment of habitat quality (Costello 2008). Historically, coastal cutthroat trout have supported diverse and regionally important sport fisheries throughout the Fraser River basin. Although increasingly restrictive fishing regulations have come into effect, angling pressure has likely been another significant factor limiting natural coastal cutthroat production, particularly near urban areas (Post et al. 2002).

Rainbow/Steelhead Trout

Rainbow trout occur in two life history forms, based primarily on where they spend their time feeding and maturing. Stream resident rainbow trout reside entirely in fresh water. Fish of the second form, known as steelhead, are anadromous. Steelhead leave fresh water as juveniles and migrate into the ocean where they grow to maturity before migrating back to their natal spawning grounds (Barnhart 1986). Larger streams with steep gradients emptying directly into the ocean usually support steelhead trout, as do larger rivers, such as the Fraser River (Hartman and Gill 1968). Spawning occurs in spring (February through June) over shallow gravel riffles of a river mainstem or a suitable clear water stream (Barnhart 1986). Hatching occurs approximately within three to four weeks. By mid-summer, fry emerge from the gravel and rear in fresh water for two to five years before smolting and migrating to the ocean (Barnhart 1986). Newly emerged fry rear in shallow depths and over small gravel substrates, and move into deeper and faster-flowing habitats as they grow (Roberge et al. 2002). Yearlings and larger juveniles are associated with large substrates and relatively deep and fast-flowing waters (Rempel et al. 2012). Juvenile steelhead smolts migrate to salt water between late April and mid-June, where they feed and grow rapidly (Levy and Parkinson 2014). Upon maturity, steelhead return to their natal streams to spawn, and spawning occurs more than once (Levy and Parkinson 2014). Spent spawners migrate to the ocean to feed and may return to their spawning grounds within the same year, or skip a year before spawning again (Levy and Parkinson 2014).

Rainbow/steelhead trout are not provincially or federally listed. However, wild steelhead stocks in the lower Fraser River have declined to 30 per cent of estimated carrying capacity since the early 1990s, largely due to reduced ocean survival and impaired freshwater habitat quality (Lill 2002). Fisheries restrictions and area closures have led to a reduction of angling pressure. Fishing tends to be restricted to recreational fisheries, as well as limited and localized Aboriginal harvesting (Beacham et al. 2004). Steelhead are also incidentally caught in salmon fisheries (Beacham et al. 2004). In the early 2000s, the Greater Georgia Basin Steelhead Recovery Action Plan was initiated with the primary objective to stabilize and restore wild steelhead stocks and habitats within the lower Fraser River (Lill 2002). Initiatives within the action plan include habitat protection and restoration, stream enrichment, as well as research including stock assessment (Lill 2002).

Dolly Varden

Dolly Varden (*Salvelinus malma*) are found in coastal areas of the Pacific Ocean from Washington to southeast Alaska. In B.C., Dolly Varden can be found in most coastal drainages, and are associated with cool-body watersheds (McPhail 2007). Dolly Varden are largely a coastal and anadromous species entering the ocean regularly, with distribution of this species not typically extending far inland (i.e., past Hope, within the Fraser River system) (McPhail 2007). Dolly Varden are commonly smaller than bull trout (*S. confluentus*), inhabiting small streams and feeding primarily on drift. In contrast, bull trout (described below) are typically larger, piscivorous, inhabiting cool waters throughout the interior, and generally absent from shorter coastal rivers (McPhail 2007). Where distributions overlap, Dolly Varden and bull trout coexist, without extensive hybridization (McPhail and Baxter 1996). Within B.C., their geographic ranges overlap in northern and western-central Coast Mountain drainages, and in the lower Fraser Valley (McPhail and Baxter 1996).

Dolly Varden occurs in three life-history forms: an anadromous form that migrates between freshwater streams and the ocean, a stream-resident form that remains in rivers and streams for most of its life, and a lake-run form that remains within a single freshwater body and spawns in adjacent streams (McPhail 2007).

Spawning occurs in autumn within headwaters of small streams. Females lay between 70 and 500 eggs, in pool tail-outs (McPhail 2007). Fry emerge from the gravel in spring (April/May), with juveniles remaining in the stream for two to four years (Armstrong 1970). Juveniles use a variety of habitats, including areas of still or moving water, with gravel or muddy substrates having dense instream vegetation, or open water with little or no instream complexity (Armstrong and Morrow 1980). Large rivers are important as overwintering habitats for larger juveniles, as well as sub-adult anadromous Dolly Varden. The lower Fraser River is likely used as a migratory corridor by Dolly Varden, due to its proximity to nearshore estuarine and coastal feeding and overwintering grounds.

Dolly Varden smolts migrate to the ocean in spring and may remain for only two to four months before returning to fresh water (Armstrong and Morrow 1980), where they feed on the eggs and flesh of decaying salmon (Bond and Quinn 2013). Alternatively, Dolly Varden may remain in marine waters well into the fall months, returning only for spawning or overwintering in freshwater habitats (Bond and Quinn 2013). Spawning can occur over multiple years, but does not necessarily occur in successive years (Mochnacz et al. 2010). Dolly Varden movement patterns are complex and often influenced by a combination of age, size, or maturational state, and the relative abundance of resources in marine and fresh waters. Local environmental

conditions influence the relative benefit of each habitat, and Dolly Varden may respond with flexibility in the timing of movements among habitats (Bond and Quinn 2013). Generation time for Dolly Varden is five years (Scott and Crossman 1973).

The diet of Dolly Varden varies with life history stages, and is also apparently influenced by the presence of competing fish species. The stream-resident form tends to feed near the bottom of creeks on nymphs and larvae of aquatic insects, with diet shifting to larger prey as fish grow (McPhail 2007). The lake-run form feeds on zooplankton, shifting to benthos found on the lake floor when trout are present (McPhail 2007). Sea-run Dolly Varden feed on macroinvertebrates, juvenile salmon, and other species of fish (Armstrong 1965).

Dolly Varden are not provincially or federally listed. Although population sizes within the Fraser River basin are largely unknown, Dolly Varden are thought to be susceptible to disturbance (e.g., logging, resource extraction, urban development, stream channelization), particularly when it degrades habitat quality and reduces availability of suitable spawning and rearing habitat (COSEWIC 2010). Dolly Varden have and continue to support diverse and regionally important sport fisheries throughout the Fraser River basin.

Bull Trout

Bull trout are endemic to western Canada and the U.S. Pacific Northwest. The species' current distribution extends from the Oregon-California border and northern Nevada, north to southern Yukon, and southwestern Northwest Territories (McPhail 2007). Although bull trout reach the Pacific coast (B.C. Fraser and Squamish River drainages; Washington: Skagit River drainage, Olympic Peninsula), they are generally restricted to interior drainages (COSEWIC 2012). In B.C., bull trout are found in the cool waters of most major interior watersheds (i.e., upper Columbia, Peace, Liard, and Yukon River drainages), and in major coastal watersheds that penetrate into the interior (Fraser, Homathko, Klinaklini, Skeena, Nass, Iskut-Stikine, and Taku River drainages) (McPhail 2007).

Of the salmonids present within the Fraser River watershed, bull trout are notably a cold water species generally found in waters below 18°C and most commonly in temperatures less than 12°C (Dunham et al. 2003). They exhibit variable life histories (McPhail and Baxter 1996, McPhail 2007), including stream resident, adfluvial (lake-run), large river (fluvial), and sea-run.

Stream resident bull trout are typically associated with high gradient, headwater streams in mountainous regions. They are usually separated from other populations by barrier (e.g., falls, velocity barriers, high temperature) (McPhail and Baxter 1996, McPhail 2007). Stream resident bull trout are non-migratory, and spend their entire life in small streams (McPhail and Baxter 1996, McPhail 2007).

Adfluvial bull trout migrate between lakes or reservoirs and tributary rivers or streams where they spawn. Spawning can also occur in the inlet or outlet of lakes (Carl et al. 1989). In lakes, adults forage in the littoral zone in the fall and spring, and move to deeper water in the summer, most likely due to temperature constraints (McPhail and Baxter 1996).

Fluvial bull trout live in large rivers and major tributaries, and often migrate to smaller rivers or streams to spawn. Adult bull trout tend to concentrate in cooler areas of the river mainstem, and are often associated with the mouths of spawning streams (McPhail and Baxter 1996, McPhail 2007). Some fluvial bull trout populations are anadromous, and spend part of their life at sea.

Anadromous bull trout populations are suspected to occur in the Squamish and lower Fraser rivers (McPhail and Baxter 1996, McPhail 2007). Because anadromous char populations occur where bull trout and Dolly Varden overlap, evidence that these char are bull trout rather than Dolly Varden is often circumstantial. One char tagged in the Squamish River was recaptured in the Skagit River, after a journey of about 150 km through the Strait of Georgia. Also, tagged char in the Pitt River above Pitt Lake have been recaptured in the Fraser River estuary (McPhail and Baxter 1996).

Bull trout spawn in shallow stream habitats characterized by relatively low gradient, a predominance of small gravel (<20 mm), relatively low water velocity (0.03-0.80 m/s), and proximity to cover (e.g., cut banks, log jams, pools, overhanging vegetation) (McPhail and Baxter 1996). Spawning occurs in the fall, when water temperatures drop below 9°C, which is likely the cue to initiate redd building and spawning behaviour (McPhail and Baxter 1996). Egg incubation occurs during the winter, and fry emerge from the gravel in early spring (mid-April to mid-May) (McPhail and Baxter 1996). Bull trout fry are closely associated with shallow edges of rivers and streams, especially in areas of large, loose gravel, where they use the interstitial habitat for cover (McPhail and Baxter 1996).

Juvenile bull trout rear in spawning streams for at least two years before migrating to the larger rivers, or the ocean, depending on the form (Pratt 1992, McPhail and Baxter 1996). In fresh water, juvenile bull trout tend to shift to deeper, slower-flowing water in the fall, where they stay in contact with coarse substrates and remain closer to cover, which provides ice-free refuge throughout winter (COSEWIC 2012). They forage near the substrate and in the water column, but not at the surface (McPhail and Baxter 1996). As they grow, juveniles shift their diet from benthic organisms and drift to small fish, such as sculpins, mountain whitefish, and trout fry (Pratt 1992).

Migratory forms seek suitable feeding and overwintering habitat in larger streams and rivers, as well as nearshore coastal areas (COSEWIC 2012). After spawning, bull trout move to overwintering habitats by September or October (Hayes et al. 2011, COSEWIC 2012). The lower Fraser River is likely used as a migratory corridor by bull trout, due to its proximity to nearshore estuarine and coastal feeding and overwintering grounds. Generation time for bull trout is five to seven years (Rieman and Allendorf 2001).

Bull trout are provincially Blue-listed and were designated by COSEWIC in 2012 as being of Special Concern (B.C. CDC 2015). Bull trout populations found in the south coast region of B.C. are currently being considered for listing as species of Special Concern under SARA (DFO 2014d). In B.C., bull trout populations are thought to be diminishing (Hammond 2004). Limiting factors include habitat fragmentation resulting from development associated with resource extraction and logging activities, as well as degradation of habitat quality such as through obstruction to movement, stream channel instability, sedimentations, lack of cover, or increasing water temperatures (Hammond 2004). Furthermore, increasing angling effort may pose additional pressure to diminishing bull trout populations, as new roads allows access to streams that were previously remote (Hammond 2004).

4.2.1.4 Deas Slough

Hydrology and Hydraulics

Deas Slough is a backwater feature of the lower Fraser River South Arm. The slough was formerly a side arm of the river that was dammed off at its upstream end in 1949 (Birtwell et al. 1987a). It is situated about 15 km upstream from the Fraser River mouth at Sand Heads. It is approximately 2,700 m long, 250 m wide, with an average depth of five metres (Birtwell et al. 1987a). Some deeper sections exist in dredged locations in front of the two marinas situated on, and occupying about one-third of the shore of the slough's south bank (Birtwell et al. 1987a).

In contrast to riverine areas in the South Arm where the riverbed is dominated by sandy substrate, the bottom material in the slough is predominantly silt and clay (Birtwell et al. 1987a). Infrequent and localized dredging takes place to maintain access to small craft harbours and moorage (FREMP 2006). Recent dredging (February 2014) was initiated in lower Deas Slough to re-establish the depth and width of the navigation channel, and to remove materials around the Ferry Road boat ramp that had been affecting recreational boating activity (PMV 2014b). By November 2014, approximately 60,000 m³ of river bottom were removed by cutter suction and disposed of via in-river dispersal (PMV 2015).

Deas Slough is tidally influenced, with salt water intrusion during the winter freshwater low-flow period, resulting in vertical stratification of the water column. Salinities at depth increase progressively as freshwater flows decrease. However, a sill at the mouth of Deas Slough prevents saline penetration in water greater than four metres deep; thus, salinity at depth is not as high (i.e., approximately 10 practical salinity units) as that recorded in the river just outside the slough, which often reaches 26 practical salinity units (Birtwell et al. 1987a). Stratified conditions in the deeper pockets of the slough are also associated with low levels of dissolved oxygen, and reduced oxidation-reduction potential likely due to low photosynthetic activity, and higher pH (ranging from 6.4 to 8.2), also reflecting the influence of salt water (Birtwell et al. 1987a).

With the onset of freshet, increased river flows reduce salt water intrusion, with low salinity levels characterizing slough waters throughout the water column (Birtwell et al. 1987a). Influx of turbid fresh water reduces water clarity of the slough's surface water; however, DO levels are generally high (Birtwell et al. 1987a). With the progression of freshet, oxidation-reduction potential also rises in response to increased photosynthetic activity (Birtwell et al. 1987a).

Physical Fish Habitat

The shoreline along Deas Slough is designated primarily as highly productive (red-coded) habitat (BIEAP - FREMP 2014). The intertidal bench transitions shoreward from a mudflat into a brackish marsh, with varying width from approximately 10 m along the north and south banks to approximately 200 m at the upstream end of the slough near the Delta Deas Rowing Club, and on either side of the Deas Slough Bridge north support pier (BIEAP - FREMP 2014). Marsh vegetation is dominated by hard-stemmed bulrush (*Schoenoplectus acutus*), Arctic rush (*Juncus arcticus*), Lyngbye's sedge (*Carex lyngbyei*), and common cattail (*Typha latifolia*) (BIEAP - FREMP 2014). Riparian vegetation backing the marsh along the north and east banks of Deas Slough consists of reed canary grass (*Phalaris arundinacea*), and shrub species such as hardhack (*Spiraea douglasii*) (BIEAP - FREMP 2014). The riparian zone on the south bank is narrow and confined to the crest and slope of the dike, consisting primarily of mowed grass and clumps of Himalayan blackberry (*Rubus armeniacus*) (BIEAP - FREMP 2014).

Deas Island is a Metro Vancouver regional park and defines the slough's north bank. Most of the areas south of the slough are farmland (grass, crops). Some of the land is below sea level, and is intersected by ditches to facilitate drainage (Birtwell et al. 1987a). Within the park, as well as immediately upstream of the Deas Slough Bridge south support pier, upland vegetation consists of deciduous, mixed, and coniferous tree woodland (BIEAP - FREMP 2014) dominated by black cottonwood, with an understory of red alder and willow, a shrub layer of salmonberry (*R. spectabilis*) and blackberry, as well as salal (*Gaultheria shallon*), and huckleberry (*Vaccinium* sp.) (Birtwell et al. 1987a).

Intertidal habitat of low (green-coded) to moderate (yellow-coded) productivity also occurs in Deas Slough (**Appendix A, Figure 3**; BIEAP - FREMP 2014) described as follows:

- A short (about 50 m) section of shoreline at the upstream end of the slough at the Delta Deas Rowing Club pier, as well as approximately 300 m of shoreline fronting the Deas Island Yacht Club marina on the south bank, are classified as habitat of moderate productivity (yellow-coded).
- Riprap-armoured shoreline in the vicinity of support piers and pedestals of the existing Deas Slough Bridge on the north and south banks of the slough is characterized as habitat of low (green-coded) to moderate (yellow-coded) productivity.
- The shoreline fronting the dock, boat launch, and haul-out area at the Captain's Cove marina on the south bank of the mouth of Deas Slough is characterized as low-productivity habitat (green-coded).

Aquatic Resources

The vertically stratified nature of Deas Slough perpetuates a shallow, productive, low-salinity environment that is used for rearing and overwintering by a number of fish species. Deas Slough is important rearing habitat for underyearling sockeye salmon, which are present in the slough from April to October, with maximum abundance in late June and late July (Birtwell et al. 1987*b*). Underyearling starry flounder also rear in the lower and, to a lesser extent, in upper Deas Slough in spring and summer, while adult starry flounder are present in the slough in the autumn and winter (Birtwell et al. 1993). Other fish species that have been recorded in Deas Slough include chinook, chum, coho, and pink salmon, prickly sculpin, Pacific staghorn sculpin (*Leptocottus armatus*), slimy sculpin (*C. cognatus*), largescale sucker (*Catostomus macrocheilus*), northern pikeminnow, peamouth, redbelly darter, threespine stickleback, longfin smelt (*Spirinchus thaleichthys*), white sturgeon, mountain whitefish (*Prosopium williamsoni*), and the non-native American shad (*Alosa sapidissima*) (FISS 2014). Refer to **Section 4.2.1** for summaries of the biology, habitat requirements, and status of Pacific salmon, sturgeon, eulachon, trout, and char.

4.2.1.5 Green Slough

Hydrology and Hydraulics

Green Slough drains into the lower Deas Slough and ultimately into the lower Fraser River South Arm. The channel parallels Highway 99 for approximately 155 m from its confluence with Deas Slough until it bends southwest along River Road West for approximately 1.2 km to the Westminster Avenue junction in Delta. Green Slough is outside of Delta's Fraser River dikes; therefore, it is tidally influenced, and flows into the Fraser River are not impeded. The Green Slough pumping station located at 5596 River Road drains agricultural and residential runoff from Crescent Slough into Green Slough.

Green Slough is 15 m to 20 m wide along most of its length, although channel width narrows to about 10 m near the pump station. The channel is characterized as a very low-gradient glide, with fairly uniform depths that range from about 0.9 m to 1.5 m. Water levels and flows are relatively stable throughout the year with no surface turbulence, providing perennially wetted fish habitat. The substrate consists predominantly of fines (silt).

The Green Slough pump station consists of two flood boxes and four pumps of a combined capacity of 6.25 m³/s (LGL et al. 2009). The pumps are not screened to prevent fish entrainment, and no fish deflection or entrainment prevention devices are employed at the station (LGL et al. 2009). The pump station is run in two modes: drainage occurs from late September/late November to mid-May/early June to provide flood protection, while irrigation occurs from mid-May/early June to late September/late November to provide agricultural water supply. The side-hinged flood box flap gates are operated using head differential between the upstream and downstream water levels. They typically close whenever water levels are higher downstream than upstream, i.e., on rising tides (LGL et al. 2009). Slough water levels are manipulated by means of chaining shut the flap gates, inserting stop logs into the flood boxes, or opening a sluice gate or flap gate inset to allow for limited water exchange (LGL et al. 2009). As part of the Delta Irrigation Enhancement Project, the operation of this pump station was modestly modified in 2013 to provide enhanced upstream fish access.

Physical Fish Habitat

Green Slough is classified as an environmentally sensitive area (ESA) under Delta's Official Community Plan. An ESA designation identifies areas of high environmental value requiring protection or mitigation of environmental impacts for any proposed development. As a backwater feature that is tidally influenced, Green Slough provides perennially wetted rearing and overwintering salmonid habitat (LGL et al. 2009). Along Green Slough's length, the riparian buffer is 30 m wide, and overhanging vegetation is ample; however, since it is a very low-gradient glide with a predominance of fines, Green Slough does not offer valuable salmon spawning habitat (LGL et al. 2009).

The shoreline of Green Slough is classified as habitat of high productivity (red-coded) (BIEAP - FREMP 2014). A tidal marsh comprises the lower elevations of the intertidal bench, with vegetation consisting of Lyngbye's sedge, hard-stemmed bulrush, scouring rush (*Equisetum hyemale*), and the non-native purple loosestrife (*Lythrum salicaria*) (BIEAP - FREMP 2014). Riparian vegetation backing the marsh consists of low and tall shrubs of hardhack, red-osier dogwood (*Cornus stolonifera*), non-native Himalayan blackberry and Scotch broom (*Cytisus scoparius*), with isolated areas with black cottonwood (BIEAP - FREMP 2014).

At EastpointPark Reserve, immediately downstream of the Green Slough pump station, marsh habitat was created and the riparian zone was restored with plantings of native vegetation, to compensate for loss of riparian and mudflat habitat as a result of riprap installation and sheet piling in Green Slough during bridge construction at Admiral Blvd (BIEAP - FREMP 2014). Tidal flows were also improved by removing an old wooden culvert that had collapsed (BIEAP - FREMP 2014).

Compensation works were also undertaken in 1997 at the mouth of Green Slough to restore habitat that was disturbed during upgrade and maintenance works within the existing Captain's Cove Marina Ltd. marina facility. Compensation included the creation of an intertidal marsh bench, as well as riparian plantings on top of riprap slope (BIEAP - FREMP 2014).

Aquatic Resources

Fish passage into Green Slough is unobstructed. Although salmonid spawning values do not apply, this backwater feature is expected to provide high-value rearing and overwintering habitat for fish, including Pacific salmon, particularly coho and chinook (LGL et al. 2009). Habitat values for salmonids upstream of the flood box and pump station at the confluence with Crescent Slough is anticipated to be relatively low, given impeded fish access, water withdrawal for agricultural use, and high water temperatures in the summer (LGL et al. 2009).

Historical records of cutthroat trout from Crescent Slough exist from 1983 (FISS 2014); however, no salmonids have been detected in the slough since then. Green Slough is also used by non-salmonid species, such as threespine stickleback, prickly sculpin, redbelly darter, peamouth, and brassy minnow (*Hybognathus hankinsoni*) (FISS 2014). Non-native fish species also reported from Green Slough include brown catfish, black crappie, pumpkinseed (*Lepomis gibbosus*), carp, goldfish (*Carassius auratus*), and largemouth bass (*Micropterus salmoides*) (FISS 2014). Refer to **Section 4.2.1** for summaries of the biology, habitat requirements, and status of Pacific salmon, sturgeon, eulachon, trout, and char.

4.2.1.6 Upland Watercourses

106 upland watercourses were identified within the study area (**Table 4-1**) (see also **Appendix A, Figures 1a through 1p**).

Table 4-1 Upland Watercourses Identified within the Study Area (Listed in Southbound Order)

| Watercourse Reference No. ¹ | Watercourse Name | Watercourse Type | Classification |
|---|---|-------------------------|-----------------------|
| 6 | Bridgeport Road Ditch North | Ditch | Green |
| 7 | Bridgeport Road Ditch South | Swale | Green |
| 8 | Patterson Road Ditch North | Ditch | Yellow |
| 9 | Tuttle Avenue Ditch West | Ditch, permanent | Yellow |
| 10 | Tuttle Avenue Ditch East | Ditch, permanent | Yellow |
| 11 | Highway 99 Ditch West (between Cambie Road and Shell Road) | Swale | Yellow |
| 12 | Shell Road Ditch East, north of Highway 99 | Ditch | Yellow |
| 13 | Highway 99 Ditch East (between Shell Road and Highway 91) | Roadside ditch | Yellow |
| 14 | Highway 99 Ditch Southwest (between Shell Road and Highway 91) | Roadside ditch | Yellow |
| 15 | Highway 99 Ditch Northeast (between Highway 91 and Westminster Highway) | Roadside ditch/Slough | Yellow |
| 16 | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | Roadside ditch/Slough | Yellow |
| 17 | Westminster Highway Ditch North, east of Highway 99 | Ditch | Yellow |
| 18 | Westminster Highway Ditch South, east of Highway 99 | Ditch | Yellow |
| 20 | Highway 99 Ditch East (between Westminster Highway and Blundell Road) | Roadside ditch/Slough | Yellow |

| Watercourse Reference No. ¹ | Watercourse Name | Watercourse Type | Classification |
|--|---|-----------------------|--|
| 21 | Highway 99 Ditch West (between Westminster Highway and Blundell Road) | Roadside ditch/Slough | Yellow |
| 22 | Blundell Road Ditch South, east of Highway 99 | Ditch | Yellow |
| 23 | Highway 99 Ditch East (between Blundell Road and Steveston Highway) | Roadside ditch/Slough | Yellow from Blundell Road to King Road Ditch, east of Highway 99, orange from King Road Ditch, east of Highway 99 to Steveston Highway |
| 24 | Highway 99 Ditch West (between Blundell Road and Steveston Highway) | Roadside ditch/Slough | Yellow from Blundell Road to King Road Ditch, west of Highway 99, orange from King Road Ditch, west of Highway 99 to Steveston Highway |
| 25 | Richmond Agricultural Ditch #1 | Ditch | Yellow |
| 26 | Richmond Agricultural Ditch #2 | Ditch | Yellow |
| 27 | Richmond Agricultural Ditch #3 | Ditch | Yellow |
| 28 | Richmond Agricultural Ditch #4 | Ditch | Yellow |
| 29 | Richmond Agricultural Ditch #5 | Ditch | Green |
| 30 | Richmond Agricultural Ditch #6 | Ditch | Yellow |
| 31 | Richmond Agricultural Ditch #7, east of Highway 99 | Ditch | Yellow |
| 32 | Richmond Agricultural Ditch #7, west of Highway 99 | Ditch | Green |
| 33 | King Road Ditch, west of Highway 99 | Ditch | Orange |

| Watercourse Reference No. ¹ | Watercourse Name | Watercourse Type | Classification |
|--|--|----------------------------------|----------------|
| 34 | King Road Ditch, east of Highway 99 | Ditch | Orange |
| 35 | Williams Road Ditch, east of Highway 99 | Ditch | Orange |
| 36 | Williams Road Ditch, west of Highway 99 | Ditch | Orange |
| 37 | Richmond Agricultural Ditch #8 | Ditch | Green |
| 38 | Richmond Agricultural Ditch #9 | Ditch | Green |
| 39 | Steveston Highway Ditch North, east of Highway 99 | Ditch | Orange |
| 40 | Steveston Highway Interchange Northwest Ditch | Ditch | Orange |
| 41 | Steveston Highway Ditch South, east of Highway 99 | Ditch | Orange |
| 42 | Steveston Highway Interchange Southeast Ditch | Ditch | Green |
| 43 | Highway 99 Ditch East (between Steveston Highway and Fraser River) | Roadside ditch | Yellow |
| 44 | Highway 99 Ditch West (between Steveston Highway and Fraser River) | Roadside ditch/slough, Permanent | Dashed-red |
| 45 | Richmond Agricultural Ditch #10 | Ditch | Yellow |
| 46 | Jacobsen Way/Hartnell Road Ditch | Ditch | Dashed-red |
| 47 | Richmond Agricultural Ditch #11 | Ditch | Orange |
| 48 | Rice Mill Road Ditch North | Ditch | Orange |
| 49 | Rice Mill Road Ditch South | Ditch | Orange |
| 53 | River Road Ditch Northwest, north of Highway 99 | Ditch | Dashed-red |
| 54 | River Road Ditch Southeast, south of Highway 99 | Ditch | Dashed-red |

| Watercourse Reference No. ¹ | Watercourse Name | Watercourse Type | Classification |
|--|---|-------------------|--|
| 55 | Highway 99 Ditch Northeast (between River Road and Highway 17A) | Roadside ditch | Dashed-red |
| 56 | Highway 99 Ditch Southwest (between River Road and Highway 17A) | Roadside ditch | Dashed-red |
| 57 | Highway 99 Ditch Northeast (between Highway 17A and 64 St) | Roadside ditch | Yellow |
| 58 | Highway 99 Ditch Southwest (between Highway 17A and 64 St) | Roadside ditch | Yellow |
| 59 | Delta Agricultural Ditch #1 | Ditch | Yellow |
| 60 | Burns Drive Ditch Northeast (between 64 St and Highway 17) | Roadside ditch | Yellow |
| 61 | Highway 99 Ditch Southwest (between 64 St and Highway 17) | Roadside ditch | Yellow |
| 62 | 64 Street Ditch East, north of Highway 99 | Ditch | Yellow |
| 64 | Delta Agricultural Ditch #2 | Ditch | Yellow |
| 65 | Delta Agricultural Ditch #4 | Ditch | Yellow |
| 66 | Crescent Slough, northeast of Highway 99 | Slough, Permanent | Orange |
| 67 | Crescent Slough, southwest of Highway 99 | Slough, Permanent | Orange |
| 68 | Highway 99 Ditch North (between Highway 17 and Ladner Trunk Road) | Roadside ditch | Yellow |
| 69 | Highway 99 Ditch South (between Highway 17 and Ladner Trunk Road) | Roadside ditch | Orange immediately west of Crescent Slough, yellow otherwise |

| Watercourse Reference No. ¹ | Watercourse Name | Watercourse Type | Classification |
|--|--|------------------|----------------|
| 70 | Delta Agricultural Ditch #6 | Ditch | Orange |
| 71 | SFPR Ditch West, north of Highway 99 | Ditch | Yellow |
| 72 | Delta Agricultural Ditch #7 | Ditch | Yellow |
| 73 | Delta Agricultural Ditch #8 | Ditch | Yellow |
| 74 | Delta Agricultural Ditch #9 | Ditch | Green |
| 75 | 72 St Ditch West, south of Highway 99 | Ditch | Yellow |
| 76 | 72 St Ditch East, south of Highway 99 | Ditch | Yellow |
| 77 | Delta Agricultural Ditch #10 | Ditch | Yellow |
| 78 | Delta Agricultural Ditch #11 | Ditch | Yellow |
| 79 | 80 St Ditch West, south of Highway 99 | Ditch | Yellow |
| 80 | 80 St Ditch East, south of Highway 99 | Ditch | Yellow |
| 81 | Burns Drive Ditch North (between Highway 17 and Ladner Trunk Road) | Ditch | Yellow |
| 82 | Burns Drive Cross-Ditch #1 | Ditch | Yellow |
| 83 | Burns Drive Cross-Ditch #2 | Ditch | Yellow |
| 86 | 88 St Ditch East, north of Highway 99 | Ditch | Yellow |
| 87 | 88 St Ditch East, south of Highway 99 | Ditch | Yellow |
| 88 | 88 St Ditch West, north of Highway 99 | Ditch | Yellow |
| 89 | 88 St Ditch West, south of Highway 99 | Ditch | Yellow |
| 90 | Delta Agricultural Ditch #18 | Ditch | Yellow |
| 91 | Delta Agricultural Ditch #14 | Ditch | Yellow |

| Watercourse Reference No. ¹ | Watercourse Name | Watercourse Type | Classification |
|--|---|------------------|---|
| 92 | Delta Agricultural Ditch #15, north of Highway 99 | Ditch | Yellow |
| 93 | Delta Agricultural Ditch #15, south of Highway 99 | Ditch | Yellow |
| 94 | Delta Agricultural Ditch #17 | Ditch | Yellow |
| 95 | Ladner Trunk Road Interchange Southwest Inner Ditch | Roadside ditch | Yellow |
| 96 | Ladner Trunk Road Interchange Southeast Inner Ditch | Roadside ditch | Yellow |
| 97 | Ladner Trunk Road Interchange Northwest Outer Ditch | Roadside ditch | Yellow |
| 98 | Ladner Trunk Road Interchange Northeast Inner Ditch | Roadside ditch | Yellow |
| 99 | Ladner Trunk Road Interchange Northeast Outer Ditch | Roadside ditch | Yellow |
| 100 | Ladner Trunk Road Ditch North, east of 96 St | Roadside ditch | Yellow |
| 102 | Highway 99 Ditch North (between Ladner Trunk Road and Highway 91) | Roadside ditch | Yellow from Ladner Trunk Road to Delta Agricultural Ditch # 16, orange from Delta Agricultural Ditch # 16 to approximately 500 m east of 104 Street Ditch, dashed-red from 500 m east of 104 Street Ditch to 112 Street Ditch, orange from 112 Street Ditch to Highway 91 |

| Watercourse Reference No. ¹ | Watercourse Name | Watercourse Type | Classification |
|--|---|-------------------|---|
| 103 | Highway 99 Ditch South (between Ladner Trunk Road and Highway 91) | Roadside ditch | Dashed-red |
| 104 | Delta Agricultural Ditch #16 | Ditch | Orange |
| 105 | 104 Street Ditch | Ditch | Orange |
| 106 | BNSF Ditch | Ditch | Orange from BNSF Railway Overpass to approximately 500 m east of 104 Street Ditch, dashed-red east of there |
| 109 | 112 Street Ditch, north of Highway 99 | Ditch | Dashed-red |
| 110 | 112 Street Ditch, south of Highway 99 | Ditch | Dashed-red |
| 111 | Oliver Slough | Slough, permanent | Dashed-red |
| 112 | Highway 91 Interchange Ditches, south of Highway 99 | Ditch | Orange |
| 113 | Highway 91 Interchange South Outer Ditch | Ditch | Dashed-red at west end, orange at east end |
| 114 | Eugene Creek | Ditch | Dashed-red |
| 115 | Eugene Creek Diversion | Ditch | Dashed-red |
| 116 | Highway 99 Ditch South (between Highway 91 and Peacock Brook) | Roadside ditch | Dashed-red |
| 117 | Highway 99 Ditch North (between Highway 91 and Peacock Brook) | Roadside ditch | Dashed-red |

Note:

¹ Watercourse reference numbers correspond to those shown in **Appendix A**.

Physical Fish Habitat

Detailed habitat assessments were conducted at 33 of 106 minor upland watercourses (**Appendix B, Table 3**) as well as Green Slough. The remaining 73 were assessed using photographs taken in the field and from imagery available online through City of Richmond (Richmond 2014) and DeltaMap (Delta 2002, 2003a, b, 2012). Ditches and sloughs within the study area are low-gradient (≤ 0.5 per cent) with fine sediment substrates. Mesohabitats consist solely of straight runs without any pools or riffles. Overall instream cover was found to be generally limited (absent at 13 sites, trace at 48 sites, and moderate at 42 sites), with the exception of four sites that have abundant cover, i.e., Westminster Highway Ditch South, east of Highway 99; Highway 99 Ditch Southwest (between 64 St and Highway 17); and Burns Drive Cross-Ditch #1. The main cover observed in these watercourses is overhanging and instream vegetation. Instream features provided trace cover at only few sites: trace cover provided by small or large woody debris, deep pools, and undercut banks occur at 11, 12, and 11 sites, respectively. Ninety-three of 107 sites have either no or less than 20 per cent crown closure, nine sites have less than 40 per cent, four have less than 70 per cent, and one has greater than 90 per cent. Riparian vegetation was observed to consist mainly of grassed roadside shoulders, shrubs lining ditch banks, and adjacent agricultural fields.

In Situ Water Quality

Table 4-2 summarizes the spring, summer, and autumn water quality data from upland watercourses sampled within the study area, in relation to the B.C. WQG criteria for temperature, DO, and pH. Water quality data are provided in **Appendix B, Tables 4** through **6**.

All sites sampled in the spring and autumn met the B.C. WQG criteria for temperature; however, all of the sites sampled in summer exceeded the criteria. Dissolved oxygen (DO) concentrations were below the water quality guidelines for at all sites sampled in spring and summer, aside from three in the spring sampling, four in the summer, and 7 in the autumn. The B.C. WQG criteria for pH were met for nine of 25 sites sampled in spring, 13 of 15 sites sampled in the summer, and 11 of 34 sites sampled in autumn. Conductivity varied across sites but was generally low.

Table 4-2 Summary of Water Quality Data for Upland Watercourses Sampled in the Study Area

| Sampling Period (2014) | n | Descriptive Statistic | Temperature (°C) | Dissolved Oxygen (mg/L) | pH | Conductivity (µS/cm) |
|------------------------|----|-----------------------------------|------------------|-------------------------|-------------|----------------------|
| | | B.C. WQG Criteria | 6 – 17 | >5 | 6.5 – 9.0 | n/a |
| Spring | 25 | Mean | 10.6 | 1.48 | 6.30 | 649 |
| | | Range | 7.8 - 14.0 | 0.07 – 5.50 | 4.69 – 7.45 | 100 - 1,764 |
| | | Per cent within B.C. WQG criteria | 100% | 12% | 67% | n/a |
| Summer | 15 | Mean | 20.7 | 2.9 | 7.00 | 2899 |
| | | Range | 17.4 – 25.2 | 0.12 – 8.55 | 6.03 - 7.69 | 135 - 29435 |
| | | Per cent within B.C. WQG criteria | 0% | 27% | 87% | n/a |
| Autumn | 34 | Mean | 13.9 | 3.61 | 6.17 | 492 |
| | | Range | 11.9 – 15.4 | 1.03 - 12.03 | 1.86 - 6.68 | 24 – 2,027 |
| | | Per cent within B.C. WQG criteria | 100% | 21% | 32% | n/a |

Fish Presence and Distribution

Including Crescent Slough, fish presence has been previously documented in 39 of the assessed upland watercourses within the study area (Delta 2002, 2003a, FISS 2014). Crescent Slough and Big Slough are the only watercourses with historic records of CRA species (i.e., cutthroat trout, chinook and coho salmon); however, these capture dates are from 1983 (FISS 2014), and this watercourse is generally considered to be non-salmonid bearing, especially within reaches close to the Highway 99 ROW (Hemmera 2006).

During the spring sampling period, 88 minnow traps were set at 26 sites within the study area for a total of 1,971 hours of sampling effort. In autumn, 88 traps were set in 34 watercourses for a total of 1,994 hours of sampling effort. Species captured include the native species brassy minnow and threespine stickleback, and the non-native brown catfish, goldfish, and pumpkinseed. Historic and recent fish capture data for the study area are summarized in **Table 4-3**.

Table 4-3 Summary of Historic and Recent Fish Captures within Upland Watercourses in the Study Area

| Watercourse Reference No. ¹ | Watercourse Name | Current Study (Spring 2014) | Current Study (Autumn 2014) | Previous Studies (DataBC 2014, FISS 2014) | Corporation of Delta Studies |
|--|---|-----------------------------|-----------------------------|---|------------------------------|
| 6 | Bridgeport Road Ditch North | NFC | NFC | - | - |
| 7 | Bridgeport Road Ditch South | - | - | - | - |
| 8 | Patterson Road Ditch North | - | - | - | - |
| 9 | Tuttle Avenue Ditch West | TSB | TSB | - | - |
| 10 | Tuttle Avenue Ditch East | - | - | - | - |
| 11 | Highway 99 Ditch West (between Cambie Road and Shell Road) | - | - | - | - |
| 12 | Shell Road Ditch East, north of Highway 99 | - | TSB | - | - |
| 13 | Highway 99 Ditch East (between Shell Road and Highway 91) | - | TSB | - | - |
| 14 | Highway 99 Ditch Southwest (between Shell Road and Highway 91) | - | - | - | - |
| 15 | Highway 99 Ditch Northeast (between Highway 91 and Westminster Highway) | - | - | - | - |
| 16 | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | TSB | TSB | - | - |
| 17 | Westminster Highway Ditch South, east of Highway 99 | - | TSB | - | - |
| 18 | Westminster Highway Ditch South, east of Highway 99 | - | TSB | | |
| 20 | Highway 99 Ditch East (between Westminster Highway and Blundell Road) | - | - | TSB | - |

| Watercourse Reference No. ¹ | Watercourse Name | Current Study (Spring 2014) | Current Study (Autumn 2014) | Previous Studies (DataBC 2014, FISS 2014) | Corporation of Delta Studies |
|--|---|-----------------------------|-----------------------------|---|------------------------------|
| 21 | Highway 99 Ditch West (between Westminster Highway and Blundell Road) | TSB | TSB | - | - |
| 22 | Blundell Road Ditch South, east of Highway 99 | TSB | TSB | - | - |
| 23 | Highway 99 Ditch East (between Blundell Road and Steveston Highway) | - | - | RSC, TSB | - |
| 24 | Highway 99 Ditch West (between Blundell Road and Steveston Highway) | TSB | TSB | - | - |
| 33 | King Road Ditch, west of Highway 99 | TSB | PMB, TSB | - | - |
| 35 | Williams Road Ditch, east of Highway 99 | TSB, BNH | NFC | - | - |
| 39 | Steveston Highway Ditch North, east of Highway 99 | TSB | PMB, TSB | - | - |
| 41 | Steveston Highway Ditch South, east of Highway 99 | - | TSB | - | - |
| 44 | Highway 99 Ditch West (between Steveston Highway and Fraser River) | NFC | PMB, TSB | PMB, TSB | - |
| 45 | Richmond Agricultural Ditch #10 | NFC | NFC | - | - |
| 46 | Jacobsen Way/Hartnell Road Ditch | NFC | - | - | - |
| 48 | Rice Mill Road Ditch North | NFC | TSB | - | - |
| 53 | River Road Ditch Northwest, north of Highway 99 | TSB | TSB | - | CP, TSB |
| 54 | River Road Ditch Southeast, south of Highway 99 | TSB | BMC, GC, PMB, TSB | - | - |

| Watercourse Reference No. ¹ | Watercourse Name | Current Study (Spring 2014) | Current Study (Autumn 2014) | Previous Studies (DataBC 2014, FISS 2014) | Corporation of Delta Studies |
|--|--|-----------------------------|-----------------------------|---|------------------------------|
| 57 | Highway 99 Ditch Northeast (between Highway 17A and 64 St) | - | TSB | - | - |
| 58 | Highway 99 Ditch Southwest (between Highway 17A and 64 St) | TSB | GC, TSB | - | - |
| 60 | Burns Drive Ditch Northeast (between 64 St and Highway 17) | TSB, PMB | GC, PMB, TSB | - | - |
| 61 | Highway 99 Ditch Southwest (between 64 St and Highway 17) | - | BMC, PMB, TSB | - | - |
| 64 | Delta Agricultural Ditch #2 | TSB | - | - | - |
| 66 | Crescent Slough, northeast of Highway 99 | - | - | BCB, BMC, CP, CCT, PCC, PMB, TSB | BNH, CP, TSB, BMC, PMB, RSC |
| 67 | Crescent Slough, southwest of Highway 99 | - | - | BCB, BMC, BH, BSU, CAS, CP, CT, GC, LMB, PCC, PMB, RSC, TSB | - |
| 71 | Highway 17 Ditch West, north of Highway 99 | - | - | BH, BMC, CP, PMB, TSB | - |
| 72 | Delta Agricultural Ditch #7 | - | - | TSB | - |
| 75 | 72 Street Ditch West, south of Highway 99 | - | - | CP, LMB, PCC, PMB, RSC, TSB | TSB, RSC |
| 77 | Delta Agricultural Ditch #10 | - | PMB, TSB | - | - |
| 78 | Delta Agricultural Ditch #11 | TSB | NFC | - | - |

| Watercourse Reference No. ¹ | Watercourse Name | Current Study (Spring 2014) | Current Study (Autumn 2014) | Previous Studies (DataBC 2014, FISS 2014) | Corporation of Delta Studies |
|--|--|-----------------------------|-----------------------------|---|------------------------------|
| 79 | 80 St Ditch West, south of Highway 99 | - | - | BMC, RSC, TSB | - |
| 80 | 80 St Ditch East, south of Highway 99 | - | - | BMC, RSC, TSB | TSB |
| 86 | 88 St Ditch East, north of Highway 99 | NFC | TSB | - | TSB |
| 87 | 88 St Ditch East, south of Highway 99 | - | NFC | - | - |
| 88 | 88 St Ditch West, north of Highway 99 | NFC | TSB | - | - |
| 89 | 88 St Ditch West, south of Highway 99 | NFC | NFC | - | - |
| 81 | Burns Drive Ditch North (between Highway 17 and Ladner Trunk Road) | - | NFC | - | - |
| 102 | Highway 99 Ditch North (between SFPR and Ladner Trunk Road) | - | NFC | | |
| 104 | Delta Agricultural Ditch #16 | TSB | PMB, TSB | | |
| 105 | 104 Street Ditch | - | TSB | | |
| 107 | Big Slough, south of Highway 99 | | | ACT, BH, BMC, BNH, CBC, CC, CH, CO, CP, CT, FM, GC, L, PCC, PMB, RB, RL, RSC, SP, TSB | BNH, TSB, BMC, PMB, C P |
| 108 | Big Slough, north of Highway 99 | - | - | BH, CBC, PMB, TSB | - |
| 110 | 112 Street Ditch, south of Highway 99 | TSB | BNH, PMB | TSB | TSB, BMC, PMB |

| Watercourse Reference No. ¹ | Watercourse Name | Current Study (Spring 2014) | Current Study (Autumn 2014) | Previous Studies (DataBC 2014, FISS 2014) | Corporation of Delta Studies |
|--|---|-----------------------------|-----------------------------|---|------------------------------|
| 111 | Oliver Slough | - | - | BNH, CP, PMB, SB | TSB |
| 112 | Highway 91 Interchange Ditches, south of Highway 99 | - | - | - | TSB, BMC |
| 113 | Highway 91 Interchange South Outer Ditch | - | - | CAS, PMB, SB, TSB | - |
| 115 | Eugene Creek Diversion | - | - | PMB, TSB | - |
| 117 | Highway 99 Ditch North (between Highway 91 and Peacock Brook) | - | BMC, TSB | - | - |

Notes:

¹ Watercourse reference numbers correspond to those shown in **Appendix A**

- Shaded cells indicate sites where CRA fish have been documented
- NFC = no fish caught
- BCB = black crappie; BH = catfish (general); BMC = brassy minnow; BNH = brown catfish; BS = bass/sunfish (general); CAS = prickly sculpin; CP = carp; CT = cutthroat trout; GC = goldfish; LMB = largemouth bass; PCC = peamouth; PMB = pumpkinseed; RSC = redbside shiner; SB = stickleback (general); TSB = threespine stickleback.
- "-" = no data

The City of Richmond classifies ditches along the west side of Highway 99 south of Westminster Highway flowing towards the Fraser River South Arm as salmon-bearing. Along the east side of Highway 99, salmon-bearing status is assigned to ditches south of Bridgeport Road to Steveston Highway. However, no salmonid species have been previously documented within Richmond ditches (FISS 2014), and extensive sampling efforts in the study area in 2014 did not result in capture of salmonids. Connectivity of these ditches to the Fraser River South Arm appears to be very limited by the presence of pump stations and flood boxes. Located at the south end of Highway 99 Ditch West (between Steveston Highway and Fraser River), and at the intersection of Steveston Highway and No. 6 Road, this flood-control infrastructure appears to pose considerable restrictions to salmonid access into this ditch network. Connectivity and distance of the watercourses from the Fraser River South Arm are also expected to limit access and use. Classification of these watercourses according to the codes and definitions presented in **Table 3-2** reflects these limitations on fish access, results of fish sampling efforts in 2014, and low fish habitat values, which includes relatively poor water quality observed in ditches within the study area.

North of the Fraser River South Arm, Highway 99 Ditch West (between Steveston Highway and Fraser River South Arm) is classified as dashed-red, and Highway 99 Ditch East (between Steveston Highway and Fraser River South Arm) as yellow. Jacobsen Way/Hartnell Road Ditch is also classified as dashed-red, because it has the potential to flow directly into Highway 99 Ditch West (between Steveston Highway and Fraser River) (**Appendix A, Figure 1f**). North of Steveston Highway, Highway 99 ditches are classified as orange until King Road, and yellow north of that location (**Appendix A, Figure 1b-1f**).

South of Fraser River South Arm and its well-connected Deas and Green sloughs, Delta catchment areas FA-5 and FA-5 overlap with the study area and have some potential to support salmonid species, such as cutthroat trout. Salmonid presence was documented more than 30 years ago (Delta 2003a, FISS 2014); however, previous sampling conducted for the Ministry's South Fraser Perimeter Road (SFPR) project and sampling efforts applied in 2014 did not result in the capture of any salmonids. Access to these Delta ditches by salmonids from the Lower Fraser River/Green Slough is likely impaired by flood-control infrastructure. Flows into Crescent Slough are limited by a flood box and pump station at the confluence with Green Slough (LGL et al. 2009). In classifying these ditches, consideration was given to distance from Green Slough. Ditches from Deas Slough to Highway 17A are therefore classified as dashed-red; ditches east of Highway 17A are not continuous with those west of Highway 17A and are classified as yellow and orange.

4.3 Incidental Observations

Incidental observations include aquatic and terrestrial wildlife other than fish that were either captured in minnow traps or observed during the course of the field work. Amphibian captures include the non-native American bullfrog (*Lithobates catesbeianus*), green frog (*L. clamatans*), and northwestern salamander (*Ambystoma gracile*). Invertebrate captures include dragonfly naiads (*Aeshna* sp.), water beetles, aquatic snails, and leeches (Table 4-4).

Table 4-4 Summary of Incidental Observations of Aquatic Organisms

| Common Name | Scientific Taxon | Count | |
|--|--|--------|--------|
| | | Spring | Autumn |
| Amphibians | | | |
| American bullfrog and/or green frog tadpoles | <i>Lithobates</i> spp. | 65 | ~380 |
| Northwestern salamander | <i>Ambystoma gracile</i> | - | 1 |
| Invertebrates | | | |
| Aquatic snails | Phylum Mollusca, Class Gastropoda | 9 | ~120 |
| Beetle | Order Coleoptera | 7 | 29 |
| Dragonfly naiads | <i>Aeshna</i> sp. | 2 | - |
| Freshwater leeches | Phylum Annelida, Subclass Hirudinea | 9 | 70 |

Notes: “-” indicates no incidental captures

Field crews took particular care to look for autumn meadowhawk (*Sympetrum vicinum*), a provincially Blue-listed dragonfly species (B.C. CDC 2015), and signs of Pacific water shrew (*Sorex bendirii*), a semi-aquatic mammal species that is provincially Red-listed (B.C. CDC 2015), listed as Endangered under SARA Schedule 1 (Government of Canada 2013), and designated as Endangered by COSEWIC (2006). However, none were observed. Table 4-5 provides a summary of terrestrial wildlife incidental observations.

Table 4-5 Summary of Incidental Observations of Terrestrial Wildlife

| Species | Location Observed | Number Observed/ Comments |
|--|--|------------------------------|
| Mallard (<i>Anas platyrhynchos</i>) | Highway 99 Ditch West (between Steveston Highway and Fraser River) | 1 |
| Marsh Wren (<i>Cistothorus palustris</i>) | Richmond Agricultural Ditch #10 | 1 |
| | Delta Agricultural Ditch #11 | 1 |
| Muskrat (<i>Ondatra zibethicus</i>) | 80 St Ditch East, south of Highway 99 | 1 |

5.0 Discussion

The major results arising from the information review and field freshwater fish and fish habitat study of existing conditions are discussed below.

5.1 Key Findings

5.1.1 Commercial, Recreational, or Aboriginal Fish Values

The review of existing information confirmed that extensive fish and fish habitat information is available for the major watercourses that intersect the study area, including the lower Fraser River, specifically South Arm, and Deas and Green sloughs. Major watercourses have suitable habitat to meet the life history needs of various fish species that are considered to have CRA fisheries values. The full list of CRA fish species that occur within the study area includes five species of Pacific salmon (coho, chinook, chum, pink, and sockeye), two species of trout (coastal cutthroat, and rainbow/steelhead), two species of char (Dolly Varden and bull trout), two species of sturgeon (green and white), and eulachon.

The Fraser River South Arm and tidal features in the lower river reaches (e.g., Deas and Green sloughs) are well-documented as providing important habitat values for all of the aforementioned CRA fish species. Most notably, the lower river is a significant upstream migration corridor for adult Pacific salmon and a rearing habitat corridor for out-migrating juveniles. Juvenile salmon (especially chinook, chum, and to a lesser extent coho) receive considerable feeding and refuge benefits from key estuarine tidal habitats, in particular tidal marshes and adjacent un-vegetated flats, as they move downstream into the lower estuary. These same river reaches and well-connected tidal backwaters also provide important habitat values for various life history stages of coastal cutthroat trout, rainbow trout (including steelhead), white sturgeon, and eulachon. Adult green sturgeon also potentially occur, but in low numbers and primarily in the lower estuary.

Upland watercourses within the study area comprise mainly roadside or agricultural ditches. Fish access into these ditches is typically limited by flood control infrastructure (i.e., dikes with pump stations and flood boxes), which impacts their connectivity to higher-value CRA fish waters located further downstream. With specific consideration towards salmonids (i.e., Pacific salmon, trout and char), which are the most likely CRA fish to occur in these ditches, low gradients and finer streambed substrates preclude any potential for spawning. The most likely life history stage of salmonids that would inhabit these ditches are juvenile fish, in particular rearing juvenile Pacific salmon (e.g., chinook and coho salmon). Based on fieldwork in 2014, water quality tends to be quite poor seasonally, with relatively high water temperatures, low

DO concentrations, and seasonally acidic pH levels. These conditions are expected to preclude or deter the use of these watercourses by rearing salmonids, except during winter months when more suitable water quality conditions may occur.

Although fish sampling occurred at 61 sites during the spring and autumn 2014, when water levels and water quality should have been most suitable for salmonids, no salmonids were caught in upland ditches within the study area.

All of the watercourses within the study area were classified based on a classification scheme that focuses primarily on CRA fisheries values. Watercourse reaches with CRA values are described in this report and mapped in the appended watercourse classification maps (**Appendix A**) as year-round CRA fish habitats (red-coded), seasonal CRA fish habitats (dashed-red-coded), or as a significant upstream source of food and nutrients to CRA fish habitats (orange-coded). For the upland watercourses, this coding is generally based on potential rather than confirmed CRA fish habitat values. Furthermore, it is noted that potential habitat use by CRA fish is considered to decrease with distance from downstream confirmed CRA fish habitats into which these watercourses drain. This assumption is based on the best professional judgement of this report's authors; additional fieldwork would be required to more definitely characterize the full distribution of CRA fish.

5.1.2 Non-Commercial, Recreational, or Aboriginal Fish Values

With the exception of major watercourses and a select few minor upland watercourses within the study area, the majority of the remaining watercourses are low-gradient channelized ditches characterized by fine bottom substrates and poor connectivity to downstream CRA waters. Additionally, the use of these watercourses by fish may be limited by poor water quality conditions, in particular high temperatures and low DO levels. In the warmer summer months, these poor water quality conditions would presumably be heightened due to lower flows, higher water temperatures, and lower DO concentrations. As a result, some of these ditches may not support any fish (even resident fish) on a year-round basis.

Numerous different resident fish species have been previously documented within the study area (refer to **Appendix B, Table 1**); however, fish fauna captured by minnow trapping in 2014 were limited to three native fish species (threespine stickleback, brassy minnow, and bull trout) and two introduced fish species (goldfish and pumpkinseed). All of these fish, in particular threespine stickleback and the three introduced species, are known to be tolerant of poor water quality conditions and therefore are not unexpected within the study area.

Based on the watercourse classification scheme developed for this study, non-CRA watercourse reaches are described in this report and mapped in the accompanying watercourse classification maps (**Appendix A**) as resident fish habitats (yellow-coded) or non-fish bearing habitats (green-coded). The majority of the watercourses overlapping with the Project alignment have non-CRA fish habitat values.

6.0 References

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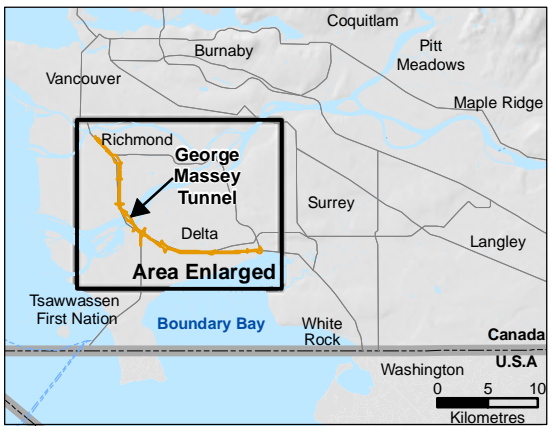
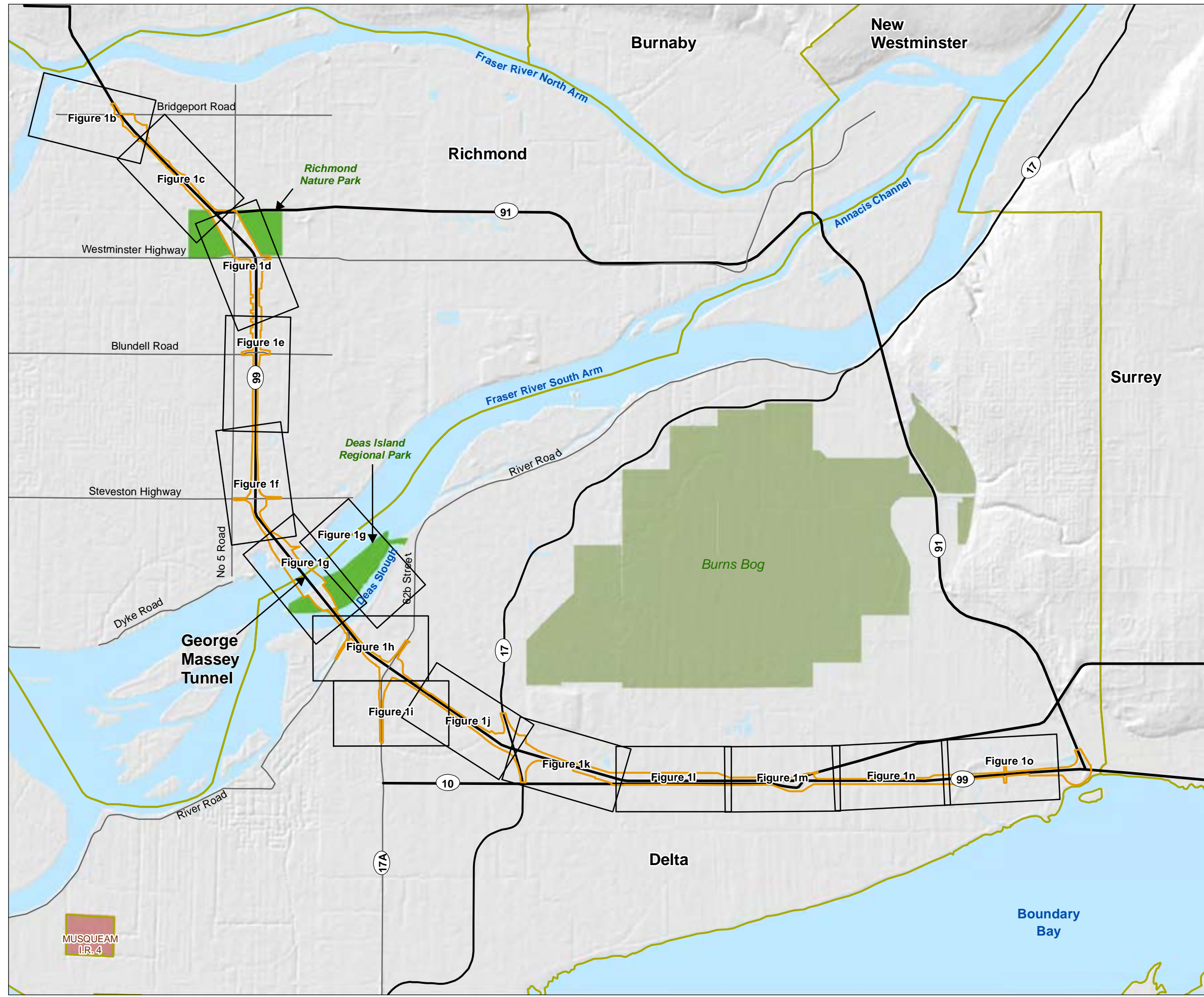
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ATTACHMENT A

**Study Area and Watercourse Classifications
Figures, Fish and Amphibian Distribution Map,
and FREMP Habitat Inventory Figure**

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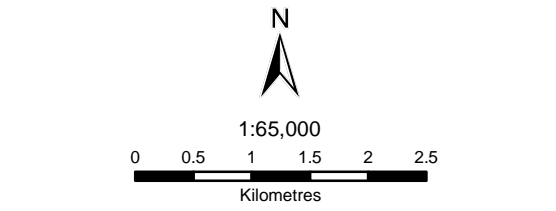


Legend

- Project Alignment
- First Nation Reserve
- Municipal Boundaries
- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road

SOURCES

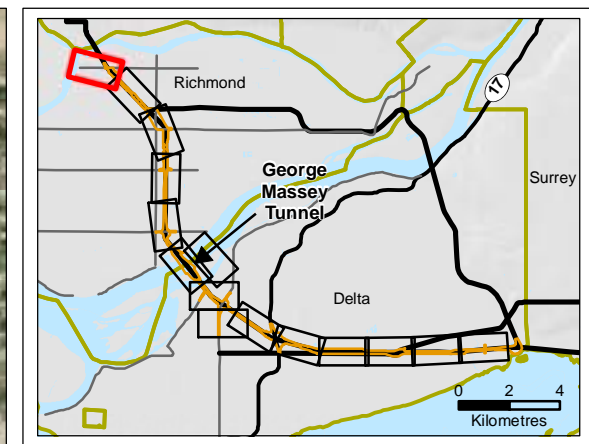
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

FRESHWATER FISH AND FISH
HABITAT STUDY KEY MAP

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| Figure 1a | 13/05/2016 |
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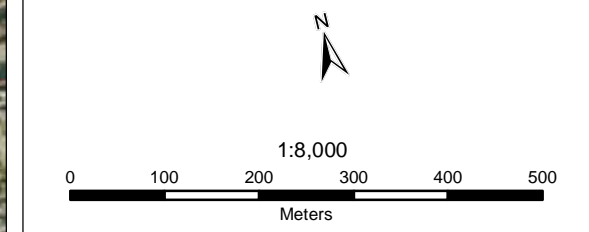
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Watercourse Classification

- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

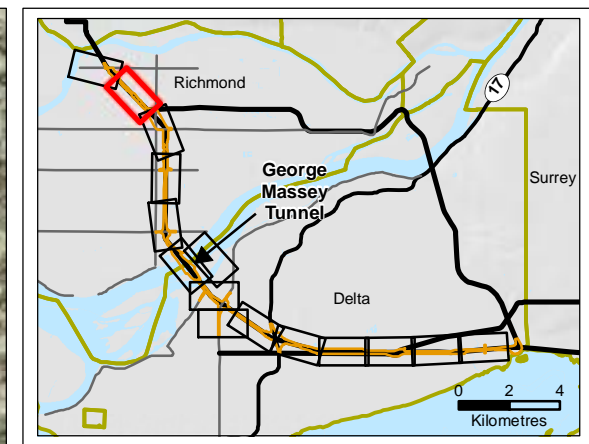
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1b | 20/01/2016 |
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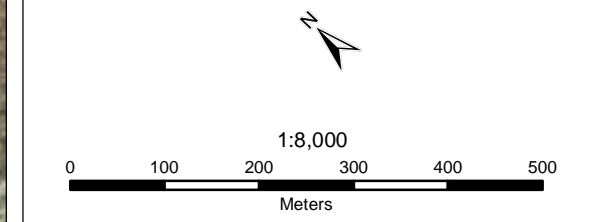
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Watercourse Classification

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- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

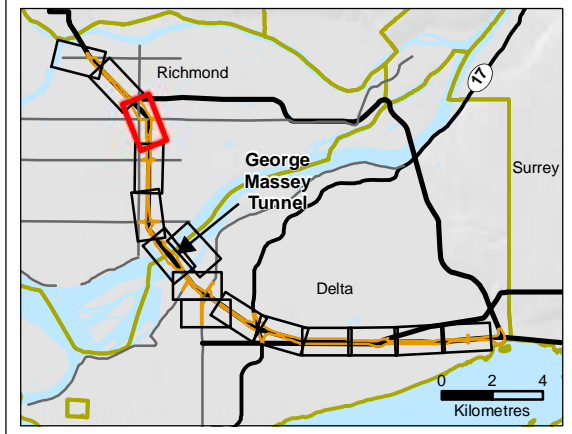
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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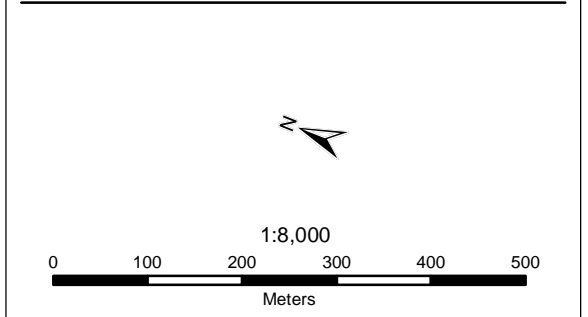


Legend

- Watercourse Classification**
- Red
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 - Green
 - Project Alignment
 - Municipal Boundaries
 - Waterbody
 - Canada - U.S Border

SOURCES

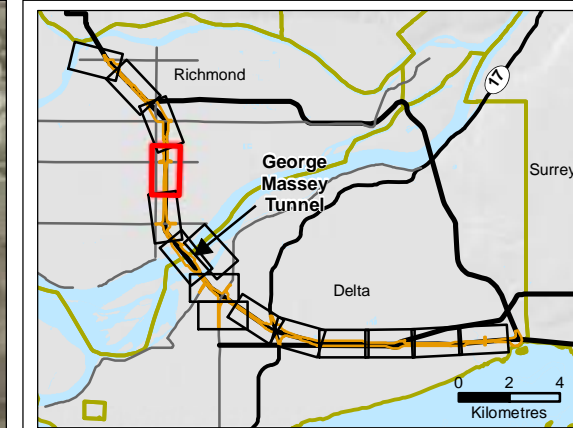
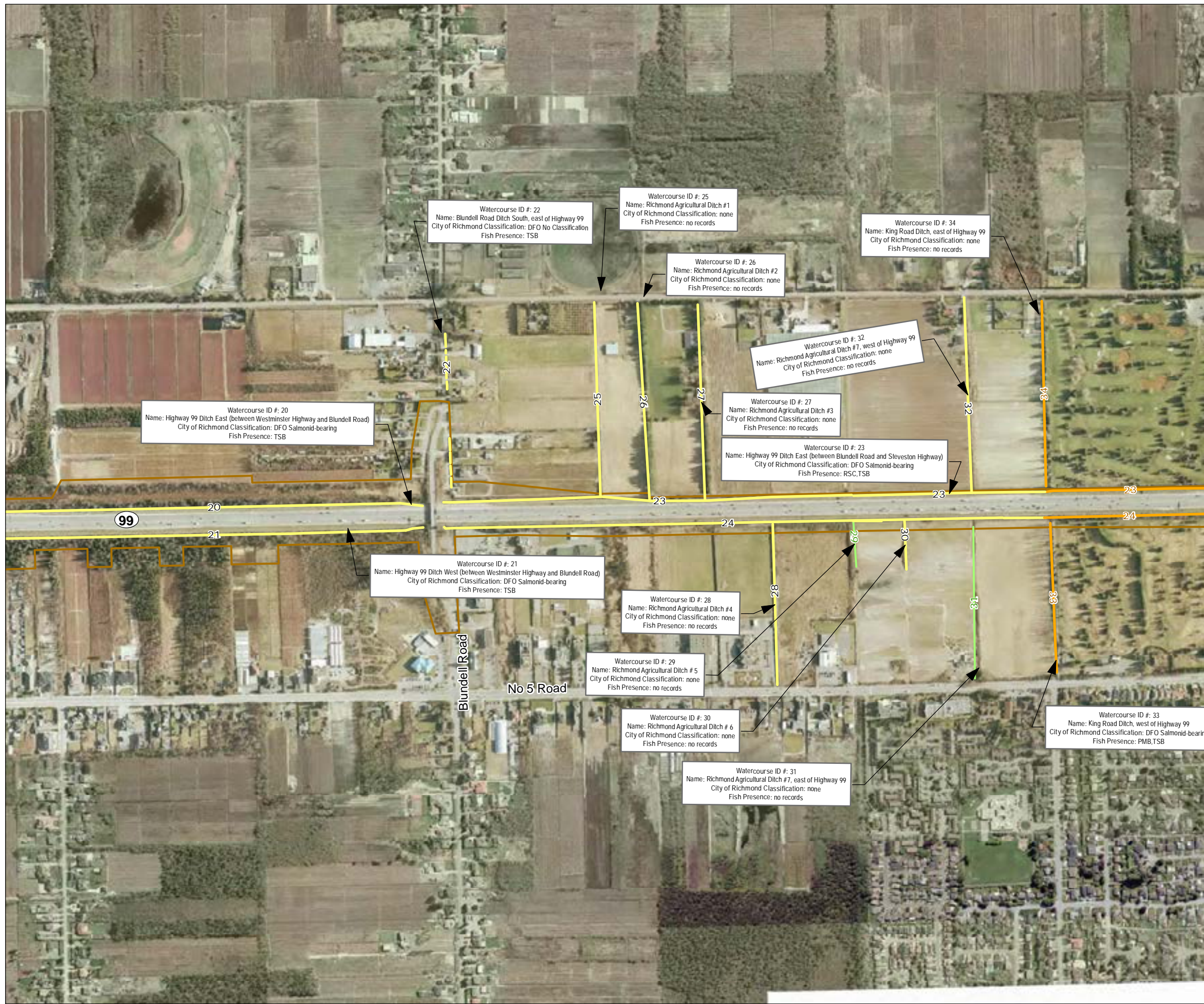
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**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1d | 20/01/2016 |
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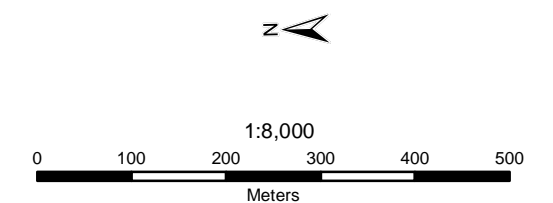
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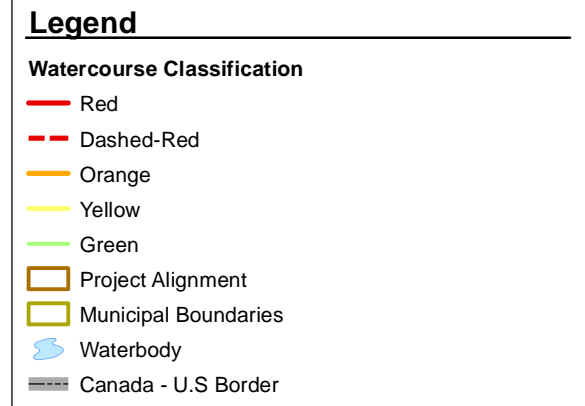
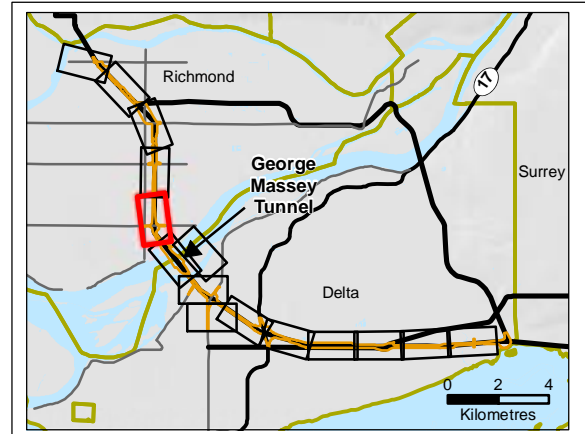
- Red
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- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

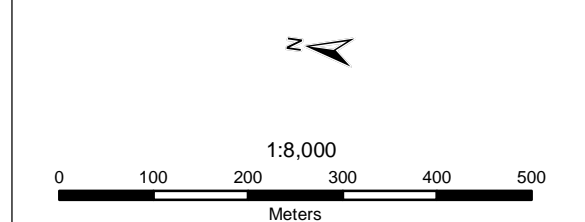


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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| WATERCOURSE CLASSIFICATIONS | |
| Figure 1e | 20/01/2016 |
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SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1f | 20/01/2016 |
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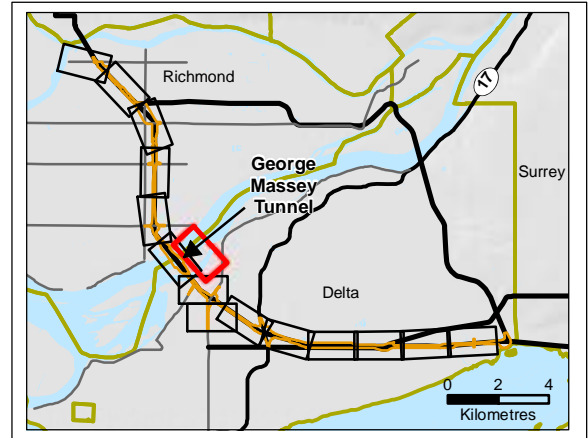
Watercourse ID #: 50
 Name: Fraser River South Arm
 No Municipal Classification
 Fish Presence: CL,NSC,PCC,PK,RSC,SFL,WSG

Watercourse ID #: 53
 Name: River Road Ditch Northwest, north of Highway 99
 Corporation of Delta Timing Window: C-Highway 99 to 60 Ave: B-
 Fish Presence: CP,TSB

Watercourse ID #: 45
 Name: Cultural Ditch #10
 City of Richmond
 Fish Presence: none

Watercourse ID #: 47
 Name: Richmond Agricultural Ditch #11
 City of Richmond
 Classification: DFO Salmonid-bearing
 Fish Presence: no records

Watercourse ID #: 52
 Name: PK-RSC-SFL-SK-TSB
 Fish Presence: none

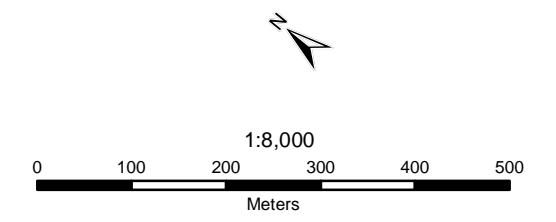


Legend

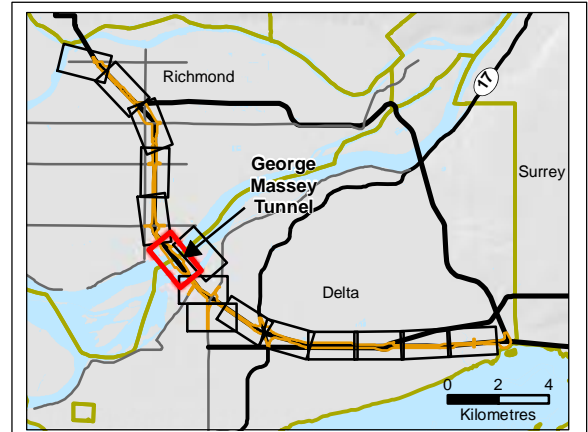
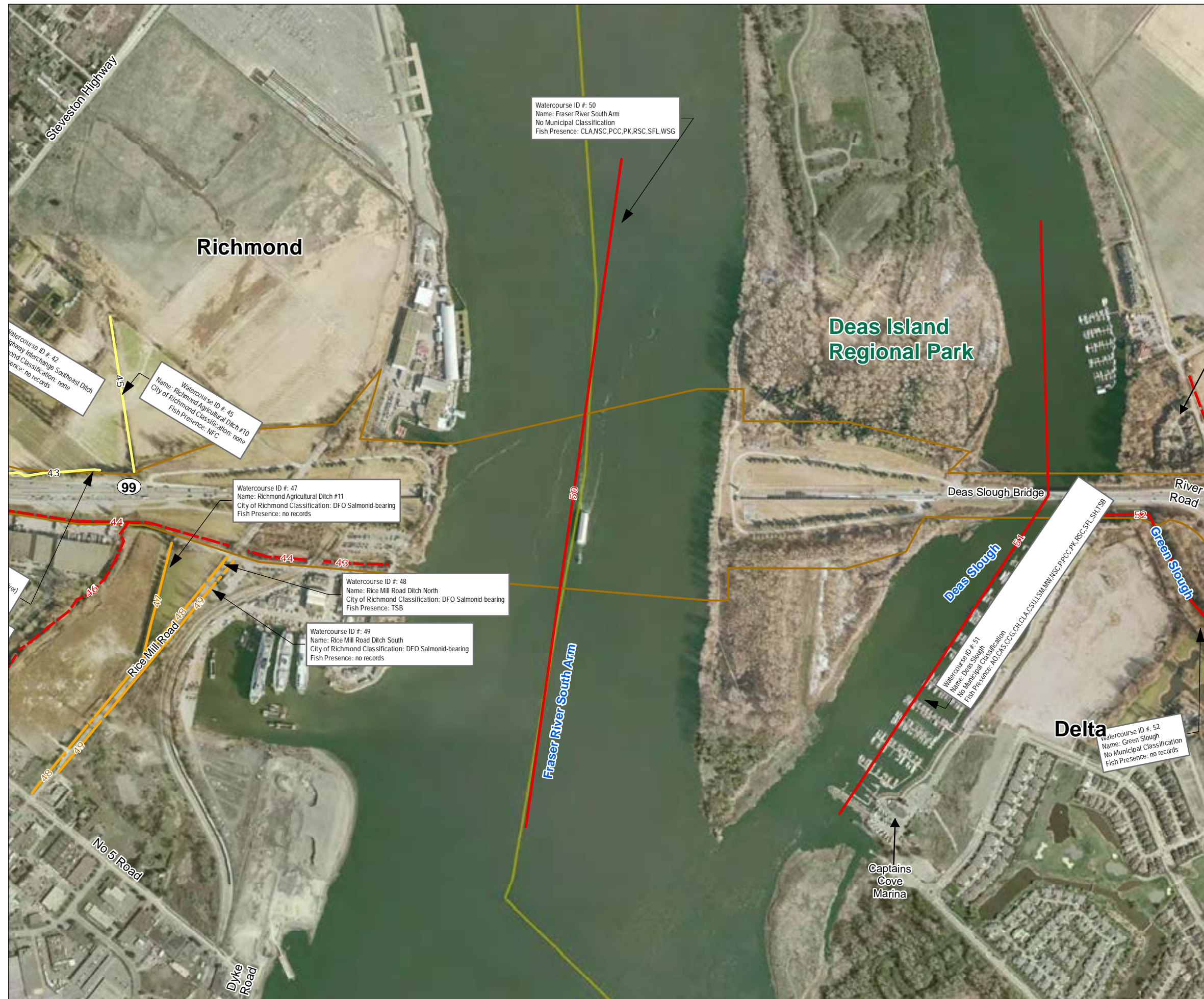
- Watercourse Classification**
- Red
 - Dashed-Red
 - Orange
 - Yellow
 - Green
 - Project Alignment
 - Municipal Boundaries
 - Waterbody
 - Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| WATERCOURSE CLASSIFICATIONS | |
| Figure 1g | 20/01/2016 |
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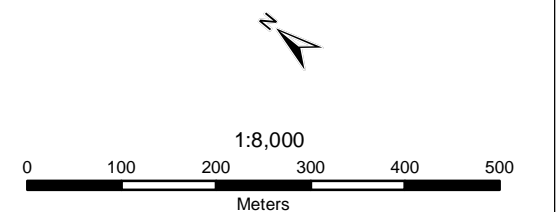
Legend

Watercourse Classification

- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

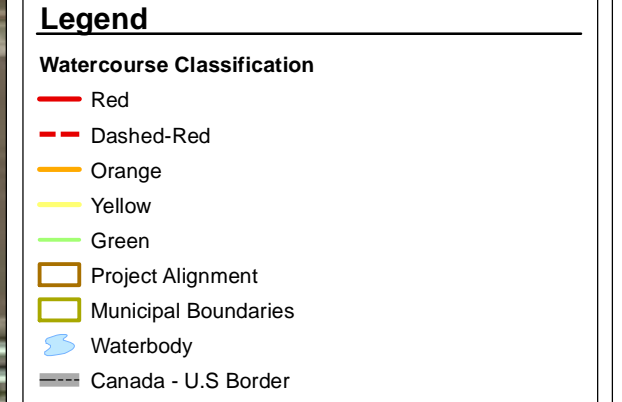
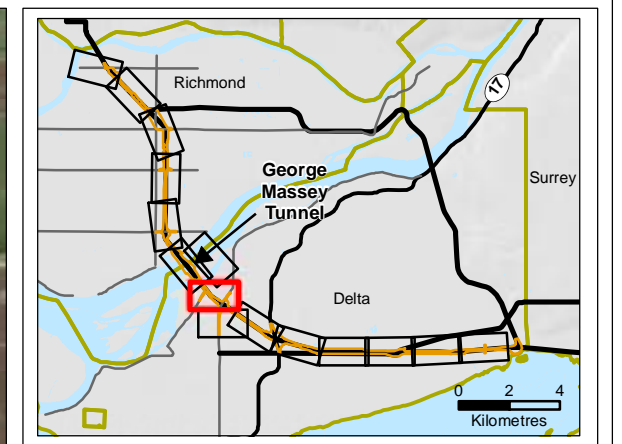
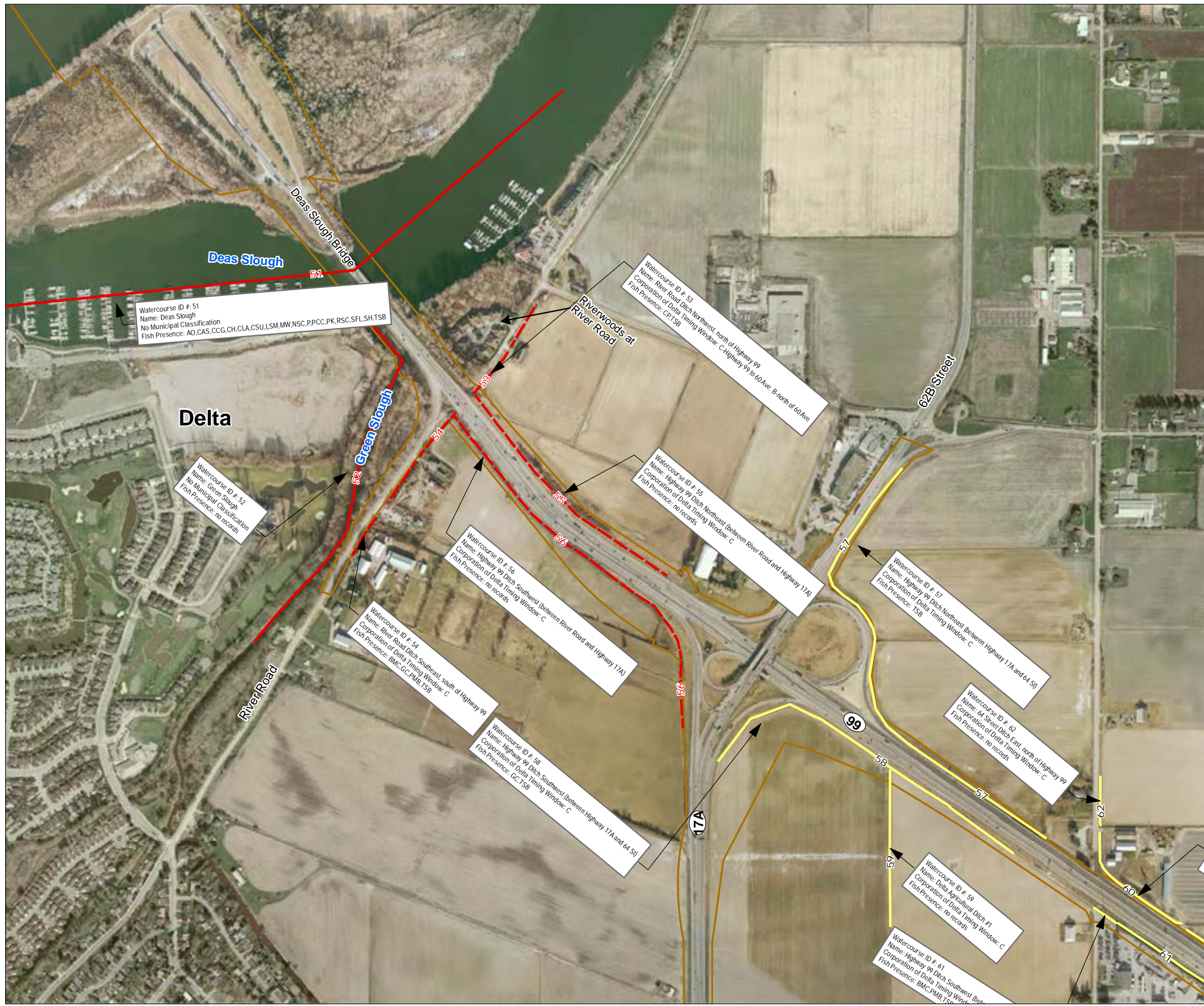
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
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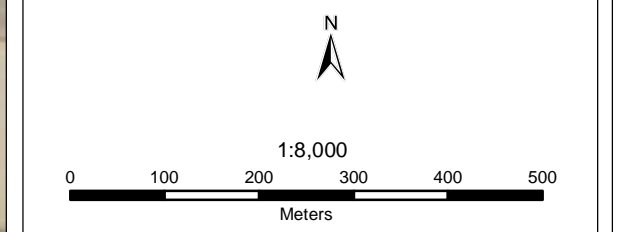
WATERCOURSE CLASSIFICATIONS

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| Figure 1g | 20/01/2016 |
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SOURCES

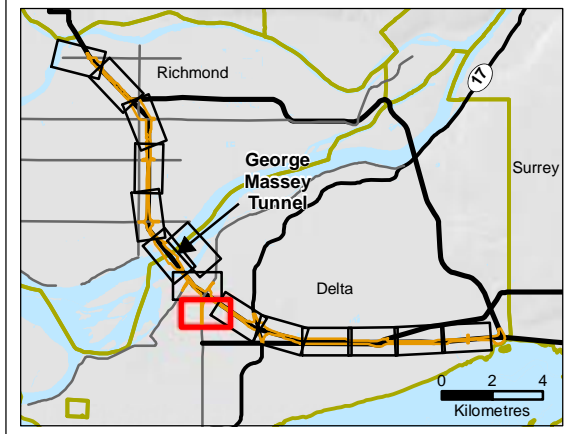
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



GEORGE MASSEY TUNNEL REPLACEMENT PROJECT

WATERCOURSE CLASSIFICATIONS

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| Figure 1h | 20/01/2016 |
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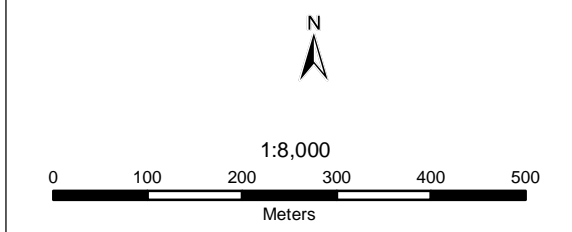


Legend

- Watercourse Classification**
- Red
 - Dashed-Red
 - Orange
 - Yellow
 - Green
 - Project Alignment
 - Municipal Boundaries
 - Waterbody
 - Canada - U.S Border

SOURCES

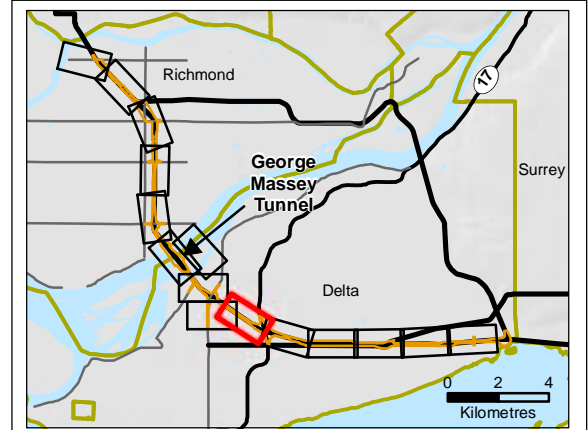
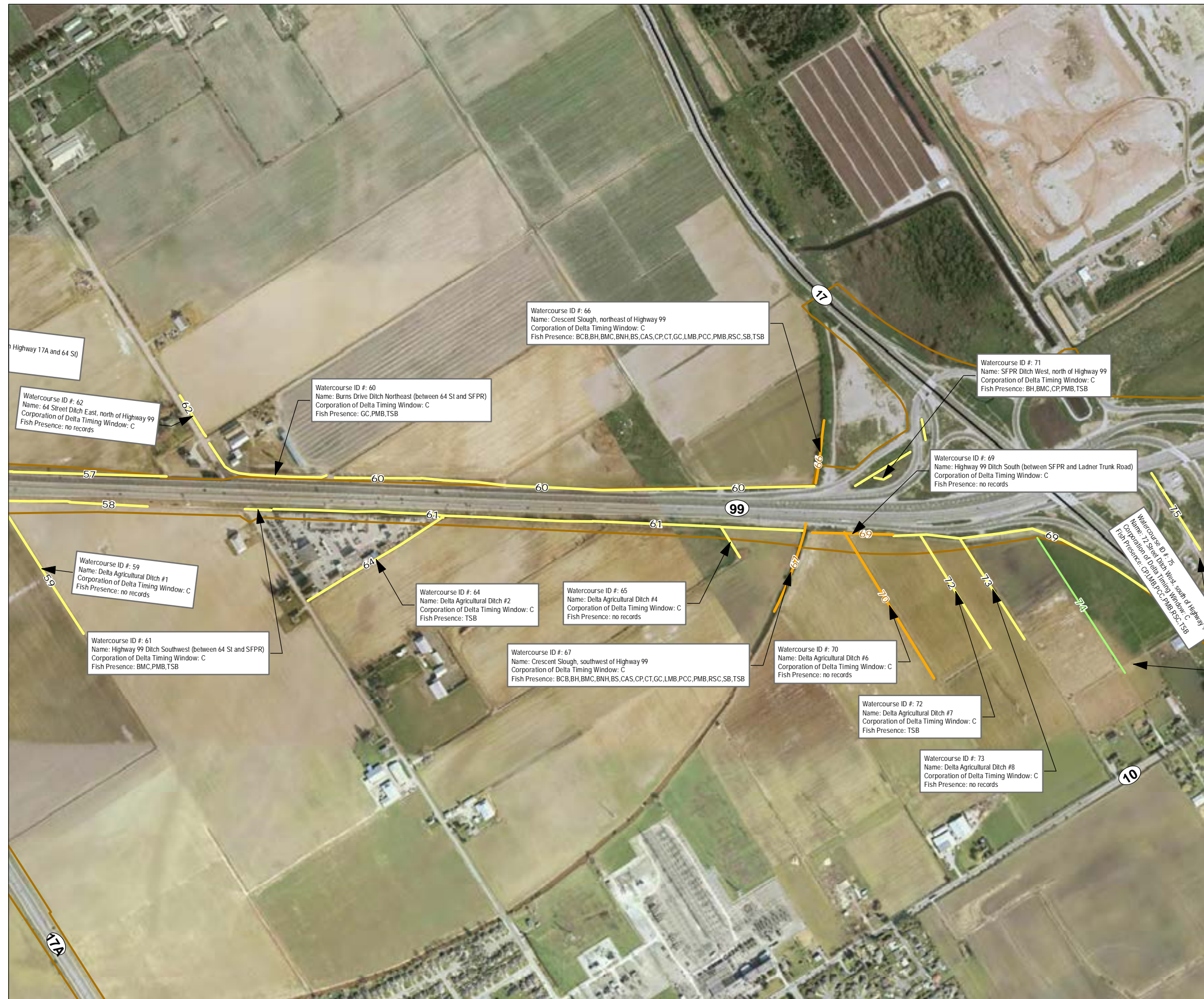
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1i | 20/01/2016 |
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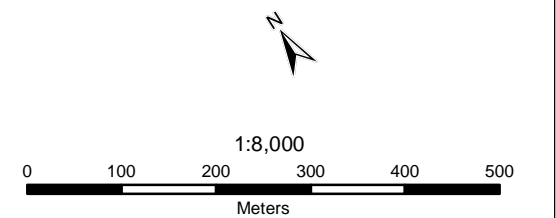
Legend

Watercourse Classification

- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

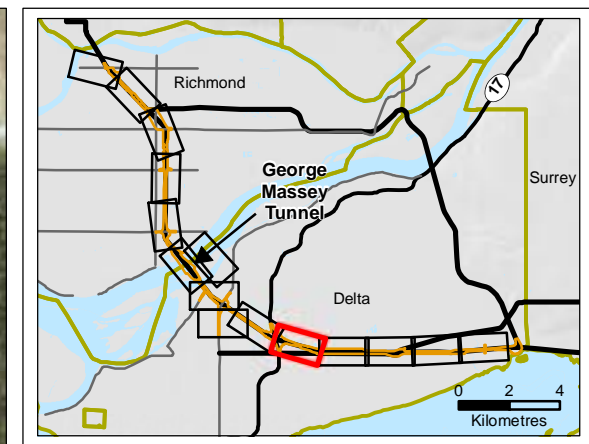
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1j | 20/01/2016 |
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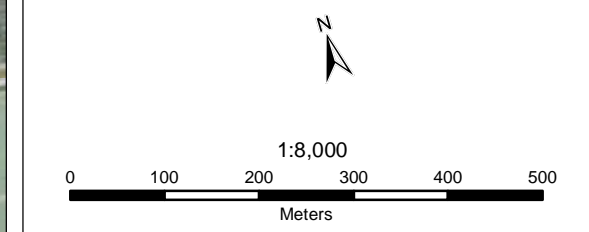
Legend

Watercourse Classification

- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

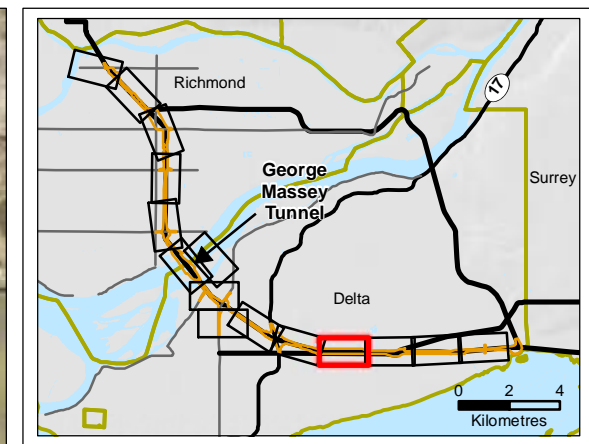
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1k | 20/01/2016 |
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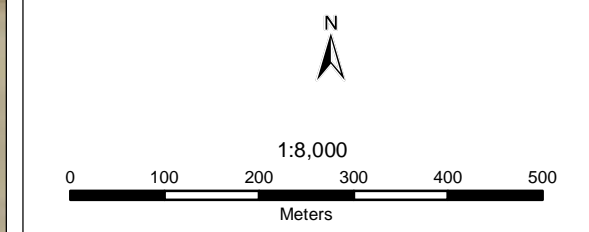
Legend

Watercourse Classification

- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

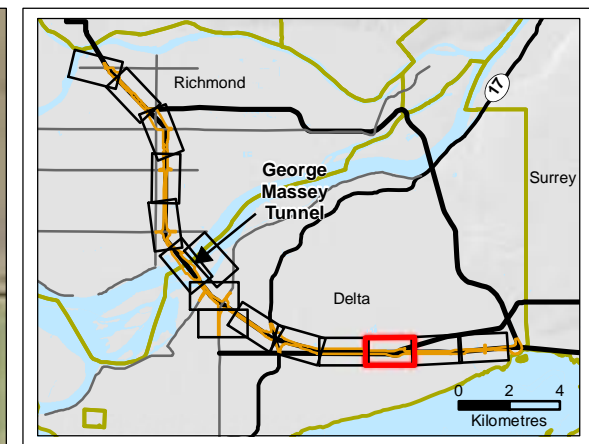
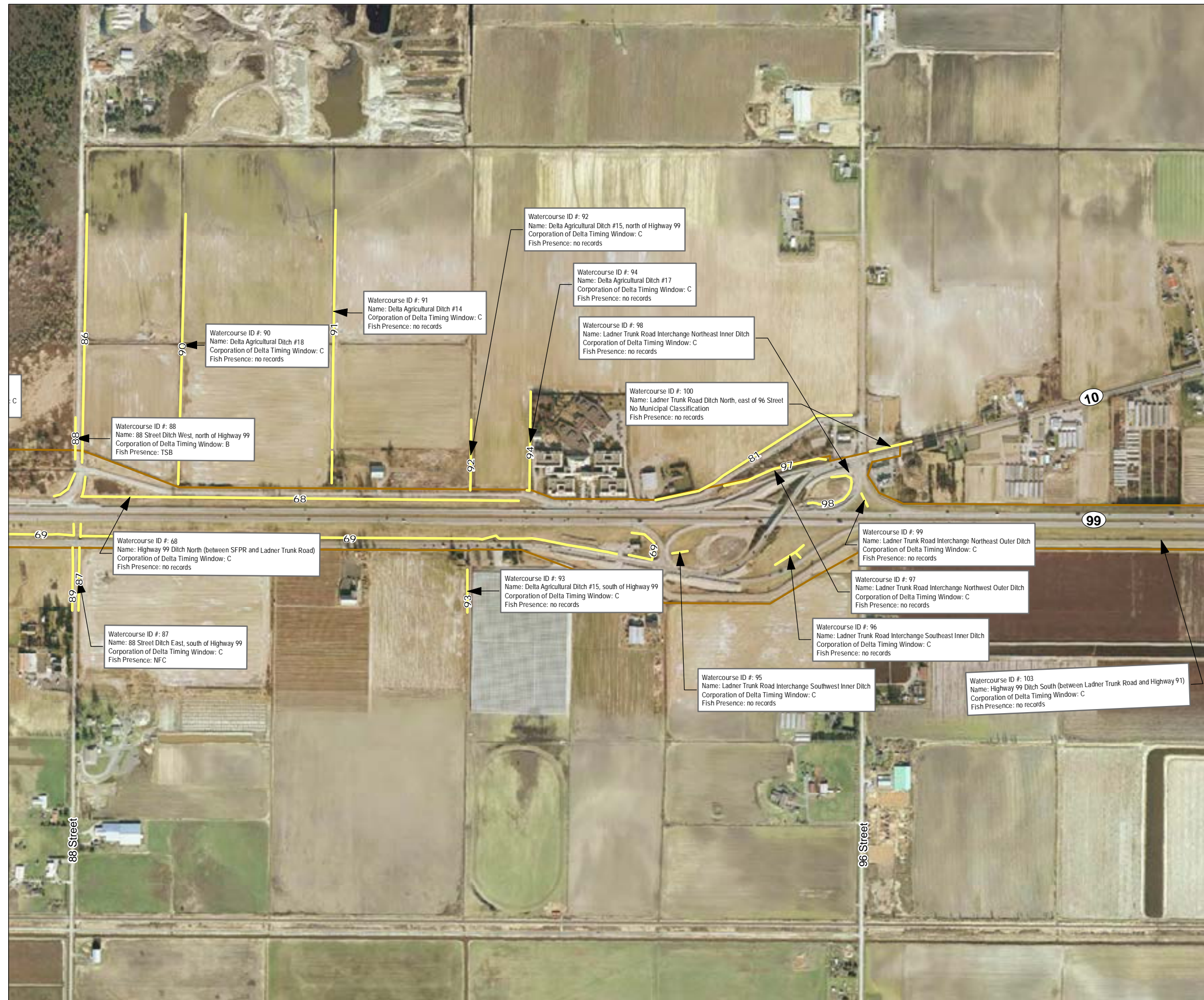
Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 11 | 20/01/2016 |
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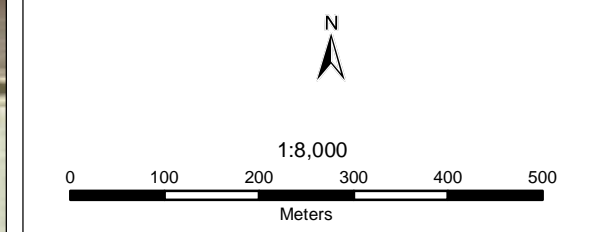
Legend

Watercourse Classification

- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1m | 20/01/2016 |
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Watercourse ID #: 99
Name: Ladner Trunk Road Interchange Northeast Outer Ditch
Corporation of Delta Timing Window: C
Fish Presence: no records

Watercourse ID #: 97
Name: Ladner Trunk Road Interchange Northwest Outer Ditch
Corporation of Delta Timing Window: C
Fish Presence: no records

Watercourse ID #: 96
Name: Ladner Trunk Road Interchange Southeast Inner Ditch
Corporation of Delta Timing Window: C
Fish Presence: no records

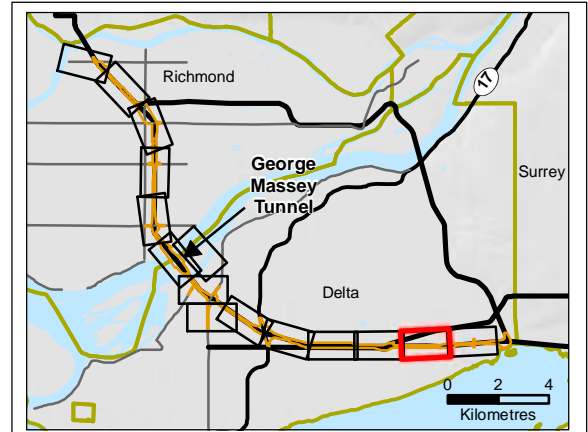
Watercourse ID #: 103
Name: Highway 99 Ditch South (between Ladner Trunk Road and Highway 91)
Corporation of Delta Timing Window: C
Fish Presence: no records

Watercourse ID #: 102
Name: Highway 99 Ditch North (between Ladner Trunk Road and Highway 91)
Corporation of Delta Timing Window: C
Fish Presence: TSB

Watercourse ID #: 104
Name: Delta Agricultural Ditch #16
Corporation of Delta Timing Window: C
Fish Presence: BNH,CP,PMB,TSB

Watercourse ID #: 105
Name: 104 Street Ditch
Corporation of Delta Timing Window: C
Fish Presence: TSB

Watercourse ID #: 106
Name: BNSF Ditch
Corporation of Delta Timing Window: C
Fish Presence: no records



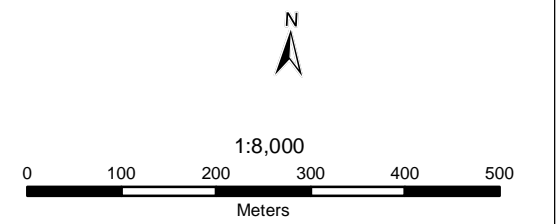
Legend

Watercourse Classification

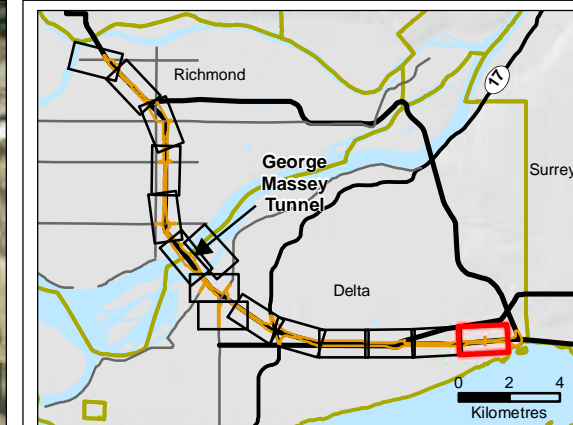
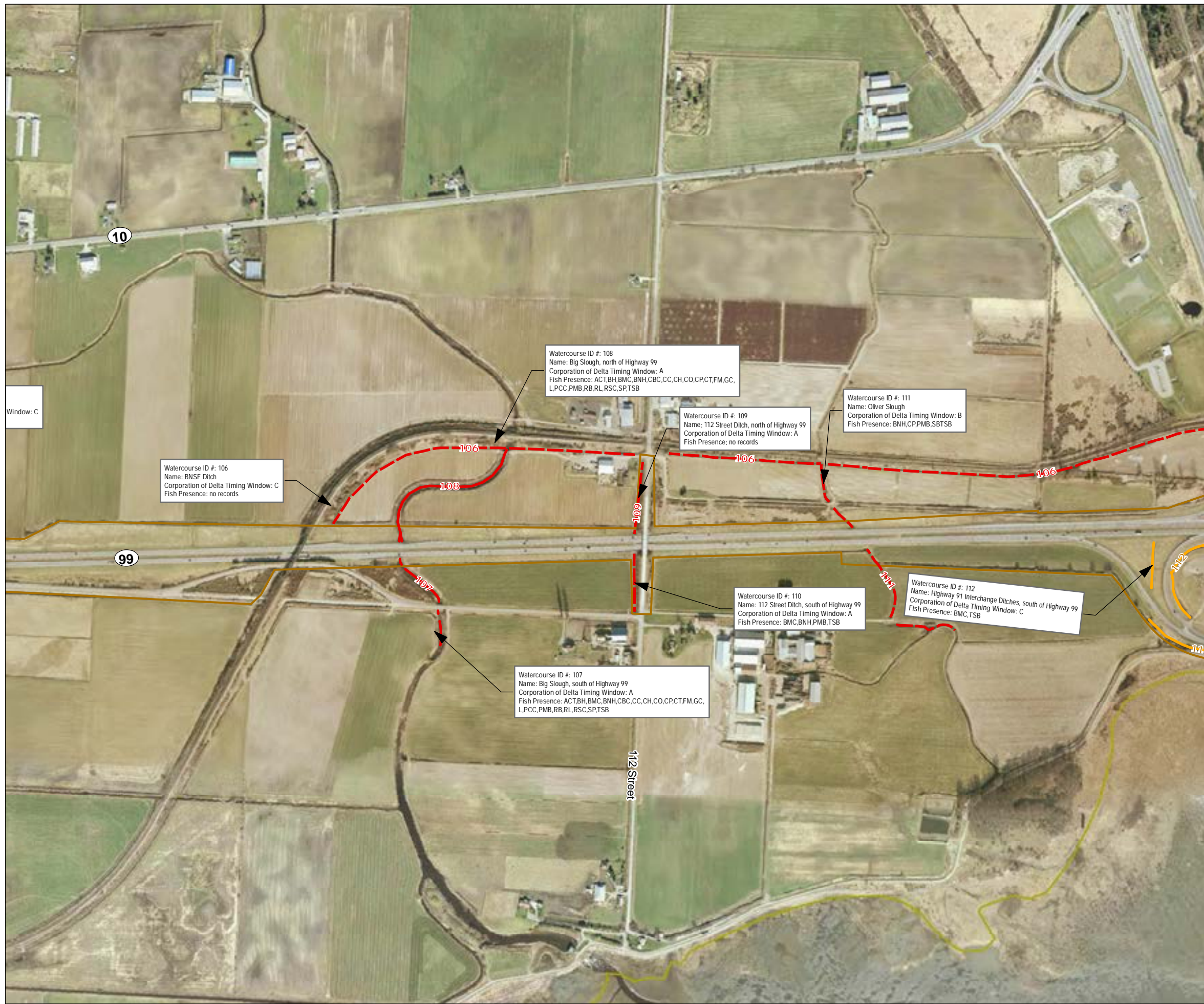
- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| WATERCOURSE CLASSIFICATIONS | |
| Figure 1n | 20/01/2016 |
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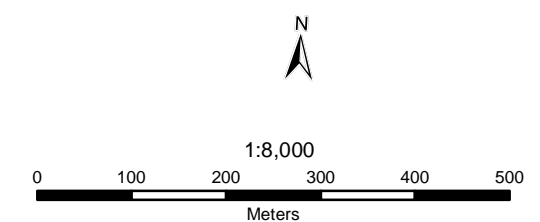
Legend

Watercourse Classification

- Red
- Dashed-Red
- Orange
- Yellow
- Green
- Project Alignment
- Municipal Boundaries
- Waterbody
- Canada - U.S Border

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007. 2014 Ortho imagery from Binnie. All other data courtesy of Canvec - GeoGratis.

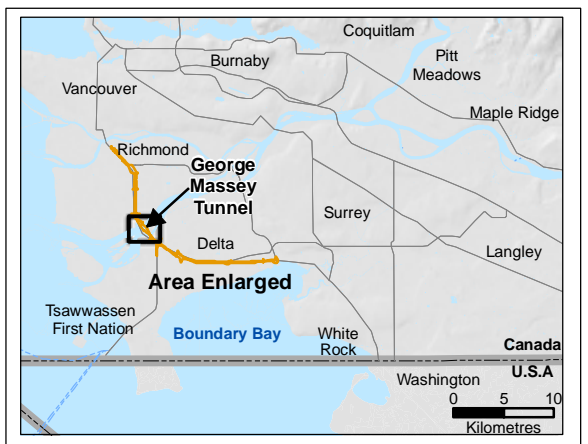
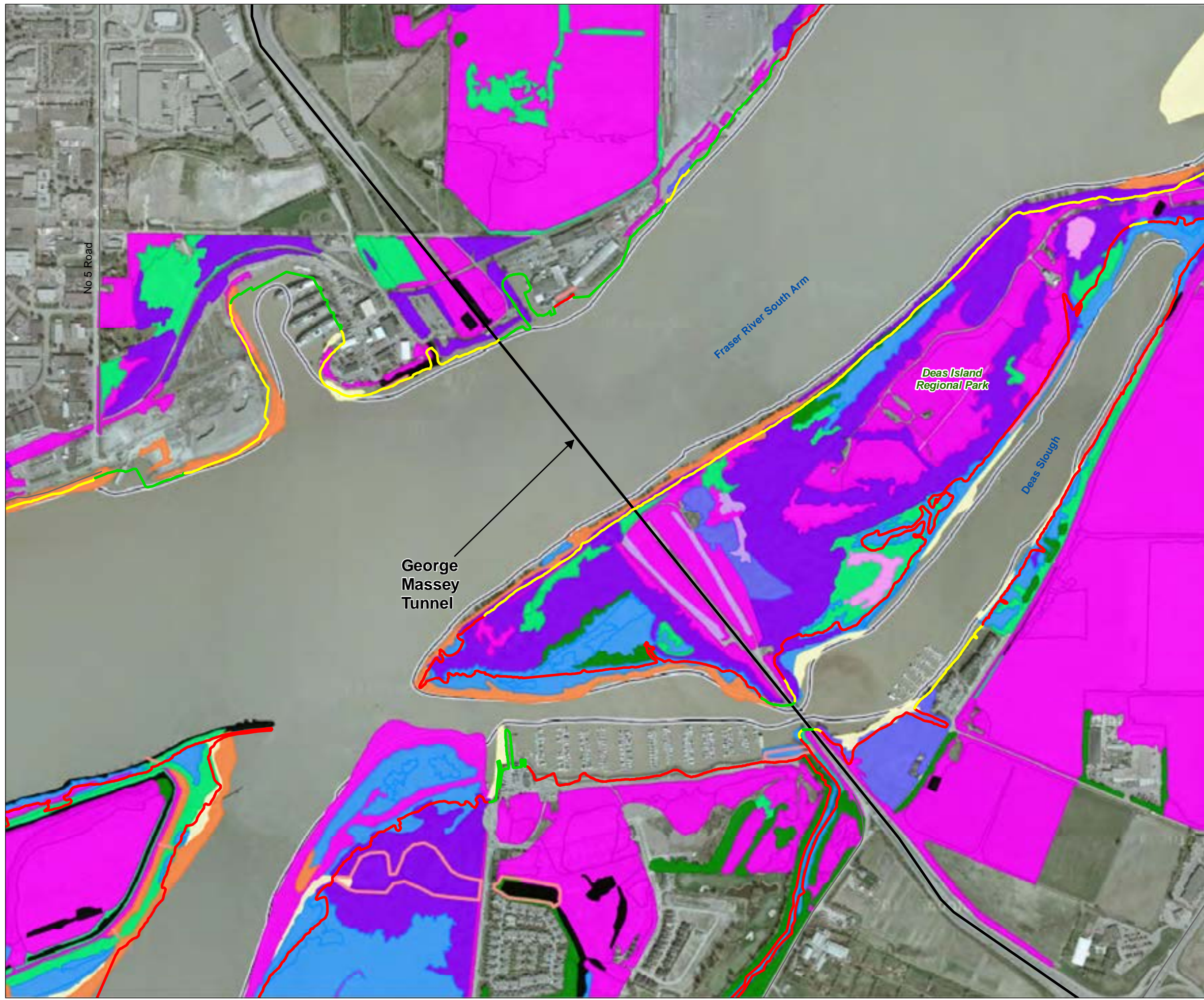


**GEORGE MASSEY TUNNEL
REPLACEMENT PROJECT**

WATERCOURSE CLASSIFICATIONS

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| Figure 1o | 20/01/2016 |
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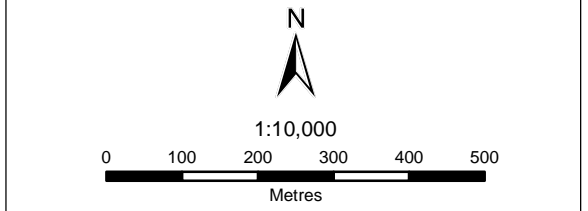
Path: O:\1217-299\285\077\03\mxd\Fish\TV\Fig3_285_077_03_EA_FREMP_HabCompensate_160119_FINAL.mxd



Legend

- Burns Bog Ecological Conservancy Area
- Waterbody
- Canada - U.S. Border
- Highway
- Arterial/Collector Road
- High Productivity Habitat
- Moderate Productivity Habitat
- Low Productivity Habitat
- deciduous tree woodland
- coniferous tree woodland
- mixed tree woodland
- low shrub woodland
- tall shrub woodland
- meadow, vascular
- meadow, non-vascular
- marsh
- eel-grass
- macroalgae
- mud
- sand
- rock
- other
- habitat compensation site

SOURCES
 Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis. All other data obtained from the Fraser River Estuary Management Program & Burrard Inlet Environmental Action Program Habitat Atlas available online through the Community Mapping Network (http://www.cmnbc.ca/atlas_gallery/fremp-bieap-habitat-atlas). Data was accessed in November 2014. Productivity data was digitized at a scale of 1:5000 and is an approximate representation only.



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| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| FRASER RIVER ESTUARY MANAGEMENT PROGRAM HABITAT INVENTORY | |
| Figure 3 | 13/05/2016 |
| | |

ATTACHMENT B

**Tables Summarizing Historical Fish Presence,
Field Water Quality, and Fish Capture Results
for the Project**

Table B1 Overview of Results of Previous Fish Sampling Within and Adjacent to the Study Area

| Watercourse Name | Species Code ¹ | Year Documented | Company | Project Information | Easting | Northing |
|---|---|-----------------|--|--|---------|----------|
| Fraser River South Arm | WSG | 2005 | LGL Sidney | Project ID/Name: 26933/Post-capture mortality white sturgeon - 2005; SU05-15280 | 494075 | 5440490 |
| Highway 99 Ditch East (between Westminster Highway and Blundell Road) | TSB | 2009 | Hatfield Consulting Ltd. | Project ID/Name: 25979/Highway 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536, Project ID/Name: 26697/Hwy 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536 | 493727 | 5445832 |
| Highway 99 Ditch East (between Blundell Road and Steveston Highway) | RSC, TSB | 2009 | Hatfield Consulting Ltd. | Project ID/Name: 25979/Highway 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536, Project ID/Name: 26697/Hwy 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536 | 493707 | 5444154 |
| Highway 99 Ditch East (between Blundell Road and Steveston Highway) | TSB | 2009 | Hatfield Consulting Ltd. | Project ID/Name: 25979/Highway 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536, Project ID/Name: 26697/Hwy 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536 | 493706 | 5443734 |
| Highway 99 Ditch East (between Blundell Road and Steveston Highway) | RSC, TSB | 2009 | Hatfield Consulting Ltd. | Project ID/Name: 25979/Highway 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536, Project ID/Name: 26697/Hwy 99 Richmond Bus Lanes ISL1554 - 2009; SU09-58536 | 493713 | 5444686 |
| Highway 99 Ditch West (between Steveston Highway and Fraser River) | PMB, TSB | 2012 | Golder Associates Ltd. | Project ID/Name: 28477/Highway 99 and Steveston Overpass EA - 2012; SU12-83112 | 493546 | 5442284 |
| Fraser River South Arm | WSG | 2007 | LGL Sidney | Project ID/Name: 22805/Sturgeon Habitat Use Lower Fraser River - 2006; NASU06-37260 | 493701 | 5441263 |
| Fraser River South Arm | CLA, NSC, PCC, PK, RSC, SFL | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 493632 | 5440158 |
| Fraser River South Arm | WSG | 2007 | LGL Sidney | Project ID/Name: 22805/Sturgeon Habitat Use Lower Fraser River - 2006; NASU06-37260 | 493774 | 5440929 |
| Deas Slough | CAS, CLA, CSU, NSC, PCC, PK, RSC, SFL | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 494335 | 5440291 |
| Deas Slough | CCG, CH, LSM, MW, NSC, RSC, SFL | 2003 | - | 01-JAN-03 Interim Fish Collection Reports for FC2003-10 | 494183 | 5440288 |
| Deas Slough | CAS, CLA, CSU, P, PCC, SFL, TSB | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 494399 | 5440285 |
| Deas Slough | CAS, CSU, NSC, P, PCC, SFL, TSB | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 495832 | 5441242 |
| Deas Slough | CLA, CSU, PCC, RSC, SFL | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 494435 | 5440285 |
| Deas Slough | AO, CAS, CLA, CSU, NSC, P, PCC, PK, RSC, SFL, TSB | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 494475 | 5440282 |

(1) Refer to Appendix B, Table 2 for species codes
 " - " Not available

| Watercourse Name | Species Code ¹ | Year Documented | Company | Project Information | Easting | Northing |
|---|---|------------------------------|--|--|---------|----------|
| Deas Slough | AO, CAS, CLA, CSU, NSC, P, PCC, RSC, SFL, SH | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 494364 | 5440287 |
| Deas Slough | CAS, CLA, CSU, NSC, P, PCC, RSC, SFL | 2007 | IRC Integrated Resource Consultants Inc. | Project ID/Name: 24834/Fraser River Ambient Fish Health - 2007; SU07-37947a | 494152 | 5440206 |
| Crescent Slough, northeast of Highway 99 | TSB | 2011 | Stantec | Project ID/Name: 28242/South Fraser Perimeter Road Fish Salvage - 2011; SU11-71531 | 497830 | 5438618 |
| Crescent Slough, northeast of Highway 99 | CP, PMB, TSB | 2011 | Stantec | Project ID/Name: 28370/South Fraser Perimeter Road Fish Salvage - 2011; SU11-68327 | 497620 | 5438276 |
| Crescent Slough, northeast of Highway 99 | CT, TSB | 1983 | - | 01-SEP-83 CRESCENT SLOUGH | 497871 | 5438819 |
| Crescent Slough, northeast of Highway 99 | BCB, BMC, CP, CT, PCC, TSB | 1983 | - | 01-SEP-83 CRESCENT SLOUGH | 497662 | 5438343 |
| Delta Agricultural Ditch #7 | TSB | 2011 | Stantec | Project ID/Name: 28242/South Fraser Perimeter Road Fish Salvage - 2011; SU11-71531, Project ID/Name: 28248/South Fraser Perimeter Road Fish Salvage - 2011; SU11-72110 | 497779 | 5438115 |
| 72 Street Ditch West, south of Highway 99 | LMB, PMB, RSC, TSB | 2011 | Stantec | Project ID/Name: 28313/South Fraser Perimeter Road Fish Salvage - 2011; SU11-69445 | 498251 | 5438055 |
| 72 Street Ditch West, south of Highway 99 | CP, PCC, PMB, TSB | 2011 | Stantec | Project ID/Name: 28361/South Fraser Perimeter Road Fish Salvage - 2010; SU10-68047 | 498249 | 5437725 |
| Crescent Slough, southwest of Highway 99 | TSB | 2012 | Nova Pacific Environmental | Project ID/Name: 28082/Fish Salvage Crescent Slough - 2012; SU12-77341 | 495849 | 5438140 |
| Crescent Slough, southwest of Highway 99 | TSB | 1983 | - | 01-SEP-83 CRESCENT SLOUGH | 494750 | 5439044 |
| Crescent Slough, southwest of Highway 99 | BMC, TSB | 1983 | - | 01-SEP-83 CRESCENT SLOUGH | 496859 | 5437926 |
| Crescent Slough, southwest of Highway 99 | BCB, BH, BMC, BNH, BS, CAS, CP, CT, GC, LMB, PCC, PMB, RSC, SB, TSB | 1983, 1997, 2011, 2012, 2013 | - | 01-SEP-83 CRESCENT SLOUGH | 494714 | 5439110 |
| Crescent Slough, southwest of Highway 99 | CP, TSB | 2009 | University of British Columbia | Project ID/Name: 23654/Phylogeography of Brassy Minnow - 2008; SU08-44382 | 494771 | 5439075 |
| Crescent Slough, southwest of Highway 99 | BNH, BS, TSB | 2012, 2013 | Nova Pacific Environmental | Project ID/Name: 28088/Hwy 17 Crescent Slough Fish Salvage - 2012; SU12-82683, Project ID/Name: 28097/Crescent Slough Culvert Lining Salvage - 2012; SU12-84514 | 495741 | 5438188 |
| Crescent Slough, southwest of Highway 99 | TSB | 1983 | - | 01-SEP-83 CRESCENT SLOUGH | 495585 | 5438253 |

(1) Refer to Appendix B, Table 2 for species codes
 " - " Not available

| Watercourse Name | Species Code ¹ | Year Documented | Company | Project Information | Easting | Northing |
|--|---|--|-----------------------------------|--|---------|----------|
| Crescent Slough, southwest of Highway 99 | TSB | 2012 | Nova Pacific Environmental | Project ID/Name: 28082/Fish Salvage Crescent Slough - 2012; SU12-77341 | 495758 | 5438178 |
| 80 St Ditch East, south of Highway 99 | BMC, RSC, TSB | 2009 | University of British Columbia | Project ID/Name: 23654/Phylogeography of Brassy Minnow - 2008; SU08-44382 | 499881 | 5437423 |
| 80 St Ditch West, south of Highway 99 | BMC, RSC, TSB | 2009 | University of British Columbia | Project ID/Name: 23654/Phylogeography of Brassy Minnow - 2008; SU08-44382 | 499858 | 5437440 |
| Big Slough, south of Highway 99 | CC, CH, CO, PCC, TSB | 1995 | - | 01-JAN-95 FISHERIES BRANCH, SURREY: FISHERIES FILES: INVENTORY; ENHANCEMENT; BIOPHYSICAL DATA; andamp; RECORDS OF PERSONAL COMMUNICATION | 505975 | 5437449 |
| Big Slough, south of Highway 99 | ACT, BH, BMC, BNH, CBC, CP, CT, FM, GC, PMB, TSB | 1994, 1995, 2008, 2009, 2010, 2011, 2012 | - | 01-JAN-91 Untitled; 01-JAN-95 FISHERIES BRANCH, SURREY: FISHERIES FILES: INVENTORY; ENHANCEMENT; BIOPHYSICAL DATA; andamp; RECORDS OF PERSONAL COMMUNICATION, 01-JAN-94 Untitled, 01-JAN-95 FISHERIES BRANCH, SURREY: FISHERIES FILES: INVENTORY; ENHANCEMENT; | 506490 | 5436799 |
| Big Slough, south of Highway 99 | BMC, BNH, CC, PMB, RSC, TSB | 1995, 2009 | - | 01-JAN-95 FISHERIES BRANCH, SURREY: FISHERIES FILES: INVENTORY; ENHANCEMENT; BIOPHYSICAL DATA; andamp; RECORDS OF PERSONAL COMMUNICATION | 505901 | 5437116 |
| Big Slough, south of Highway 99 | ACT, BNH, CC, CH, CO, CT, GC, L, PCC, RB, RL, SP, TSB | 1994, 1995, 2006, 2009, 2010 | - | 01-JAN-95 FISHERIES BRANCH, SURREY: FISHERIES FILES: INVENTORY; ENHANCEMENT; BIOPHYSICAL DATA; andamp; RECORDS OF PERSONAL COMMUNICATION | 506296 | 5436821 |
| Big Slough, south of Highway 99 | BNH, FM, GC, TSB | 2011 | Marlim Ecological Consulting Ltd. | Project ID/Name: 27672/Fish Salvage Big Slough Culvert Relining - 2011; SU11-71628 | 505964 | 5437482 |
| Big Slough, north of Highway 99 | PMB | 2010 | Dillon Consulting Limited | Project ID/Name: 27734/Fish salvage From Various Sites Region 2 - 2010; SU10-63886 | 505979 | 5437716 |
| Big Slough, north of Highway 99 | BH, CBC, PMB, TSB | 2008 | Marlim Ecological Consulting Ltd. | Project ID/Name: 23506/Big Slough Culvert Re-Lining Salvage - 2008; SU08-45308 | 505888 | 5437598 |
| 112 Street Ditch, north of Highway 99 | TSB | 2012 | Nova Pacific Environmental | Project ID/Name: 28466/Site Assessment Salvage HWY 99 at 112 Delta-2012; SU12-82265 | 506366 | 5437639 |
| Oliver Slough | PMB, SB | 2010 | Hemmera | Project ID/Name: 27450/SFPR Inventory - 2010; SU10-59922a | 506882 | 5437606 |
| Highway 91 Interchange South Outer Ditch | TSB | 2011 | Hemmera | Project ID/Name: 28334/South Fraser Perimeter Road Fish Salvage - 2011; SU11-70849 | 507820 | 5437594 |
| Highway 91 Interchange South Outer Ditch | TSB | 2011 | Hemmera | Project ID/Name: 28334/South Fraser Perimeter Road Fish Salvage - 2011; SU11-70849 | 507821 | 5437600 |
| Highway 91 Interchange South Outer Ditch | TSB | 2011 | Hemmera | Project ID/Name: 28334/South Fraser Perimeter Road Fish Salvage - 2011; SU11-70849 | 507801 | 5437559 |
| Highway 91 Interchange South Outer Ditch | TSB | 2011 | Hemmera | Project ID/Name: 28334/South Fraser Perimeter Road Fish Salvage - 2011; SU11-70849 | 507818 | 5437588 |

(1) Refer to Appendix B, Table 2 for species codes
 " - " Not available

| Watercourse Name | Species Code ¹ | Year Documented | Company | Project Information | Easting | Northing |
|--|---------------------------|-----------------|-----------------------------------|--|---------|----------|
| Highway 91 Interchange South Outer Ditch | TSB | 2011 | Hemmera | Project ID/Name: 28334/South Fraser Perimeter Road Fish Salvage - 2011; SU11-70849 | 507826 | 5437633 |
| Highway 91 Interchange South Outer Ditch | CAS, PMB, SB | 2010 | Hemmera | Project ID/Name: 27450/SFPR Inventory - 2010; SU10-59922a | 507683 | 5437474 |
| Highway 91 Interchange South Outer Ditch | TSB | 2011 | Hemmera | Project ID/Name: 28334/South Fraser Perimeter Road Fish Salvage - 2011; SU11-70849 | 507829 | 5437647 |
| Highway 91 Interchange South Outer Ditch | TSB | 2011 | Marlim Ecological Consulting Ltd. | Project ID/Name: 28373/Maxxam Stickleback Collection - 2011; SU11-68562 | 507827 | 5437638 |

(1) Refer to Appendix B, Table 2 for species codes
 " – " Not available

Table B2 Complete List of Fish Species Previously Documented Within the Study Area

| Common Name | Scientific Name | Species Code | Comments |
|--|-------------------------------------|--------------|----------|
| Native Species | | | |
| Anadromous cutthroat trout | <i>Oncorhynchus clarki</i> | ACT | - |
| Brassy Minnow | <i>Hybognathus hankinsoni</i> | BMC | - |
| Bull Trout | <i>Salvelinus confluentus</i> | BT | - |
| Chinook Salmon | <i>Oncorhynchus tshawytscha</i> | CH | - |
| Chub, General | | CBC | |
| Chum Salmon | <i>Oncorhynchus keta</i> | CM | - |
| Coastal Cutthroat Trout | <i>Oncorhynchus clarkii clarkii</i> | CCT | - |
| Coastrange Sculpin (formerly Aleutian Sculpin) | <i>Cottus aleuticus</i> | CAL | - |
| Coho Salmon | <i>Oncorhynchus kisutch</i> | CO | - |
| Cutthroat Trout, General | <i>Oncorhynchus clarki</i> | CT | |
| Dolly Varden | <i>Salvelinus malma</i> | DV | - |
| Eulachon | <i>Thaleichthys pacificus</i> | EU | - |
| Green Sturgeon | <i>Acipenser medirostris</i> | GSG | - |
| Kokanee | <i>Oncorhynchus nerka</i> | KO | - |
| Lamprey | <i>Lampetra</i> spp. | L | - |
| Largescale Sucker | <i>Catostomus macrocheilus</i> | CSU | - |
| Leopard Dace | <i>Rhinichthys falcatus</i> | LDC | - |

| Common Name | Scientific Name | Species Code | Comments |
|----------------------------------|----------------------------------|--------------|--|
| Longfin Smelt | <i>Spirinchus thaleichthys</i> | LSM | - |
| Longnose Sucker | <i>Catostomus catostomus</i> | LSU | Species in the lower Fraser Valley is genetically distinct from <i>C. catostomus</i> |
| Longnose Dace | <i>Rhinichthys cataractae</i> | LNC | Those in Fraser system are genetically distinct from Nooksack tributaries |
| Mountain Whitefish | <i>Prosopium williamsoni</i> | MW | - |
| Northern Pikeminnow | <i>Ptychocheilus oregonensis</i> | NSC | - |
| Pacific Lamprey | <i>Lampetra tridentata</i> | PL | - |
| Peamouth Chub | <i>Mylocheilus caurinus</i> | PCC | - |
| Pink Salmon | <i>Oncorhynchus gorbuscha</i> | PK | - |
| Prickly Sculpin | <i>Cottus asper</i> | CAS | - |
| Rainbow Trout | <i>Oncorhynchus mykiss</i> | RB | - |
| Redside Shiner | <i>Richardsonius balteatus</i> | RSC | - |
| River Lamprey | <i>Lampetra ayresii</i> | RL | - |
| Sculpins, General | <i>Cottus spp</i> | CC | - |
| Sockeye Salmon | <i>Oncorhynchus nerka</i> | SO | - |
| Species Present (not identified) | <i>n/a</i> | SP | - |
| Staghorn Sculpin | <i>Leptocottus armatus</i> | CLA | Estuarine or Tidal (McPhail and Corveth 1993) |
| Starry Flounder | <i>Platichthys stellatus</i> | SFL | Estuarine or Tidal (McPhail and Corveth 1993) |
| Steelhead | <i>Oncorhynchus mykiss</i> | ST | - |

| Common Name | Scientific Name | Species Code | Comments |
|---|---------------------------------|--------------|--|
| Surf Smelt | <i>Hypomesus pretiosus</i> | none | - |
| Threespine Stickleback | <i>Gasterosteus aculeatus</i> | TSB | - |
| Western Brook Lamprey | <i>Lampetra richardsoni</i> | BL | - |
| White Sturgeon | <i>Acipenser transmontanus</i> | WSU | - |
| Native Species | | | |
| Bridgelip Sucker | <i>Catostomus columbianus</i> | BSU | Presence in lower Fraser known from a single specimen (McPhail and Corveth 1993) |
| Burbot | <i>Lota lota</i> | BT | Peripheral range only (iMap BC 2014), presence in lower Fraser known from a single specimen (McPhail and Corveth 1993) |
| Lake Trout | <i>Salvelinus namaycush</i> | LT | Exotic in study area (iMap BC 2014), presence in lower Fraser known from a single specimen (McPhail and Corveth 1993) |
| Northern Mountain Sucker | <i>Catostomus platyrhynchus</i> | MSU | Presence in lower Fraser known from a single specimen (McPhail and Corveth 1993) |
| Introduced Species | | | |
| American Shad | <i>Alosa sapidissima</i> | SH | - |
| Black Crappie | <i>Pomoxis nigromaculatus</i> | BCB | - |
| Brook Trout | <i>Salvelinus fontinalis</i> | EB | - |
| Brown Catfish (formerly Brown Bullhead) | <i>Ameiurus nebulosus</i> | BNH | - |
| Catfish | - | BH | - |
| Carp | <i>Cyprinus carpio</i> | CP | - |
| Fathead Minnow | <i>Pimephales promelas</i> | FM | - |

| Common Name | Scientific Name | Species Code | Comments |
|--------------------|---------------------------------------|---------------------|-----------------|
| Golden Trout | <i>Oncorhynchus mykiss aguabonita</i> | GT | - |
| Goldfish | <i>Carassius auratus</i> | GC | - |
| Lake Whitefish | <i>Coregonus clupeaformis</i> | LW | - |
| Largemouth Bass | <i>Micropterus salmoides</i> | LMB | - |
| Pumpkinseed | <i>Lepomis gibbosus</i> | PMB | - |

Table B3 Complete List of Fish Species Previously Documented Within the Study Area

| Watercourse Reference # | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|--------------------------------|---------------------------------|-----------------------------|----------------------------|--------------------------|--------------------------|--|--|---|--|---|
| Watercourse Name | Bridgeport Road Ditch North | Bridgeport Road Ditch South | Patterson Road Ditch North | Tuttle Avenue Ditch West | Tuttle Avenue Ditch East | Highway 99 Ditch West (between Cambie Road and Shell Road) | Shell Road Ditch East, north of Highway 99 | Highway 99 Ditch East (between Shell Road and Highway 91) | Highway 99 Ditch Southwest (between Shell Road and Highway 91) | Highway 99 Ditch Northeast (between Highway 91 and Westminster Highway) |
| Watercourse Type | Ditch | Swale | Ditch | Ditch, Permanent | Ditch, Permanent | Swale | Ditch | Roadside Ditch | Roadside Ditch | Roadside Ditch/Slough |
| Assessment Type | Detailed | Photos /online imagery | Detailed | Detailed | Photos /online imagery | Photos /online imagery | Photos /online imagery | Photos /online imagery | Photos /online imagery | Detailed |
| Channel Width (m) ¹ | 3.0 | 1.0 | 2.2 | 5.8 | 6.0 | 6.0 | 6.0 | 4.0 | 1.0 | 7.0 |
| Wetted Width (m) ¹ | 0.0 | 0.5 | 2.0 | 4.0 | 3.6 | 0.5 | 5.0 | 4.0 | 0.5 | 4.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Moderate (30 - 90% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | Moderate 5-20% | Trace <5% | None | Trace <5% | Trace <5% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% |
| Small woody debris amount | none | none | none | none | none | none | none | none | none | none |
| Large woody debris amount | none | none | none | none | none | none | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | none | trace | none | none | none | none | none | none | none |
| Deep Pools Amount | trace | none | none | none | none | none | trace | none | none | none |
| Overhanging Vegetation Amount | dominant | none | dominant | dominant | dominant | dominant | dominant | sub-dominant | dominant | sub-dominant |
| Instream Vegetation Amount | trace | dominant | sub-dominant | sub-dominant | sub-dominant | sub-dominant | sub-dominant | dominant | sub-dominant | dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 |
|------------------------------|---|--------------------------------------|--|--|------------------------------------|--|--|---|--|---|
| Watercourse Name | Bridgeport Road Ditch North | Bridgeport Road Ditch South | Patterson Road Ditch North | Tuttle Avenue Ditch West | Tuttle Avenue Ditch East | Highway 99 Ditch West (between Cambie Road and Shell Road) | Shell Road Ditch East, north of Highway 99 | Highway 99 Ditch East (between Shell Road and Highway 91) | Highway 99 Ditch Southwest (between Shell Road and Highway 91) | Highway 99 Ditch Northeast (between Highway 91 and Westminster Highway) |
| Crown Closure | 1-20% | 0% | 0% | 0% | 0% | 1-20% | 0% | 1-20% | 1-20% | 1-20% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Channel Pattern | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight |
| Riparian Description | North bank is mix of cut and uncut grass, south bank is grassed road shoulder | Both banks are grassed road shoulder | North bank is residential yards, south bank is grassed road shoulder | Left and right banks are covered with blackberries | Left and right banks are cut grass | South bank is fringe of shrubs then residential road, north bank is grassed Highway shoulder | Left bank is grassed road shoulder, right bank is fringe of blackberries, then railway | East bank is fringe of uncut grass then road shoulder, west bank is blackberries on slope to Highway 99 | East and west banks are fringe of blackberries, then road shoulder | West bank is grassed shoulder transitioning to mixed forest at the north end, east bank is mixed forest |
| Vegetated Riparian Width (m) | <15 (north) / <5 (south) | <5 (both) | <15 (north) / <15 (south) | <15 (left) / <15 (right) | >30 (left) / <30 (right) | <5 (south) / <5 (north) | <5 (left) / <15 (right) | <5 (east) / <15 (west) | <5 (east) / >5 (west) | <15 (west) / >30 (east) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|--------------------------------|---|---|---|---|---|---|---|--|---|--------------------------------|--------------------------------|--------------------------------|--------------------------------|
| Watercourse Name | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | Westminster Highway Ditch North, east of Highway 99 | Westminster Highway Ditch South, east of Highway 99 | Westminster Highway Ditch North, west of Highway 99 | Highway 99 Ditch East (between Westminster Highway and Blundell Road) | Highway 99 Ditch West (between Westminster Highway and Blundell Road) | Blundell Road Ditch South, east of Highway 99 | Highway 99 Ditch East (between Blundell and Steveston) | Highway 99 Ditch West (between Blundell Road and Steveston Highway) | Richmond Agricultural Ditch #1 | Richmond Agricultural Ditch #2 | Richmond Agricultural Ditch #3 | Richmond Agricultural Ditch #4 |
| Watercourse Type | Roadside Ditch/ Slough | Ditch | Ditch | Ditch | Roadside Ditch/Slough | Roadside Ditch/Slough | Ditch | Roadside Ditch/Slough | Roadside Ditch/Slough | Ditch | Ditch | Ditch | Ditch |
| Assessment Type | Photos /online imagery | Detailed | Detailed | Photos /online imagery | Photos /online imagery | Photos /online imagery | Detailed | Detailed | Detailed | Photos /online imagery | Photos /online imagery | Photos /online imagery | Photos /online imagery |
| Channel Width (m) ¹ | 5.0 | 3.0 | 7.0 | 0.0 | 7.0 | 4.0 | 3.5 | 7.0 | 9.5 | 3.0 | 1.0 | 3.5 | 4.0 |
| Wetted Width (m) ¹ | 2.0 | 0.0 | 3.0 | 0.0 | 3.0 | 4.0 | 2.0 | 3.0 | 7.0 | 1.5 | 0.5 | 2.0 | 1.5 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Moderate (30 - 90% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | Moderate 5-20% | Abundant >20% | Abundant >20% | None | Moderate 5-20% | Moderate 5-20% | Trace <5% | Trace <5% | Trace <5% | Moderate 5-20% | Trace <5% | Moderate 5-20% | Moderate 5-20% |
| SWD Amount | none | trace | none | none | none | none | none | none | none | none | none | none | none |
| LWD Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | trace | trace | none | trace | none | none | none | trace | none | none | none | none |
| Deep Pools Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Overhanging Vegetation Amount | sub-dominant | dominant | dominant | none | dominant | dominant | trace | trace | dominant | sub-dominant | sub-dominant | dominant | dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 |
|------------------------------|---|---|--|--|---|---|--|---|---|--|--|---|--|
| Watercourse Name | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | Westminster Highway Ditch North, east of Highway 99 | Westminster Highway Ditch South, east of Highway 99 | Westminster Highway Ditch North, west of Highway 99 | Highway 99 Ditch East (between Westminster Highway and Blundell Road) | Highway 99 Ditch West (between Westminster Highway and Blundell Road) | Blundell Road Ditch South, east of Highway 99 | Highway 99 Ditch East (between Blundell and Steveston) | Highway 99 Ditch West (between Blundell Road and Steveston Highway) | Richmond Agricultural Ditch #1 | Richmond Agricultural Ditch #2 | Richmond Agricultural Ditch #3 | Richmond Agricultural Ditch #4 |
| Instream Vegetation Amount | dominant | sub-dominant | sub-dominant | none | sub-dominant | sub-dominant | dominant | dominant | trace | trace | trace | trace | sub-dominant |
| Crown Closure | 0% | >90% | 21-40% | 1-20% | 21-40% | 21-40% | 0% | 0% | 0% | 0% | 21-40% | 21-40% | 1-20% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Channel Pattern | straight | straight | straight | sinuous | straight | straight | straight | straight | straight | straight | straight | straight | straight |
| Riparian Description | West bank is principally grass with shrubs and some mixed forest, east bank is grassed Highway shoulder | North bank is mixed forest, south bank is grassed road shoulder | North bank is grassed road shoulder, south bank is mix of shrubs and residential yards | South bank is grassed road shoulder, north bank is mix of grass and shrubs with intermittent trees | West bank is grassed Highway shoulder, east bank is fringe of trees and shrubs, then mix of agricultural fields and industrial area | West bank is mixed forest, east bank is grassed Highway shoulder | North bank is grassed road shoulder, south bank is fringe of grass then residential shrubs and yards | West bank is grassed Highway shoulder, east bank is fringe of shrubs then agricultural fields | West bank is fringe of blackberries then agricultural and old fields, east bank is grassed Highway shoulder | North bank is fringe of uncut grass and cedars then agricultural fields, south bank is fringe of uncut grass then agricultural field | North bank is agricultural field, south bank is fringe of cedars and deciduous trees, then agricultural fields | North bank is agricultural field, south bank is fringe of deciduous trees, then agricultural fields | Both banks are fringe of blackberries with cedar hedge on north bank, then agricultural fields |
| Vegetated Riparian Width (m) | >30 (west) / <5 (east) | >30 (north) / >15 (south) | <5 (north) / <15 (south) | <15 (south) / >30 (north) | <15 (west) / >30 (east) | >30 (west) / <15 (east) | <5 (north) / <5 (south) | <15 (west) / >30 (east) | >30 (west) / <15 (east) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / >30 (south) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 |
|--------------------------------|---------------------------------|---------------------------------|--|--|-------------------------------------|-------------------------------------|---|---|--------------------------------|--------------------------------|---|---|---|
| Watercourse Name | Richmond Agricultural Ditch # 5 | Richmond Agricultural Ditch # 6 | Richmond Agricultural Ditch #7, east of Highway 99 | Richmond Agricultural Ditch #7, west of Highway 99 | King Road Ditch, west of Highway 99 | King Road Ditch, east of Highway 99 | Williams Road Ditch, east of Highway 99 | Williams Road Ditch, west of Highway 99 | Richmond Agricultural Ditch #8 | Richmond Agricultural Ditch #9 | Steveston Highway Ditch North, east of Highway 99 | Steveston Highway Interchange Northwest Ditch | Steveston Highway Ditch South, east of Highway 99 |
| Watercourse Type | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch |
| Assessment Type | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Detailed | Photos / online imagery | Detailed |
| Channel Width (m) ¹ | 1.0 | 1.0 | 0.5 | 0.0 | 4.0 | 4.0 | 4.0 | 3.0 | 0.5 | 0.5 | 5.9 | 1.0 | 4.0 |
| Wetted Width (m) ¹ | 0.0 | 0.5 | 0.3 | 0.0 | 2.0 | 2.0 | 1.5 | 1.5 | 0.0 | 0.0 | 0.0 | 0.0 | 1.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Moderate (30 - 90% of bankfull) | Moderate (30 - 90% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | None | Trace <5% | Trace <5% | None | Trace <5% | Trace <5% | Moderate 5-20% | Trace <5% | None | None | Moderate 5-20% | Trace <5% | Moderate 5-20% |
| SWD Amount | none | none | none | trace | none | none | none | none | none | none | none | none | none |
| LWD Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Deep Pools Amount | none | none | none | none | trace | trace | none | none | none | none | none | none | none |
| Overhanging Vegetation Amount | none | sub-dominant | sub-dominant | none | dominant | dominant | dominant | dominant | none | none | sub-dominant | none | sub-dominant |
| Instream Vegetation Amount | none | trace | trace | none | sub-dominant | sub-dominant | sub-dominant | sub-dominant | none | none | dominant | dominant | dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 29 | 30 | 31 | 32 | 33 | 34 | 35 | 36 | 37 | 38 | 39 | 40 | 41 | |
|------------------------------|--|--|---|---|--|---|---|---|---|--|--|--|--|---|
| Watercourse Name | Richmond Agricultural Ditch # 5 | Richmond Agricultural Ditch # 6 | Richmond Agricultural Ditch #7, east of Highway 99 | Richmond Agricultural Ditch #7, west of Highway 99 | King Road Ditch, west of Highway 99 | King Road Ditch, east of Highway 99 | Williams Road Ditch, east of Highway 99 | Williams Road Ditch, west of Highway 99 | Richmond Agricultural Ditch #8 | Richmond Agricultural Ditch #9 | Steveston Highway Ditch North, east of Highway 99 | Steveston Highway Interchange Northwest Ditch | Steveston Highway Ditch South, east of Highway 99 | |
| Crown Closure | 1-20% | 1-20% | 0% | 0% | 1-20% | 1-20% | 21-40% | 21-40% | 0% | 0% | 0% | 0% | 41-70% | |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | |
| Channel Pattern | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | |
| Riparian Description | North bank is fringe of blackberries then agricultural field, right bank is agricultural field | Both banks are fringe of blackberries then agricultural fields | North bank is fringe of grass then agricultural field, south bank is fringe of shrubs with occasional deciduous tree, then agricultural field | North bank is fringe of grass then agricultural field, south bank is fringe of shrubs then agricultural field | North bank is agricultural field, south bank is fringe of deciduous trees then golf course | North bank is agricultural field, south bank is fringe of deciduous trees and shrubs then golf course | North bank is fringe of deciduous trees then golf course, south bank is fringe of grass then agricultural field | North bank is fringe of deciduous trees then golf course, south bank is fringe of grass then agricultural field | North bank is fringe of coniferous trees then golf course, south bank is agricultural field | North and south banks are fringe of uncut grass then hay field | North bank is blueberry field, south bank is uncut grass | North bank is fringe of shrubs then old field, south bank is grassed road shoulder | North bank is grassed road shoulder, south bank is uncut grass | North bank is grassed road shoulder, south bank is fringe of trees then parking lot |
| Vegetated Riparian Width (m) | >30 (north) / >30 (south) | >30 (both) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / >30 (south) | >30 (north) / <30 (south) | >30 (north) / <5 (south) | <15 (north) / <30 (south) | <1 (north) / <5 (south) | |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 52 | 53 | 54 | 55 | 56 |
|--------------------------------|---|--|--|---------------------------------|----------------------------------|---------------------------------|----------------------------|----------------------------|-------------------------|---|---|---|---|
| Watercourse Name | Steveston Highway Interchange Southeast Ditch | Highway 99 Ditch East (between Steveston Highway and Fraser River) | Highway 99 Ditch West (between Steveston Highway and Fraser River) | Richmond Agricultural Ditch #10 | Jacobsen Way/Hartnell Road Ditch | Richmond Agricultural Ditch #11 | Rice Mill Road Ditch North | Rice Mill Road Ditch South | Green Slough | River Road Ditch Northwest, north of Highway 99 | River Road Ditch Southeast, south of Highway 99 | Highway 99 Ditch Northeast (between River Road and Highway 17A) | Highway 99 Ditch Southwest (between River Road and Highway 17A) |
| Watercourse Type | Ditch | Roadside Ditch | Roadside Ditch/ slough, Permanent | Ditch | Ditch | Ditch | Ditch | Ditch | Slough, Permanent | Ditch | Ditch | Roadside Ditch | Roadside Ditch |
| Assessment Type | Photos / online imagery | Photos / online imagery | Detailed | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Detailed | Detailed | Photos / online imagery | Photos / online imagery | Photos / online imagery |
| Channel Width (m) ¹ | 0.5 | 1.0 | 4.0 | 2.0 | 7.0 | 3.0 | 3.0 | 3.0 | 30.0 | 3.9 | 5.0 | 4.0 | 5.0 |
| Wetted Width (m) ¹ | 0.0 | 0.5 | 5.0 | 1.0 | 4.0 | 0.5 | 1.0 | 0.0 | 13.0 | 2.0 | 3.0 | 2.0 | 3.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.0 | 0.5 | 1.0 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | None | Trace <5% | Moderate 5-20% | Moderate 5-20% | Trace <5% | Moderate 5-20% | Trace <5% | Trace <5% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% |
| SWD Amount | none | none | none | none | none | none | none | none | trace | none | none | none | none |
| LWD Amount | none | none | none | none | none | none | none | none | sub-dominant | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | none | trace | none | none | none | none | none | trace | none | none | none | none |
| Deep Pools Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Overhanging Vegetation Amount | none | trace | dominant | dominant | trace | trace | none | none | dominant | sub-dominant | sub-dominant | dominant | sub-dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 42 | 43 | 44 | 45 | 46 | 47 | 48 | 49 | 52 | 53 | 54 | 55 | 56 |
|------------------------------|--|---|--|--|--|--|--|--|--|---|---|--|--|
| Watercourse Name | Steveston Highway Interchange Southeast Ditch | Highway 99 Ditch East (between Steveston Highway and Fraser River) | Highway 99 Ditch West (between Steveston Highway and Fraser River) | Richmond Agricultural Ditch #10 | Jacobsen Way/Hartnell Road Ditch | Richmond Agricultural Ditch #11 | Rice Mill Road Ditch North | Rice Mill Road Ditch South | Green Slough | River Road Ditch Northwest, north of Highway 99 | River Road Ditch Southeast, south of Highway 99 | Highway 99 Ditch Northeast (between River Road and Highway 17A) | Highway 99 Ditch Southwest (between River Road and Highway 17A) |
| Instream Vegetation Amount | none | sub-dominant | sub-dominant | trace | sub-dominant | sub-dominant | trace | trace | trace | dominant | dominant | sub-dominant | dominant |
| Crown Closure | 0% | 1-20% | 1-20% | 0% | 41-70% | 0% | 1-20% | 41-70% | 21-40% | 21-40% | 1-20% | 0% | 1-20% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Channel Pattern | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight |
| Riparian Description | Outer bank is grassed road shoulder, inner bank is cut grass | Right bank is grassed Highway shoulder, left bank is a fringe of trees then agricultural field or parking lot | Left bank is grassed Highway shoulder, right bank is fringe of blackberries then parking lot or grass fields | North bank is agricultural field, south bank is fringe of shrubs then agricultural field | Left and right banks are mix of uncut grass and deciduous forest | North bank is fringe of shrubs then old field, south bank is cut grass | North bank is fringe of uncut grass and shrubs then cut grass field, south bank is grassed road shoulder | North bank is grassed road shoulder, south bank is fringe of deciduous trees then parking lot or cut grass | West bank is deciduous forest, east bank is grassed road shoulder with intermittent shrubs and deciduous trees | North bank is fringe of blackberries then road/trail shoulder, south bank is fringe of shrubs then agricultural field | North bank is fringe of blackberries then grassed road shoulder, south bank is fringe of blackberries then agricultural field | West bank is fringe of blackberries then agricultural field, east bank is grassed Highway shoulder | West bank is grassed Highway shoulder, east bank is uncut grass with shrubs then agricultural fields |
| Vegetated Riparian Width (m) | <15 (outer) / >30 (inner) | <15 (right) / <30 (left) | <15 (left) / <15 (right) | >30 (north) / >30 (south) | <30 (left) / >30 (right) | >30 (north) / >30 (south) | >30 (north) / <5 (south) | <5 (north) / <15 (south) | <15 (west) / <30 (east) | <15 (north) / >30 (south) | <15 (north) / >30 (south) | >30 (west) (east) / <15 | <15 (west) / >30 (east) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 57 | 58 | 59 | 60 | 61 | 62 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
|--------------------------------|--|--|-----------------------------|--|---|---|-----------------------------|-----------------------------|--|--|---|---|-----------------------------|
| Watercourse Name | Highway 99 Ditch Northeast (between Highway 17A and 64 St) | Highway 99 Ditch Southwest (between Highway 17A and 64 St) | Delta Agricultural Ditch #1 | Burns Drive Ditch Northeast (between 64 St and SFPR) | Highway 99 Ditch Southwest (between 64 St and SFPR) | 64 Street Ditch East, north of Highway 99 | Delta Agricultural Ditch #2 | Delta Agricultural Ditch #4 | Crescent Slough, northeast of Highway 99 | Crescent Slough, southwest of Highway 99 | Highway 99 Ditch North (between SFPR and Ladner Trunk Road) | Highway 99 Ditch South (between SFPR and Ladner Trunk Road) | Delta Agricultural Ditch #6 |
| Watercourse Type | Roadside Ditch | Roadside Ditch | Ditch | Roadside Ditch | Roadside Ditch | Ditch | Ditch | Ditch | Slough, Permanent | Slough, Permanent | Roadside Ditch | Roadside Ditch | Ditch |
| Assessment Type | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Detailed | Detailed | Detailed | Photos / online imagery | Photos / online imagery | Detailed | Photos / online imagery | Photos / online imagery | Detailed |
| Channel Width (m) ¹ | 1.5 | 1.5 | 1.5 | 8.0 | 3.0 | 8.0 | 2.8 | 0.8 | 11.0 | 10.8 | 1.0 | 2.0 | 3.3 |
| Wetted Width (m) ¹ | 0.5 | 0.5 | 0.5 | 3.0 | 0.0 | 3.0 | 2.0 | 0.3 | 7.0 | 7.0 | 0.0 | 0.0 | 2.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | Moderate 5-20% | Trace <5% | None | Trace <5% | Abundant >20% | Trace <5% | Moderate 5-20% | Moderate 5-20% | Trace <5% | Trace <5% | Moderate 5-20% | Trace <5% | Trace <5% |
| SWD Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| LWD Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Deep Pools Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Overhanging Vegetation Amount | trace | trace | none | trace | sub-dominant | trace | dominant | dominant | trace | trace | dominant | none | sub-dominant |
| Instream Vegetation Amount | sub-dominant | sub-dominant | trace | dominant | dominant | trace | sub-dominant | sub-dominant | dominant | dominant | sub-dominant | sub-dominant | dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 57 | 58 | 59 | 60 | 61 | 62 | 64 | 65 | 66 | 67 | 68 | 69 | 70 |
|------------------------------|---|---|--|---|---|---|--|--|--|---|---|--|---|
| Watercourse Name | Highway 99 Ditch Northeast (between Highway 17A and 64 St) | Highway 99 Ditch Southwest (between Highway 17A and 64 St) | Delta Agricultural Ditch #1 | Burns Drive Ditch Northeast (between 64 St and SFPR) | Highway 99 Ditch Southwest (between 64 St and SFPR) | 64 Street Ditch East, north of Highway 99 | Delta Agricultural Ditch #2 | Delta Agricultural Ditch #4 | Crescent Slough, northeast of Highway 99 | Crescent Slough, southwest of Highway 99 | Highway 99 Ditch North (between SFPR and Ladner Trunk Road) | Highway 99 Ditch South (between SFPR and Ladner Trunk Road) | Delta Agricultural Ditch #6 |
| Crown Closure | 0% | 0% | 0% | 0% | 0% | 0% | 1-20% | 0% | 0% | 0% | 0% | 0% | 0% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Channel Pattern | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight |
| Riparian Description | North bank is agricultural field, south bank is grassed road shoulder | North bank is grassed highway shoulder, south bank is agricultural fields | Left and right banks are fringe of uncut grass, then agricultural fields | North bank is occasional shrub or tree then agricultural field, south bank is grassed road shoulder | North bank is grassed Highway shoulder, south bank is agricultural fields with section of parking lot | West bank is grassed road shoulder, east bank is fringe of grass then paved parking lot | Left and right banks are both fringe of uncut grass then agricultural fields | North and south ditches are fringe of uncut grass then agricultural fields | West bank is agricultural field, east bank is fringe of deciduous trees and grass, then road | West bank is agricultural field, east bank is agricultural field with occasional deciduous tree along bank edge | South bank is grassed Highway shoulder, north bank is grassed road shoulder | South bank is mix of agricultural fields and road shoulder, north bank is grassed Highway shoulder | Left and right banks are agricultural field |
| Vegetated Riparian Width (m) | >30 (north) / <5 (south) | <15 (north) / >30 (south) | >30 (left) / >30 (right) | <5 (north) / >30 (south) | <15 (north) / >30 (south) | <5 (west) / <5 (east) | >30 (left) / >30 (right) | >30 (north) / >30 (south) | >30 (west) / <30 (east) | >30 (west) / >30 (east) | <15 (south) / <5 (north) | <15 (south) / <5 (north) | >30 (left) / >30 (right) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 81 | 82 |
|--------------------------------|--------------------------------------|-----------------------------|-----------------------------|-----------------------------|---|---|------------------------------|------------------------------|---|---|--|--|----------------------------|
| Watercourse Name | SFPR Ditch West, north of Highway 99 | Delta Agricultural Ditch #7 | Delta Agricultural Ditch #8 | Delta Agricultural Ditch #9 | 72 Street Ditch West, south of Highway 99 | 72 Street Ditch East, south of Highway 99 | Delta Agricultural Ditch #10 | Delta Agricultural Ditch #11 | 80 street Ditch West, south of Highway 99 | 80 Street Ditch East, south of Highway 99 | Burns Drive Ditch North (between SFPR and Ladner Trunk Road) | Burns Drive Ditch North (between SFPR and Ladner Trunk Road) | Burns Drive Cross-Ditch #1 |
| Watercourse Type | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Roadside Ditch | Ditch |
| Assessment Type | Detailed | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Detailed | Photos / online imagery | Detailed | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery |
| Channel Width (m) ¹ | 5.4 | 1.5 | 2.0 | 0.5 | 5.0 | 5.5 | 3.0 | 2.5 | 3.0 | 4.5 | 2.0 | 2.0 | 1.5 |
| Wetted Width (m) ¹ | 4.0 | 0.5 | 0.5 | 0.0 | 2.5 | 3.0 | 2.0 | 2.0 | 1.5 | 2.5 | 1.0 | 1.0 | 1.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Moderate (30 - 90% of bankfull) | Moderate (30 - 90% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | Trace <5% | Trace <5% | Trace <5% | None | Moderate 5-20% | Moderate 5-20% | Trace <5% | Moderate 5-20% | Trace <5% | Moderate 5-20% | Trace <5% | Trace <5% | Abundant >20% |
| SWD Amount | none | none | none | none | none | trace | none | none | none | none | none | none | trace |
| LWD Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Deep Pools Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Overhanging Vegetation Amount | dominant | none | trace | none | dominant | sub-dominant | dominant | dominant | none | sub-dominant | none | none | dominant |
| Instream Vegetation Amount | sub-dominant | trace | sub-dominant | none | trace | dominant | trace | trace | sub-dominant | dominant | trace | trace | sub-dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 71 | 72 | 73 | 74 | 75 | 76 | 77 | 78 | 79 | 80 | 81 | 81 | 82 |
|------------------------------|--|---|---|---|--|---|--|--|---|--|---|---|--|
| Watercourse Name | SFPR Ditch West, north of Highway 99 | Delta Agricultural Ditch #7 | Delta Agricultural Ditch #8 | Delta Agricultural Ditch #9 | 72 Street Ditch West, south of Highway 99 | 72 Street Ditch East, south of Highway 99 | Delta Agricultural Ditch #10 | Delta Agricultural Ditch #11 | 80 street Ditch West, south of Highway 99 | 80 Street Ditch East, south of Highway 99 | Burns Drive Ditch North (between SFPR and Ladner Trunk Road) | Burns Drive Ditch North (between SFPR and Ladner Trunk Road) | Burns Drive Cross-Ditch #1 |
| Crown Closure | 0% | 0% | 0% | 0% | 0% | 0% | 1-20% | 1-20% | 0% | 1-20% | 0% | 0% | 41-70% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Channel Pattern | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight |
| Riparian Description | Both banks are fringe of grass, then road shoulder | Left and right banks are agricultural field | Left and right banks are agricultural field | Left and right banks are agricultural field | West bank is grassed road shoulder, east bank is fringe of shrubs and deciduous trees then grass | North bank is grassed road shoulder, south bank is agricultural field | West bank is fringe of uncut grass then agricultural field, east bank is old field | West bank is uncut grass, east bank is blueberry field | Left bank is grassed road shoulder, right bank is uncut grass | Left bank is shrubs and uncut grass, right bank is grassed road shoulder | South bank is grassed road shoulder, north bank is agricultural field | South bank is grassed road shoulder, north bank is agricultural field | North of highway both banks are mix of grass and shrubs, south of highway both banks are cut grass |
| Vegetated Riparian Width (m) | <15 (both) | >30 (left) / >30 (right) | >30 (left) / >30 (right) | >30 (left) / >30 (right) | >5 (west) / <30 (east) | <5 (north) / >30 (south) | >30 (west) / >30 (east) | >30 (west) / >30 (east) | <5 (left) / >30 (right) | <30 (left) / <5 (right) | <5 (south) / >30 (north) | <5 (south) / >30 (north) | >30 (north) / >30 (south) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 83 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 |
|--------------------------------|----------------------------|---|---|---|---|------------------------------|------------------------------|---|---|------------------------------|---|---|---|
| Watercourse Name | Burns Drive Cross-Ditch #2 | 88 Street Ditch East, north of Highway 99 | 88 Street Ditch East, south of Highway 99 | 88 Street Ditch West, north of Highway 99 | 88 Street Ditch West, south of Highway 99 | Delta Agricultural Ditch #18 | Delta Agricultural Ditch #14 | Delta Agricultural Ditch #15, north of Highway 99 | Delta Agricultural Ditch #15, south of Highway 99 | Delta Agricultural Ditch #17 | Ladner Trunk Road Interchange Southwest Inner Ditch | Ladner Trunk Road Interchange Southeast Inner Ditch | Ladner Trunk Road Interchange Northwest Outer Ditch |
| Watercourse Type | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Ditch | Roadside Ditch | Roadside Ditch | Roadside Ditch |
| Assessment Type | Photos / online imagery | Detailed | Photos / online imagery | Detailed | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery | Photos / online imagery |
| Channel Width (m) ¹ | 1.0 | 8.0 | 1.5 | 8.5 | 2.5 | 4.5 | 2.5 | 2.5 | 2.0 | 2.0 | 2.0 | 1.0 | 2.5 |
| Wetted Width (m) ¹ | 0.5 | 3.0 | 1.0 | 4.0 | 1.5 | 2.5 | 0.0 | 2.0 | 1.5 | 0.0 | 0.5 | 0.0 | 0.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | Moderate 5-20% | Trace <5% | Trace <5% | Trace <5% | Trace <5% | Trace <5% | Trace <5% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% | None | None | Trace <5% |
| SWD Amount | trace | none | none | none | none | none | trace | none | none | none | none | none | none |
| LWD Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Deep Pools Amount | none | none | none | none | none | trace | none | none | none | none | none | none | none |
| Overhanging Vegetation Amount | dominant | dominant | sub-dominant | dominant | dominant | trace | dominant | trace | trace | dominant | none | none | sub-dominant |
| Instream Vegetation Amount | sub-dominant | sub-dominant | dominant | trace | sub-dominant | trace | trace | sub-dominant | sub-dominant | sub-dominant | none | none | dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 83 | 86 | 87 | 88 | 89 | 90 | 91 | 92 | 93 | 94 | 95 | 96 | 97 |
|------------------------------|---|--|--|---|--|--|---|--|---|--|---|--|--|
| Watercourse Name | Burns Drive Cross-Ditch #2 | 88 Street Ditch East, north of Highway 99 | 88 Street Ditch East, south of Highway 99 | 88 Street Ditch West, north of Highway 99 | 88 Street Ditch West, south of Highway 99 | Delta Agricultural Ditch #18 | Delta Agricultural Ditch #14 | Delta Agricultural Ditch #15, north of Highway 99 | Delta Agricultural Ditch #15, south of Highway 99 | Delta Agricultural Ditch #17 | Ladner Trunk Road Interchange Southwest Inner Ditch | Ladner Trunk Road Interchange Southeast Inner Ditch | Ladner Trunk Road Interchange Northwest Outer Ditch |
| Crown Closure | 1-20% | 0% | 0% | 0% | 0% | 0% | 1-20% | 0% | 0% | 0% | 0% | 0% | 1-20% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Channel Pattern | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight | straight |
| Riparian Description | North of Highway both banks are scrub forest, south of Highway both banks are cut grass | West bank is grassed road shoulder, east bank is mix of uncut grass and shrubs | East bank is grassed road shoulder, west bank is cut grass (agricultural field south of Ladner Trunk Road) | West bank is uncut grass and deciduous forest, east bank is grassed road shoulder | West bank is cut grass (agricultural field south of Ladner Trunk Road), east bank is grassed road shoulder | East and west banks are fringe of uncut grass then agricultural fields | West bank is fringe of uncut grass then agricultural field, fringe of trees/shrubs, then residential yard | West bank is old field, east bank is fringe of grass then agricultural field | West bank is agricultural field, east bank is grassed road shoulder | West bank is fringe of uncut grass then agricultural field, east bank is fringe of shrubs then residential road and garden | Both banks are cut grass on road shoulder | North bank is cut grass, south bank is road shoulder | South bank is grassed road shoulder, north bank is fringe of shrubs and deciduous trees then road shoulder |
| Vegetated Riparian Width (m) | >30 (north) / >30 (south) | <15 (west) / >30 (east) | <5 (east) / >30 (west) | <5 (west) / >30 (east) | >30 (west) / <5 (east) | >30 (east) / >30 (west) | >30 (west) / <15 (east) | >30 (west) / >30 (east) | >30 (west) / <5 (east) | >30 (west) / <5 (east) | >15 (both) | >15 (north) / <5 (south) | <5 (south) / <15 (north) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 98 | 99 | 100 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 |
|--------------------------------|---|---|---|---|---|------------------------------|-------------------------|-------------------------|---------------------------------|---------------------------------|---------------------------------------|---------------------------------------|-------------------------|
| Watercourse Name | Ladner Trunk Road Interchange Northeast Inner Ditch | Ladner Trunk Road Interchange Northeast Outer Ditch | Ladner Trunk Road Ditch North, east of 96 Street. | Highway 99 Ditch North (between Ladner Trunk Road and Highway 91) | Highway 99 Ditch South (between Ladner Trunk Road and Highway 91) | Delta Agricultural Ditch #16 | 104 Street Ditch | BNSF Ditch | Big Slough, south of Highway 99 | Big Slough, north of Highway 99 | 112 Street Ditch, north of Highway 99 | 112 Street Ditch, south of Highway 99 | Oliver Slough |
| Watercourse Type | Roadside Ditch | Roadside Ditch | Roadside Ditch | Roadside Ditch | Roadside Ditch | Ditch | Ditch | Ditch | Slough, Permanent | Slough, Permanent | Ditch | Ditch | Slough, Permanent |
| Assessment Type | Photos / online imagery | Photos / online imagery | Photos / online imagery | Detailed | Photos / online imagery | Detailed | Detailed | Photos / online imagery | Detailed | Detailed | Detailed | Detailed | Detailed |
| Channel Width (m) ¹ | 4.0 | 4.0 | 1.0 | 1.7 | 0.5 | 9.4 | 3.8 | 1.0 | 18.2 | 15.4 | 5.5 | 6.9 | 5.0 |
| Wetted Width (m) ¹ | 3.0 | 2.0 | 0.0 | 0.0 | 0.0 | 5.0 | 0.0 | 0.0 | 14.0 | 11.0 | 4.0 | 3.0 | 2.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | None | None | Moderate 5-20% | Trace <5% | Trace <5% | Trace <5% | Trace <5% | Trace <5% | Moderate 5-20% | Moderate 5-20% | Trace <5% | Trace <5% | Trace <5% |
| SWD Amount | none | none | none | none | none | none | none | none | none | trace | none | none | none |
| LWD Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none | none | none | none | none | none | none | none |
| Undercut Banks Amount | none | none | none | none | none | none | none | none | trace | none | none | none | trace |
| Deep Pools Amount | none | none | none | none | trace | dominant | none | none | dominant | dominant | none | none | none |
| Overhanging Vegetation Amount | none | none | dominant | sub-dominant | trace | sub-dominant | sub-dominant | trace | subdominant | trace | trace | dominant | dominant |
| Instream Vegetation Amount | none | none | sub-dominant | dominant | dominant | sub-dominant | dominant | sub-dominant | trace | subdominant | dominant | sub-dominant | sub-dominant |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 98 | 99 | 100 | 102 | 103 | 104 | 105 | 106 | 107 | 108 | 109 | 110 | 111 |
|------------------------------|--|---|---|--|---|---|---|---|---|---|--|--|---|
| Watercourse Name | Ladner Trunk Road Interchange Northeast Inner Ditch | Ladner Trunk Road Interchange Northeast Outer Ditch | Ladner Trunk Road Ditch North, east of 96 Street. | Highway 99 Ditch North (between Ladner Trunk Road and Highway 91) | Highway 99 Ditch South (between Ladner Trunk Road and Highway 91) | Delta Agricultural Ditch #16 | 104 Street Ditch | BNSF Ditch | Big Slough, south of Highway 99 | Big Slough, north of Highway 99 | 112 Street Ditch, north of Highway 99 | 112 Street Ditch, south of Highway 99 | Oliver Slough |
| Crown Closure | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% | 0% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines | fines |
| Channel Pattern | sinuous | straight | straight | straight | straight | straight | straight | sinuous | straight | straight | straight | straight | sinuous |
| Riparian Description | Outer bank is grassed road shoulder, inner bank is cut grass | Both banks are cut grass | South bank is fringe of uncut grass then road shoulder, north bank is mix of uncut grass and blackberries | North bank is fringe of uncut grass then agricultural fields, south bank is grassed highway shoulder | North bank is grassed roadside shoulder, south bank is grassed roadside shoulder or agricultural fields | North of highway both banks are fringe of uncut grass then agricultural fields, south of highway both banks are grassed roadside shoulder | North of highway both banks are fringe of shrubs then agricultural fields, south of highway west banks is mix of grassed shoulder and deciduous forest right bank is shoulder | West bank is shrubs (mainly blackberries) on slope up to railway, east bank is agricultural field | Left bank is fringe of uncut grass then agricultural field, right bank is patch of low shrubs and uncut grass | Both banks are fringe of uncut grass then agricultural fields | West bank is agricultural fields, east bank is fringe of blackberries along overpass slope | West bank is agricultural fields, east bank is fringe of blackberries along overpass slope | North of highway both banks are uncut grass and agricultural fields, south of highway both banks are fringe of uncut grass then agricultural fields |
| Vegetated Riparian Width (m) | <5 (outer) / <15 (inner) | <15 (both) | <5 (south) / >15 (north) | >30 (north) / <5 (south) | <15 (north) / <15 (south) | >30 (north) / <15 (south) | >30 (north) / >30 (south) | <30 (west) / >30 (east) | >30 (left) / >30 (right) | >30 (both) | >30 (west) / <15 (east) | >30 (west) / <15 (east) | >30 (both) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

| Watercourse Reference # | 112 | 113 | 114 | 115 | 116 | 117 |
|--------------------------------------|--|---|--|---|---|--|
| Watercourse Name | Highway 91 Interchange Ditches, south of Highway 99 | Highway 91 Interchange South Outer Ditch | Eugene Creek | Eugene Creek Diversion | Highway 99 Ditch South (between Highway 91 and Peacock Brook) | Highway 99 Ditch North (between Highway 91 and Peacock Brook) |
| Watercourse Type | Ditch | Ditch | Ditch | Ditch | Roadside Ditch | Roadside Ditch |
| Assessment Type | Photos / online imagery | Photos / online imagery | Detailed | Photos / online imagery | Photos / online imagery | Detailed |
| Channel Width (m)¹ | 3.5 | 4.5 | 14.0 | 14.0 | 3.0 | 3.0 |
| Wetted Width (m)¹ | 1.0 | 4.0 | 6.0 | 6.0 | 2.0 | 2.0 |
| Gradient | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Stage | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Low (0-30% of bankfull) | Moderate (30 - 90% of bankfull) | Low (0-30% of bankfull) |
| Total Cover | Trace <5% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% | Moderate 5-20% | Trace <5% |
| SWD Amount | none | trace | none | none | none | none |
| LWD Amount | none | trace | none | none | none | none |
| Boulders Amount | none | none | none | none | none | none |
| Undercut Banks Amount | none | trace | none | trace | none | none |
| Deep Pools Amount | trace | none | subdominant | subdominant | none | none |
| Overhanging Vegetation Amount | trace | trace | trace | trace | trace | trace |
| Instream Vegetation Amount | sub-dominant | sub-dominant | sub-dominant | sub-dominant | dominant | sub-dominant |
| Crown Closure | 1-20% | 1-20% | 0% | 1-20% | 1-20% | 0% |
| Dominant Bed Material | fines | fines | fines | fines | fines | fines |
| Subdominant Bed Material | fines | fines | fines | fines | fines | fines |
| Channel Pattern | sinuous | sinuous | sinuous | sinuous | straight | straight |
| Riparian Description | Both outer and inner banks are grassed roadside shoulder | North bank is grassed roadside shoulder, south bank is grassed trail shoulder | Left bank is long uncut grass, right bank is fringe of uncut grass then grassed highway shoulder | Both left and right banks are long, uncut grass | North bank is fringe of uncut grass then blueberry field, south bank is fringe of uncut grass then grassed highway shoulder | North bank is grassed highway shoulder, south bank is grassed trail shoulder with intermittent deciduous trees |
| Vegetated Riparian Width (m) | <30 (both) | <15 (north) / <5 (south) | >30 (left) / <15 (right) | <30 (left) / >30 (right) | >30 (north) / <15 (south) | <15 (north) / <30 (south) |

(1) Channel and Wetted Width were averaged at sites where detailed habitat assessments were conducted, and estimated based on photographs and field observations for the remaining sites.

Table B4 Spring Water Quality Data

| Watershed | Watercourse Name | Temperature (°C) B.C. WQG Criteria: 6 - 17 | Dissolved Oxygen (mg/L) B.C. WQG Criteria: >5 | pH B.C. WQG Criteria: 6.5- 9.0 | Conductivity (µS/cm) | Easting | Northing | Date/Time |
|---|---|--|--|---|-------------------------|---------|------------------|------------------|
| Lower Fraser River Middle Arm | Bridgeport Road Ditch North | 7.8 | 5.14 | 6.37 | 343 | 491308 | 5448872 | 01/04/2014 9:49 |
| | Tuttle Avenue Ditch West | 8.4 | 5.50 | 6.53 | 328 | 491723 | 5448379 | 01/04/2014 10:09 |
| | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | 9.2 | 0.63 | 6.56 | 1764 | 493620 | 5446432 | 01/04/2014 10:31 |
| | Westminster Highway Ditch North, east of Highway 99 | 10.4 | 1.16 | 5.31 | 347 | 493789 | 5446415 | 22/04/2014 13:47 |
| Lower Fraser River South Arm | Highway 99 Ditch West (between Westminster Highway and Blundell) | 8.9 | 1.77 | 6.32 | 232 | 493660 | 5445933 | 01/04/2014 10:58 |
| | Blundell Road Ditch South, east of Highway 99 | 12.4 | 0.11 | 6.29 | 356 | 493714 | 5444745 | 22/04/2014 14:07 |
| | Highway 99 Ditch West (between Blundell and Steveston) | 9.0 | 2.13 | 6.17 | 212 | 493661 | 5444535 | 01/04/2014 11:28 |
| | King Road Ditch, west of Highway 99 | 9.0 | 1.86 | 6.45 | 260 | 493649 | 5443507 | 01/04/2014 11:51 |
| | Williams Road Ditch, east of Highway 99 | 11.9 | 0.07 | 6.70 | 650 | 493702 | 5443097 | 22/04/2014 13:11 |
| | Steveston Highway Ditch North, east of Highway 99 | 14.0 | 0.70 | 6.49 | 479 | 494080 | 5442316 | 22/04/2014 14:24 |
| | Highway 99 Ditch West (between Steveston and F. River) | 10.5 | 0.21 | 6.36 | 1610 | 493941 | 5441494 | 22/04/2014 9:36 |
| | Richmond Agricultural Ditch #10 | 9.1 | 0.37 | 6.35 | 710 | 493945 | 5441745 | 22/04/2014 9:52 |
| | Jacobsen Way/Hartnell Road Ditch | 9.7 | 0.75 | 6.20 | 294 | 493659 | 5441680 | 22/04/2014 9:06 |
| | Rice Mill Road Ditch North | 10.1 | 2.86 | 6.38 | 478 | 493395 | 5441486 | 22/04/2014 9:25 |
| | River Road Ditch Southeast, south of Highway 99 | 9.9 | 1.49 | 6.52 | 625 | 495289 | 5439926 | 01/04/2014 12:12 |
| | River Road Ditch Northwest, north of Highway 99 | 10.6 | 2.65 | 6.86 | 423 | 495346 | 5439990 | 22/04/2014 10:15 |
| | Highway 99 Ditch Southwest (between 17A and 64 St) | 11.5 | 0.09 | 6.93 | 646 | 496460 | 5439040 | 01/04/2014 13:08 |
| | Highway 99 Ditch Southwest (between 64 St and SFPR) | 11.1 | 0.19 | 6.72 | 720 | 496650 | 5438995 | 22/04/2014 13:11 |
| | Delta Agricultural Ditch #2 | 11.8 | 0.12 | 6.86 | 1309 | 496631 | 5438686 | 01/04/2014 13:15 |
| | Delta Agricultural Ditch #11 | 12.3 | 0.79 | 6.34 | 439 | 499055 | 5437485 | 01/04/2014 14:46 |
| 88 Street Ditch East, north of Highway 99 | 11.1 | 0.20 | 6.33 | 1067 | 501509 | 5437583 | 16/04/2014 14:06 | |
| 88 Street Ditch West, north of Highway 99 | 9.5 | 0.67 | 4.81 | 100 | 501495 | 5437558 | 16/04/2014 14:06 | |
| Big Slough | 88 Street Ditch West, south of Highway 99 | 9.5 | 2.26 | 4.69 | 128 | 501493 | 5437478 | 01/04/2014 14:18 |
| | Delta Agricultural Ditch #16 | 12.8 | 0.22 | 7.45 | 2436 | 503947 | 5437491 | 01/04/2014 14:07 |
| | 112 Street Ditch, south of Highway 99 | 13.8 | 5.00 | 6.30 | 279 | 506354 | 5437586 | 01/04/2014 13:55 |

Note: Shaded cells represent sites that fell outside of B.C. WQG at the time of sampling

Table B5 Summer Water Quality Data

| Watershed | Watercourse Name | Temperature (°C) B.C. WQG Criteria: 6 - 17 | Dissolved Oxygen (mg/L) B.C. WQG Criteria: >5 | pH B.C. WQG Criteria: 6.5-9.0 | Conductivity (µS/cm) | Easting | Northing | Date/Time |
|-------------------------------|---|--|---|-------------------------------------|----------------------|---------|----------|------------------|
| Lower Fraser River Middle Arm | Patterson Road Ditch North | 18.9 | 3.52 | 7.40 | 1298 | 491472 | 5448609 | 14/07/2014 14:13 |
| | Tuttle Avenue Ditch West | 17.5 | 3.29 | 7.00 | 773 | 491728 | 5448383 | 14/07/2014 14:40 |
| | Highway 99 Ditch Northeast (between Highway 91 and Westminster Highway) | 24.2 | 0.09 | 6.50 | 194 | 493684 | 5446427 | 14/07/2014 11:55 |
| Lower Fraser River South Arm | Westminster Highway Ditch South, east of Highway 99 | 17.6 | 0.92 | 6.03 | 135 | 493806 | 5446341 | 14/07/2014 12:45 |
| | Blundell Road Ditch South, east of Highway 99 | 21.1 | 0.20 | 6.57 | 415 | 493736 | 5444718 | 14/07/2014 10:58 |
| | Highway 99 Ditch East (between Blundell and Steveston) | 17.4 | 0.25 | 6.68 | 592 | 493714 | 5444757 | 14/07/2014 11:17 |
| | Highway 99 Ditch West (between Blundell and Steveston) | 22.4 | 0.13 | 7.03 | 742 | 493568 | 5442352 | 14/07/2014 15:35 |
| | Highway 99 Ditch West (between Steveston and F. River) | 19.8 | 2.12 | 7.03 | 403 | 493520 | 5442264 | 14/07/2014 16:00 |
| | Steveston Road Ditch South, east of Highway 99 | 18.8 | 3.00 | 6.35 | 638 | 493996 | 5442298 | 14/07/2014 10:04 |
| | Delta Agricultural Ditch #16 | 24.2 | 0.12 | 6.84 | 2970 | 503938 | 5437534 | 15/07/2014 15:14 |
| Big Slough | Big Slough, north of Highway 99 | 24.6 | 8.37 | 7.69 | 3328 | 505877 | 5437603 | 15/07/2014 15:02 |
| | 112 Street Ditch, north of Highway 99 | 18.5 | 8.55 | 7.52 | 199 | 506357 | 5437642 | 15/07/2014 15:15 |
| | Oliver Slough | 23.1 | 5.25 | 7.65 | 269 | 506808 | 5437677 | 15/07/2014 13:15 |
| | Eugene Creek | 25.2 | 7.41 | 7.41 | 29435 | 508106 | 5437707 | 15/07/2014 16:19 |
| | Highway 99 Ditch North (between Highway 91 and Peacock Brook) | 16.7 | 0.16 | 7.11 | 2088 | 509507 | 5437576 | 15/07/2014 13:00 |

Note: Shaded cells represent sites that fell outside of B.C. WQG

Table B6 Autumn Water Quality Data

| Watershed | Watercourse Name | Temperature (°C) B.C. WQG Criteria: 6 - 17 | Dissolved Oxygen (mg/L) B.C. WQG Criteria: >5 | pH B.C. WQG Criteria: 6.5-9.0 | Conductivity (µS/cm) | Date/Time | Easting | Northing |
|---|---|--|--|-------------------------------------|-------------------------|-----------|---------|----------|
| Lower Fraser River Middle Arm | Bridgeport Road Ditch North | 13.5 | 4.55 | 5.86 | 231 | 19-Oct-14 | 491322 | 5448880 |
| | Tuttle Avenue Ditch West | 14.9 | 5.75 | 6.46 | 267 | 19-Oct-14 | 491725 | 5448384 |
| | Shell Road Ditch East, north of Highway 99 | 13.7 | 3.33 | 6.02 | 172 | 19-Oct-14 | 492511 | 5447711 |
| | Highway 99 Ditch East (between Shell and Highway 91) | 13.8 | 2.65 | 6.22 | 125 | 19-Oct-14 | 492565 | 5447617 |
| | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | 14.0 | 1.55 | 6.34 | 320 | 19-Oct-14 | 493612 | 5446433 |
| | Westminster Highway Ditch North, east of Highway 99 | 13.1 | 5.68 | 6.1 | 96 | 19-Oct-14 | 493683 | 5446444 |
| Lower Fraser River South Arm | Westminster Highway Ditch South, east of Highway 99 | 14.2 | 4.39 | 6.1 | 118 | 19-Oct-14 | 493824 | 5446356 |
| | Highway 99 Ditch West (between Westminster Highway and Blundell) | 14.1 | 1.54 | 6.56 | 269 | 19-Oct-14 | 493658 | 5445597 |
| | Blundell Road Ditch South, east of Highway 99 | 15.2 | 1.6 | 6.49 | 323 | 20-Oct-14 | 493707 | 5444742 |
| | Highway 99 Ditch West (between Blundell and Steveston) | 14.0 | 1.41 | 6.65 | 414 | 19-Oct-14 | 493662 | 5444619 |
| | King Road Ditch, west of Highway 99 | 14.2 | 1.48 | 6.68 | 361 | 19-Oct-14 | 493659 | 5443508 |
| | Williams Road Ditch, east of Highway 99 | 14.8 | 1.97 | 6.3 | 330 | 20-Oct-14 | 493695 | 5443110 |
| | Steveston Highway Ditch North, east of Highway 99 | 14.5 | 2.13 | 6.42 | 412 | 20-Oct-14 | 494023 | 5442325 |
| | Steveston Highway Ditch South, east of Highway 99 | 14.4 | 2.39 | 6.26 | 432 | 20-Oct-14 | 494019 | 5442308 |
| | Highway 99 Ditch West (between Steveston and F. River) | 13.5 | 1.03 | 6.36 | 753 | 19-Oct-14 | 493928 | 5441505 |
| | Richmond Agricultural Ditch #10 | 13.7 | 3.68 | 5.97 | 1315 | 20-Oct-14 | 493936 | 5441750 |
| | Rice Mill Road Ditch North | 13.8 | 3.7 | 6.36 | 213 | 19-Oct-14 | 493641 | 5441485 |
| | River Road Ditch Northwest, north of Highway 99 | 14.7 | 4.45 | 6.7 | 350 | 20-Oct-14 | 495346 | 5439992 |
| | River Road Ditch Southeast, south of Highway 99 | 13.6 | 1.25 | 6.27 | 508 | 19-Oct-14 | 495288 | 5439946 |
| | Highway 99 Ditch Northeast (between 17A and 64 St) | 14.9 | 2.72 | 6.54 | 817 | 20-Oct-14 | 496072 | 5439614 |
| | Highway 99 Ditch Southwest (between 17A and 64 St) | 15.9 | 6.82 | 6.76 | 493 | 19-Oct-14 | 496206 | 5439226 |
| | Burns Drive Ditch Northeast (between 64 St and SFPR) | 15.4 | 3.06 | 6.33 | 665 | 20-Oct-14 | 496645 | 5439001 |
| | Highway 99 Ditch Southwest (between 64 St and SFPR) | 14.8 | 2.33 | 6.5 | 364 | 19-Oct-14 | 497595 | 5438248 |
| | Delta Agricultural Ditch #10 | 14.4 | 6.6 | 6.62 | 767 | 20-Oct-14 | 498646 | 5437951 |
| | Delta Agricultural Ditch #11 | 11.9 | 12.03 | 6.59 | 293 | 16-Oct-14 | 499050 | 5437484 |
| | 88 Street Ditch East, north of Highway 99 | 15.0 | 4.55 | 6.14 | 1302 | 20-Oct-14 | 501516 | 5437593 |
| 88 Street Ditch East, south of Highway 99 | 11.9 | 1.43 | 5.83 | 314 | 16-Oct-14 | 501498 | 5437475 | |

Note: Shaded cells represent sites that fell outside of B.C. WQG at the time of sampling

| Watershed | Watercourse Name | Temperature (°C) B.C. WQG Criteria: 6 - 17 | Dissolved Oxygen (mg/L) B.C. WQG Criteria: >5 | pH B.C. WQG Criteria: 6.5-9.0 | Conductivity (µS/cm) | Date/Time | Easting | Northing |
|------------|---|--|--|-------------------------------------|-------------------------|-----------|---------|----------|
| Big Slough | 88 Street Ditch West, north of Highway 99 | 13.5 | 11.87 | 1.86 | 24 | 20-Oct-14 | 501494 | 5437596 |
| | 88 Street Ditch West, south of Highway 99 | 12.2 | 1.87 | 5.31 | 165 | 16-Oct-14 | 501495 | 5437473 |
| | Burns Drive Ditch between Ladner Trunk and SFPR | 14.2 | 3.3 | 6.56 | 937 | 20-Oct-14 | 502840 | 5437597 |
| | Highway 99 Ditch North (between Ladner Trunk Road and Highway 91) | 13.9 | 5.25 | 6.07 | 489 | 20-Oct-14 | 505773 | 5437627 |
| | Delta Agricultural Ditch #16 | 12.5 | 3.46 | 6.37 | 608 | 16-Oct-14 | 503937 | 5437475 |
| | 104 Street Ditch | 12.6 | 1.64 | 6.64 | 734 | 16-Oct-14 | 504752 | 5437461 |
| | 112 Street Ditch, south of Highway 99 | 12.6 | 2.24 | 6.13 | 197 | 16-Oct-14 | 506360 | 5437511 |
| | Highway 99 Ditch North (between Highway 91 and Peacock Brook) | 14.6 | 3.66 | 6.32 | 2027 | 20-Oct-14 | 509149 | 5437610 |

Note: Shaded cells represent sites that fell outside of B.C. WQG at the time of sampling

Table B7 Spring Fish Capture Data

| Watershed | Watercourse Name | Number of Traps Set | Species Code ^{1, 2} | Total Number | Stage | CPUE (fish per trap-hour) | Minimum Length (mm) | Maximum Length (mm) | Easting | Northing | Date/Time Trap Set | Soak Time (hours) |
|---|---|---------------------|------------------------------|--------------|-------|---------------------------|---------------------|---------------------|---------|------------------|--------------------|-------------------|
| Lower Fraser River Middle Arm | Bridgeport Road Ditch North | 4 | NFC | - | - | - | - | - | 491308 | 5448872 | 31/03/2014 11:00 | 22.8 |
| | Tuttle Avenue Ditch West | 4 | TSB | 15 | adult | 0.16 | 40 | 50 | 491723 | 5448379 | 31/03/2014 11:20 | 22.8 |
| | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | 4 | TSB | 106 | adult | 1.16 | 35 | 60 | 493620 | 5446432 | 31/03/2014 11:45 | 22.8 |
| | Westminster Highway Ditch North, east of Highway 99 | 4 | NFC | - | - | - | - | - | 493789 | 5446415 | 21/04/2014 15:30 | 22.3 |
| Lower Fraser River South Arm | Highway 99 Ditch West (between Westminster Highway and Blundell) | 4 | TSB | 52 | adult | 0.57 | 35 | 50 | 493660 | 5445933 | 31/03/2014 12:00 | 23.0 |
| | Blundell Road Ditch South, east of Highway 99 | 4 | TSB | 55 | adult | 0.62 | 20 | 55 | 493714 | 5444745 | 21/04/2014 15:56 | 22.2 |
| | Highway 99 Ditch West (between Blundell and Steveston) | 4 | TSB | 60 | adult | 0.64 | 35 | 50 | 493661 | 5444535 | 31/03/2014 12:05 | 23.4 |
| | King Road Ditch, west of Highway 99 | 4 | TSB | 27 | adult | 0.29 | 35 | 50 | 493649 | 5443507 | 31/03/2014 12:10 | 23.7 |
| | Williams Road Ditch, east of Highway 99 | 4 | TSB | 14 | adult | 0.16 | 35 | 50 | 493702 | 5443097 | 21/04/2014 15:07 | 22.1 |
| | King Road Ditch, west of Highway 99 | 4 | BNH | 1 | adult | 0.01 | 70 | 70 | 493649 | 5443507 | 31/03/2014 12:10 | 23.7 |
| | Steveston Highway Ditch North, east of Highway 99 | 4 | TSB | 140 | adult | 1.49 | 30 | 55 | 494080 | 5442316 | 21/04/2014 14:58 | 23.4 |
| | Highway 99 Ditch West (between Steveston and F. River) | 4 | NFC | - | - | - | - | - | 493941 | 5441494 | 21/04/2014 13:55 | 19.7 |
| | Richmond Agricultural Ditch #10 | 2 | NFC | - | - | - | - | - | 493945 | 5441745 | 21/04/2014 13:31 | 20.4 |
| | Jacobsen Way/Hartnell Road Ditch | 4 | NFC | - | - | - | - | - | 493659 | 5441680 | 21/04/2014 14:36 | 18.5 |
| | Rice Mill Road Ditch North | 2 | NFC | - | - | - | - | - | 493395 | 5441486 | 21/04/2014 14:22 | 19.1 |
| | River Road Ditch Southeast, south of Highway 99 | 4 | TSB | 24 | adult | 0.25 | 35 | 50 | 495289 | 5439926 | 31/03/2014 12:30 | 23.7 |
| | River Road Ditch Northwest, north of Highway 99 | 4 | TSB | 19 | adult | 0.23 | 35 | 50 | 495346 | 5439990 | 21/04/2014 13:15 | 21.0 |
| | Highway 99 Ditch Southwest (between 17A and 64 St) | 2 | TSB | 25 | adult | 0.53 | 35 | 50 | 496460 | 5439040 | 31/03/2014 13:40 | 23.5 |
| | Highway 99 Ditch Southwest (between 17A and 64 St) | 2 | NFC | - | - | - | - | - | 496481 | 5439024 | 31/03/2014 13:15 | 23.8 |
| | Highway 99 Ditch Northeast (between 64 and SFPR) | 4 | PMB | 2 | adult | 0.02 | 35 | 35 | 496650 | 5438995 | 15/04/2014 17:18 | 21.1 |
| | Highway 99 Ditch Southwest (between 17A and 64 St) | 2 | TSB | 52 | adult | 0.62 | 35 | 45 | 496481 | 5439024 | 31/03/2014 13:15 | 23.8 |
| | Delta Agricultural Ditch #2 | 2 | TSB | 44 | adult | 0.94 | 35 | 50 | 496631 | 5438686 | 31/03/2014 13:55 | 23.3 |
| | Delta Agricultural Ditch #11 | 4 | TSB | 2 | adult | 0.02 | 40 | 40 | 499055 | 5437485 | 31/03/2014 14:10 | 24.6 |
| | 88 Street Ditch East, north of Highway 99 | 2 | NFC | - | - | - | - | - | 501509 | 5437583 | 15/04/2014 16:46 | 21.3 |
| 88 Street Ditch West, north of Highway 99 | 2 | NFC | - | - | - | - | - | 501495 | 5437558 | 15/04/2014 16:46 | 21.3 | |

(1) Refer to Appendix B, Table 2 for species codes
 (2) NFC = No fish caught

| Watershed | Watercourse Name | Number of Traps Set | Species Code ^{1, 2} | Total Number | Stage | CPUE (fish per trap-hour) | Minimum Length (mm) | Maximum Length (mm) | Easting | Northing | Date/Time Trap Set | Soak Time (hours) |
|------------|---|---------------------|------------------------------|--------------|-------|---------------------------|---------------------|---------------------|---------|----------|--------------------|-------------------|
| Big Slough | 88 Street Ditch West, south of Highway 99 | 2 | NFC | - | - | - | - | - | 501493 | 5437478 | 31/03/2014 15:15 | 23.1 |
| | Delta Agricultural Ditch #16 | 4 | TSB | 89 | adult | 0.93 | 40 | 50 | 503947 | 5437491 | 31/03/2014 14:07 | 24.0 |
| | 112 Street Ditch, south of Highway 99 | 4 | TSB | 51 | adult | 0.53 | 35 | 50 | 506354 | 5437586 | 31/03/2014 13:57 | 24.0 |

(1) Refer to Appendix B, Table 2 for species codes
 (2) NFC = No fish caught

Table B8 Autumn Fish Capture Data

| Watershed | Watercourse Name | Number of Traps Set | Species Code ^{1,2} | Total Number | Stage | CPUE (fish per trap-hour) | Minimum Length | Maximum Length | Easting | Northing | Date/Time Trap Set | Soak Time (hours) | |
|-------------------------------|---|--|-----------------------------|--------------|-------|---------------------------|----------------|----------------|-----------|----------|--------------------|-------------------|------|
| Lower Fraser River Middle Arm | Bridgeport Road Ditch North | 2 | NFC | - | - | - | - | - | 491322 | 5448880 | 18-Oct-14 | 24.0 | |
| | Tuttle Avenue Ditch West | 2 | TSB | 9 | Adult | 0.19 | 25 | 30 | 491725 | 5448384 | 18-Oct-14 | 24.2 | |
| | Shell Road Ditch East, north of Highway 99 | 2 | TSB | 165 | Adult | 3.41 | 20 | 40 | 492511 | 5447711 | 18-Oct-14 | 24.2 | |
| | Highway 99 Ditch East (between Shell and Highway 91) | 2 | TSB | 75 | Adult | 1.56 | 20 | 35 | 492565 | 5447617 | 18-Oct-14 | 24.1 | |
| | Highway 99 Ditch Southeast (between Highway 91 and Westminster Highway) | 2 | TSB | 3 | Adult | 0.06 | 25 | 40 | 493612 | 5446433 | 18-Oct-14 | 24.2 | |
| | Westminster Highway Ditch North, east of Highway 99 | 2 | TSB | 2 | Adult | 0.04 | 30 | 30 | 493683 | 5446444 | 18-Oct-14 | 24.2 | |
| Lower Fraser River South Arm | Westminster Highway Ditch South, east of Highway 99 | 2 | TSB | 55 | Adult | 1.13 | 25 | 40 | 493824 | 5446356 | 18-Oct-14 | 24.2 | |
| | Highway 99 Ditch West (between Westminster Highway and Blundell) | 4 | TSB | 1 | Adult | 0.01 | 25 | 40 | 493658 | 5445597 | 18-Oct-14 | 24.3 | |
| | Blundell Road Ditch South, east of Highway 99 | 4 | TSB | 13 | Adult | 0.15 | 25 | 35 | 493707 | 5444742 | 19-Oct-14 | 21.3 | |
| | Highway 99 Ditch West (between Blundell and Steveston) | 2 | TSB | 3 | Adult | 0.06 | 30 | 40 | 493662 | 5444619 | 18-Oct-14 | 24.4 | |
| | King Road Ditch, west of Highway 99 | 4 | TSB | 6 | Adult | 0.06 | 25 | 35 | 493659 | 5443508 | 18-Oct-14 | 24.5 | |
| | Highway 99 Ditch West (between Blundell and Steveston) | 2 | PMB | 2 | Adult | 0.02 | 20 | 35 | 493662 | 5444619 | 18-Oct-14 | 24.4 | |
| | Williams Road Ditch, east of Highway 99 | 4 | NFC | - | - | - | - | - | 493695 | 5443110 | 19-Oct-14 | 21.2 | |
| | Steveston Highway Ditch North, east of Highway 99 | 3 | TSB | 15 | Adult | 0.24 | 25 | 35 | 494023 | 5442325 | 19-Oct-14 | 21.2 | |
| | Williams Road Ditch, east of Highway 99 | 4 | PMB | 8 | Adult | 0.13 | 15 | 20 | 493695 | 5443110 | 19-Oct-14 | 21.2 | |
| | Steveston Highway Ditch South, east of Highway 99 | 3 | TSB | 1 | Adult | 0.02 | 25 | 25 | 494019 | 5442308 | 19-Oct-14 | 21.1 | |
| | Highway 99 Ditch West (between Steveston and Fraser River) | 4 | PMB | 1 | Adult | 0.01 | 25 | 50 | 493928 | 5441505 | 18-Oct-14 | 24.3 | |
| | Steveston Highway Ditch South, east of Highway 99 | 3 | TSB | 46 | Adult | 0.47 | 20 | 35 | 494019 | 5442308 | 19-Oct-14 | 21.1 | |
| | Richmond Agricultural Ditch #10 | 2 | NFC | - | - | - | - | - | 493936 | 5441750 | 19-Oct-14 | 20.9 | |
| | Rice Mill Road Ditch North | 2 | TSB | 1 | Adult | 0.02 | 30 | 30 | 493641 | 5441485 | 18-Oct-14 | 24.3 | |
| | River Road Ditch Northwest, north of Highway 99 | 2 | TSB | 52 | Adult | 1.25 | 20 | 35 | 495346 | 5439992 | 19-Oct-14 | 20.9 | |
| | River Road Ditch Southeast, south of Highway 99 | 4 | BMC | 1 | Adult | 0.01 | 40 | 40 | 495288 | 5439946 | 18-Oct-14 | 24.4 | |
| | River Road Ditch Northwest, north of Highway 99 | 2 | TSB | 62 | Adult | 0.63 | 25 | 35 | 495346 | 5439992 | 19-Oct-14 | 20.9 | |
| | River Road Ditch Southeast, south of Highway 99 | Highway 99 Ditch Northeast (between 17A and 64 St) Highway 99 Ditch Southwest (between 17A and 64 St) | 4 | GC | 12 | Adult | 0.12 | 12 | 40 | 495288 | 5439946 | 18-Oct-14 | 24.4 |
| | | | 2 | PMB | 8 | Adult | 0.08 | 30 | 45 | | | 19-Oct-14 | 20.8 |
| | | | 2 | TSB | 18 | Adult | 0.43 | 25 | 30 | | | 18-Oct-14 | 24.2 |
| 2 | | | TSB | 1 | Adult | 0.02 | 35 | 35 | 19-Oct-14 | | | 20.8 | |
| 2 | GC | 11 | Adult | 0.23 | 25 | 40 | 496072 | 5439614 | 19-Oct-14 | 20.8 | | | |

(1) Refer to Appendix B, Table 2 for species codes
 NFC = No fish caught

| Watershed | Watercourse Name | Number of Traps Set | Species Code ^{1,2} | Total Number | Stage | CPUE (fish per trap-hour) | Minimum Length | Maximum Length | Easting | Northing | Date/Time Trap Set | Soak Time (hours) |
|---|---|---------------------|-----------------------------|--------------|-------|---------------------------|----------------|----------------|---------|-----------|--------------------|-------------------|
| | Burns Drive Ditch Northeast (between 64 St and SFPR) | 2 | TSB | 3 | Adult | 0.07 | 20 | 30 | 496645 | 5439001 | 19-Oct-14 | 20.9 |
| | | | GC | 12 | Adult | 0.29 | 15 | 40 | | | | |
| | Burns Drive Ditch Northeast (between 64 St and SFPR) Highway 99 Ditch Southwest (between 64 St and SFPR) | 2 2 | PMB | 20 | Adult | 0.48 | 15 | 55 | 496645 | 5439001 | 19-Oct-14 | 20.9 |
| | | | PMB | 5 | Adult | 0.10 | 25 | 45 | 497595 | 5438248 | 18-Oct-14 | 23.9 |
| | | | TSB | 42 | Adult | 0.88 | 25 | 35 | | | | |
| | Highway 99 Ditch Southwest (between 64 St and SFPR) Delta Agricultural Ditch #10 | 2 4 | BMC | 1 | Adult | 0.02 | 40 | 40 | 497595 | 5438248 | 18-Oct-14 | 23.9 |
| | | | PMB | 15 | Adult | 0.18 | 15 | 30 | 498646 | 5437951 | 19-Oct-14 | 20.7 |
| | | | TSB | 92 | Adult | 1.11 | 25 | 35 | | | | |
| | Delta Agricultural Ditch #11 88 Street Ditch East, north of Highway 99 | 2 2 | NFC | - | - | - | - | - | 499050 | 5437484 | 15-Oct-14 | 23.5 |
| | | | TSB | 12 | Adult | 0.29 | 25 | 35 | 501516 | 5437593 | 19-Oct-14 | 20.8 |
| 88 Street Ditch East, south of Highway 99 | 2 | NFC | - | - | - | - | - | 501498 | 5437475 | 15-Oct-14 | 23.6 | |
| Big Slough | 88 Street Ditch West, north of Highway 99 | 2 | TSB | 1 | Adult | 0.02 | 25 | 25 | 501494 | 5437596 | 19-Oct-14 | 20.7 |
| | 88 Street Ditch West, south of Highway 99 | 2 | NFC | - | - | - | - | - | 501495 | 5437473 | 15-Oct-14 | 23.5 |
| | Burns Drive Ditch between Ladner Trunk and SFPR | 2 | NFC | - | - | - | - | - | 502840 | 5437597 | 19-Oct-14 | 20.6 |
| | Highway 99 Ditch North (between Ladner Trunk Road and Highway 91) | 2 | TSB | 18 | Adult | 0.45 | 25 | 30 | 505773 | 5437627 | 19-Oct-14 | 19.9 |
| | Delta Agricultural Ditch #16 | 2 | TSB | 55 | Adult | 1.17 | 20 | 35 | 503937 | 5437475 | 15-Oct-14 | 23.4 |
| | Highway 99 Ditch North (between Ladner Trunk Road and Highway 91) | 2 | PMB | 310 | Adult | 6.61 | 15 | 45 | 505773 | 5437627 | 19-Oct-14 | 19.9 |
| | 104 Street Ditch | 2 | TSB | 14 | Adult | 0.30 | 25 | 40 | 504752 | 5437461 | 15-Oct-14 | 23.3 |
| | 112 Street Ditch, south of Highway 99 | 2 | PMB | 4 | Adult | 0.09 | 30 | 60 | 506360 | 5437511 | 15-Oct-14 | 23.3 |
| | 104 Street Ditch | 2 | BNH | 1 | Adult | 0.02 | 200 | 200 | 504752 | 5437461 | 15-Oct-14 | 23.3 |
| | Highway 99 Ditch North (between Highway 91 and Peacock Brook) | 4 | TSB | 36 | Adult | 0.44 | 25 | 35 | 509149 | 5437610 | 19-Oct-14 | 20.5 |
| BMC | | | 1 | Adult | 0.01 | 35 | 35 | | | | | |

(1) Refer to Appendix B, Table 2 for species codes
 NFC = No fish caught

ATTACHMENT C

Photographs of Watercourses Assessed during the Fish Field Program for the Project



Photo 1: Swale that runs to the north from Bridgeport Road North (Watercourse #6), looking south. April 1, 2014.



Photo 2: Representative photo of Bridgeport Road Ditch South (Watercourse #7), facing south. April 2, 2014.



Photo 3: Representative photo of Patterson Road Ditch North (Watercourse #8), facing west. July 14, 2014.

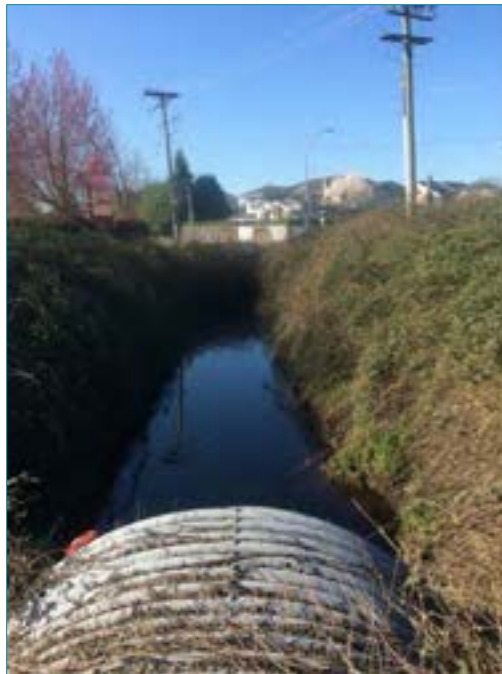


Photo 4: Representative photo of Tuttle Avenue Ditch West (Watercourse #9), facing upstream. April 1, 2014.



Photo 5: Representative photo of Tuttle Avenue Ditch East (Watercourse #10), facing downstream. October 17, 2014.



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Photo 12: Representative photo of Westminster Highway Ditch North, east of Highway 99 (Watercourse #17), facing west. April 21, 2014.



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Photo 16: Representative photo of Blundell Road Ditch South, east of Highway 99 (Watercourse #22), facing east. April 21, 2014.



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October 17, 2014.



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October 17, 2014.



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Photo 26: Looking east at Richmond Agricultural Ditch #7, west of Highway 99 (Watercourse #32) from No.5 Road. October 17, 2014.



Photo 27: Looking west from Highway 99 at King Road Ditch, west of Highway 99 (Watercourse #33).
April 1, 2014.



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October 17, 2014.



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October 17, 2014.



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October 17, 2014.



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Photo 60: Representative photo of Highway 99 Ditch Southwest (between 64 St and Highway 17) (Watercourse #61), facing southeast from Crescent Slough. October 19, 2014.



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October 18, 2014.



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Photo 101: Representative photo of BNSF Ditch (Watercourse #106). Taken from Highway 99 facing northeast. July 15, 2014.

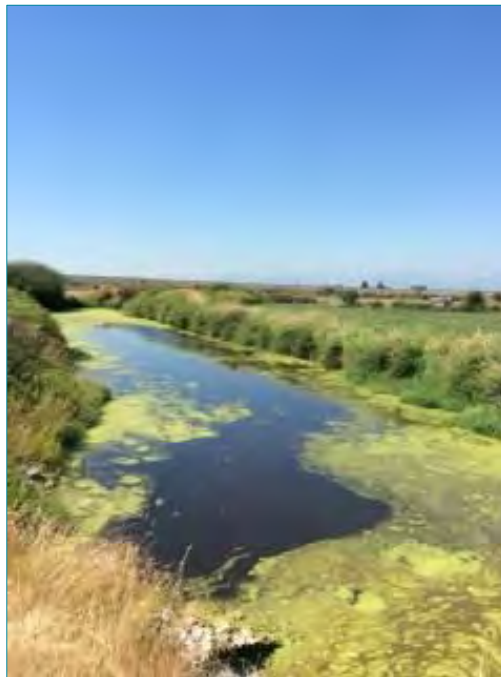


Photo 102: Representative photo of Big Slough, south of Highway 99 (Watercourse #107), facing north from Ladner Trunk Road. July 15, 2014.



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**George Massey Tunnel
Replacement Project**



**BC JOBS
PLAN**



Ministry of
Transportation
and Infrastructure

Section 16.5

AIR QUALITY STUDY

Technical Volume

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LIST OF ATTACHMENTS

Attachment A Dispersion Modelling Plan

Abbreviations and Acronyms

| Term | Description |
|--------------------------|---|
| $\mu\text{g}/\text{m}^3$ | micrograms (of contaminant) per cubic metre |
| μm | micron or micrometre |
| AAQO | Ambient Air Quality Objectives |
| CAC | criteria air contaminants |
| CNG | compressed natural gas |
| CO | carbon monoxide |
| CO ₂ | carbon dioxide |
| g/km | grams per kilometre |
| g/VkmT | grams per vehicle kilometre travelled |
| LFV | Lower Fraser Valley |
| N ₂ O | nitrous oxide |
| NH ₃ | ammonia |
| NO | nitric oxide |
| NO _x | nitrogen oxides |
| O ₃ | Ozone |
| PM ₁₀ | particulate matter having a diameter equal to or smaller than 10 μm |
| PM _{2.5} | particulate matter having a diameter equal to or smaller than 2.5 μm |
| ppb | parts per billion |
| SFPR | South Fraser Perimeter Road |
| SO ₂ | sulphur dioxide |
| TAC | toxic air contaminants (also called air toxics) |
| U.S. EPA | United States Environmental Protection Agency |
| UTM | Universal Transverse Mercator |
| VkmT | vehicle kilometres travelled |
| VOC | volatile organic compounds (excluding methane and ethane) |

Glossary

| Term | Definition |
|------------------------------|--|
| air pollutant | Any pollution agent or combination of such agents, including any physical, chemical, biological, radioactive (including source material, special nuclear material, and by-product material) substance or matter that is emitted into or otherwise enters the ambient air. |
| ambient air | Outdoor or open air. |
| annual average daily traffic | Total traffic measured over a one-year period divided by 365. |
| CALINE | California Line Source dispersion model; a steady-state Gaussian dispersion model designed to determine air pollution concentrations at receptor locations downwind of highways located in relatively uncomplicated terrain. |
| CALMET | A diagnostic three-dimensional meteorological model, the development of which was originally sponsored by the California Air Resources Board. |
| criteria air contaminant | A group of seven pollutants that are emitted predominantly into the air, and cause air issues such as smog and acid rain through their presence or interaction between one another. These seven contaminants are total PM, inhalable PM (PM ₁₀), fine PM (PM _{2.5}), CO, NO ₂ , SO ₂ , and VOCs. A brief description of each CAC is provided in this glossary. |
| emission | The act of releasing or discharging air contaminants into the ambient air from any source. |
| emission factor | An emission factor is defined as the average emission rate of a given pollutant for a given source, relative to units of activity (e.g., kg of SO ₂ emitted per kilometre travelled). |
| emission inventory | An emission inventory is a comprehensive account of air contaminant emissions and associated data from sources within the inventory area over a specified timeframe, which can be used to determine the effect of emissions on ambient air quality. |
| heavy-duty vehicle | A motor vehicle that is designed primarily for transportation of heavy goods (includes heavy-duty haul and refuse trucks). |
| light-duty vehicle | A motor vehicle that is designed primarily for transportation of persons and has a designated seating capacity of not more than 12 persons (includes light-duty gasoline vehicles and light-duty diesel vehicles). |

| Term | Definition |
|---------------------------|---|
| mesoscale | The scale of meteorological phenomena that range in size from a few kilometres to about 100 km. It includes local winds, thunderstorms, and tornadoes. |
| nitrogen oxides | Consist of nitric oxide (NO) and nitrogen dioxide (NO ₂); reported as the equivalent NO ₂ . |
| particulate matter | Any aerosol that is released to the atmosphere in either solid or liquid form. |
| point source | Major stationary emission sources discharging from a stack. |
| receptor | A geographic location for which a computer model calculates a value (eg. ambient concentration of a pollutant). |
| secondary particulate | A contaminant formed by chemical reactions of gaseous contaminants in the air. |
| sulphur oxides | Gaseous sulphur dioxide (SO ₂), for which national and provincial air quality objectives and regulations are in effect. Particulate or aerosol sulphate is excluded from emissions totals and is included under particulate matter. SO _x is reported as SO ₂ -equivalent. |
| volatile organic compound | Photochemically reactive hydrocarbons, excluding methane, ethane, acetone, methylene chloride, methyl chloroform, and several chlorinated organics, because of their low reactivity in the atmosphere (definition used by the U.S. EPA). |

1.0 Scope of Study

This appendix provides supplemental technical information on the air quality study undertaken to support the assessment of effects of the George Massey Tunnel Replacement Project (the Project) on human health and inform the selection of strategies for mitigating such effects. This appendix describes the contaminants assessed, the applicable objectives and standards, study methods, and study results.

As is typical for most air quality assessments, the study comprised two components: emissions estimates and air quality dispersion modelling. Generally, emissions estimates encompass the identification of potential emission sources associated with a project, determination of the types and magnitudes of air contaminants emanating from project sources, and evaluation of the relative contribution of these emissions on contaminant loading in the project region. Dispersion modelling uses the emissions estimates to provide a prediction of the potential effects a project may have on local air quality in the future.

The B.C. Modelling Guideline, which outlines recommended steps (e.g. development of a conceptual as well as a detailed model plan) for completing modelling projects, was used to guide Project-related air-quality modelling. Metro Vancouver was involved in the model planning discussions from the early stages of model planning, and this consultation helped identify and address some of the issues noted in this assessment. A copy of the detailed modelling plan is provided as **Attachment A**.

2.0 Emission Parameters

2.1 Air Contaminant Characteristics

Vehicles emit CACs and TACs as a result of fossil fuel combustion. While vehicle tailpipe emissions and road dust from vehicle traffic yield air contaminants that affect air quality, the combustion of fuels from construction equipment and process combustion units, such as those in asphalt plants, produce a range of similar gaseous and particulate matter contaminants. Collectively, these contaminants may directly or indirectly act as precursors to the formation of other gases and particles in the atmosphere, which may have potential effects on human health and the environment. The key characteristics associated with these air contaminants resulting from fuel combustion are provided below.

2.1.1 Sulphur Dioxide

Sulphur is present in fossil fuels and is transformed into SO_2 , a colourless gas that has a strong odour at elevated concentrations during the process of combustion.

2.1.2 Nitrogen Oxides

Oxides of nitrogen (NO_x) are a mixture of nitrogen dioxide (NO_2) and nitric oxide (NO). High temperature combustion processes typically emit 94 to 97 per cent of the NO_x as NO , with the remaining balance as NO_2 . Once emitted, NO reacts with the oxygen in air to form NO_2 .

Nitrogen dioxide is an important precursor to ground-level ozone formation that occurs through photochemical reactions involving VOCs. Elevated concentrations of NO_2 produce a brownish gas that is visible in the atmosphere. As the NO_2 reacts in the atmosphere with ammonia, fine particulate salts are formed, which increase $\text{PM}_{2.5}$ concentrations and reduce visibility.

2.1.3 Ammonia

Ammonia is a colourless gas that is a product of internal engine combustion, and is also widely used in industry to produce nitrogen-based products such as fertilizers, plastics, and explosives. It is one of the common air contaminants included in regional emissions inventories because of its role in the formation of secondary particulates. Agricultural operations are the major source of ammonia released to the atmosphere.

2.1.4 Carbon Monoxide

Carbon monoxide is a clear, odourless gas that reduces the blood's capacity to carry oxygen to tissues in the body. Carbon monoxide also participates to a minor extent in photochemical smog reactions that lead to increased ground-level ozone formation. Proper design and operation of combustion equipment helps keep CO emission levels and ambient concentrations at low levels.

2.1.5 Particulate Matter

Particulate matter (PM, PM₁₀, PM_{2.5}) includes mineral, carbonaceous, and other types of particles, as well as a mix of chemical compounds that may be adsorbed or adhered to particles, depending on the particles' origins. Particulate matter may be a primary contaminant, such as smoke emitted directly into the atmosphere, or a secondary contaminant formed by chemical reactions of gaseous contaminants in the air.

Particles larger than 10 microns are deposited in the human upper respiratory tract and are of less concern than particles equal to or less than 10 microns (PM₁₀) or particles equal to or less than 2.5 microns (PM_{2.5}). PM_{2.5} is considered the particulate size range of primary concern for human health impacts, and poses the greatest risk to human health because it can pass through the respiratory system deep within the lungs, leading to increased morbidity and mortality (FPWGAQ 1997).

For vehicles and equipment that burn diesel fuel, the diesel particulate emitted is a complex mixture of particles composed of porous elemental carbon, sulphate, nitrate, and a range of organic compounds that are adsorbed on the surface or within the solid particles. The major organic constituents are hydrocarbons, polycyclic aromatic hydrocarbons, and nitro-polyaromatic hydrocarbons. Typically, 90 per cent of these particles are less than 2.5 microns in diameter. A review by the California Air Resources Board of the literature on the health effects of diesel exhaust concluded that it is carcinogenic (ARB 1998).

Black carbon, present in diesel particulate, is the most strongly light-absorbing component of PM, absorbing solar radiation at all wavelengths. Formed as a product of incomplete fuel combustion, black carbon has a shorter residence time than greenhouse gases in the atmosphere. Since its potential radiative warming effects tend to be localized, any appropriate mitigation measures targeting black carbon can help reduce the rate of climate warming in the short term. Diesel PM also contains other components, such as sulphates, nitrates, and organic carbon, which generally reflect light and may therefore partially offset the climate warming effect of black carbon.

Road dust is made up of airborne particles that are generated by the friction of moving tires on roads. As with other particulate matter, road dust poses potential hazards to human health and the environment.

2.1.6 Volatile Organic Compounds

As defined by Environment Canada, VOCs are gaseous organic compounds, excluding those with negligible photochemical reactivity such as methane and other compounds. Volatile organic compounds are reactive in the atmosphere and can lead to increased formation of ground-level ozone through complex reactions with NO_x in the presence of sunlight. Volatile organic compounds arise from the incomplete combustion of a fuel.

2.1.7 Toxic Air Contaminants

In addition to CACs emitted from fossil-fuel burning vehicles, small amounts of TACs are released, including acetaldehyde, acrolein, benzene, benzo(a)pyrene, 1,3 butadiene, naphthalene, and formaldehyde. These substances are sometimes referred to as hazardous air pollutants, which are known or suspected to have harmful effects on human health and the environment.

2.2 Federal and Provincial Ambient Air Quality Objectives

In Canada, the federal and provincial governments have established ambient air quality objectives (AAQO) to ensure long-term protection of public health and the environment. In addition to these objectives, Metro Vancouver has created regionally focused ambient air quality objectives. Metro Vancouver has authorization to create and enforce air quality objectives within Metro Vancouver under the Environmental Management Act. Federally, up to three objective values have been recommended using the categories of maximum desirable, maximum acceptable, and maximum tolerable. The maximum desirable objective is the most stringent standard. British Columbia has established similar objective values, designated as levels A, B, and C for Carbon Monoxide (CO) while other pollutants have a single objective for a specified averaging period. Level A is the most stringent, and is typically applied to new and proposed discharges to the environment; it is usually the same as the federal maximum desirable objective. The federal and provincial objectives are summarized in **Table 1**.

Table 1 Federal and Provincial Ambient Air Quality Objectives

| Jurisdiction | Levels | Objective Description* |
|--------------|-------------------------------------|--|
| Federal | Maximum desirable (most stringent) | Long-term goal for air quality that provides a basis for an anti-degradation policy for unpolluted parts of the country and for continuing development of control technology. |
| | Maximum acceptable | Provides adequate protection against adverse effects on soil, water, vegetation, materials, animals, visibility, personal comfort and well-being. |
| | Maximum tolerable (least stringent) | Denotes time-based concentrations of air contaminants beyond which, due to a diminishing margin of safety, appropriate action is required without delay to protect the health of the general population. |
| Provincial | Level A (most stringent) | Refers to desirable goals for all discharges and/or to be applied to all new discharges and to existing installations whose discharges are significantly changed in quantity or quality. |
| | Level B | Refers to the acceptable intermediate objectives for all other discharges, to be reviewed periodically by the Director of Pollution Control. |
| | Level C (least stringent) | The immediate objective for all applicable existing industries to meet within a minimum technically feasible period of time. |

* Source: (B.C. MOE 2014, ECOLOG 2014).

3.0 Methods

The following general steps were followed to predict concentrations of the pollutants of concern:

1. Examine and analyze available ambient air quality, meteorological, and climate data.
2. Estimate the air contaminant emissions from vehicles for the three scenarios (existing 2011 conditions, and future (2031) conditions without, and with the Project).
3. Predict the effects of estimated emissions on ambient concentrations within the LSA using dispersion models.
4. Compare the predicted concentrations with applicable air quality objectives (e.g., federal, provincial and municipal)
5. Compare the estimated vehicle emissions for the existing and projected scenarios to emissions within the regional study area.

3.1 Air Quality, and Meteorological and Climate Data

Data from 2008 to 2012 were obtained from Metro Vancouver, which operates air quality monitoring stations for the region surrounding the Project area. Representative concentrations for the pollutants of concern were developed from the analyzed data. Data on toxic air contaminants (TACs) were obtained from the National Air Pollution Surveillance Network. Where available, meteorological data were also obtained from the Metro Vancouver sites, and from the Environment Canada station at Vancouver International Airport. **Table 2** lists the six ambient air quality monitoring stations from which data were used to characterize existing air quality in the vicinity of the Project area, and their coordinates.

Table 2 Ambient Air Quality Monitoring Stations and Parameters Measured

| Station ID | Station Name | Location Coordinates | Air Quality Parameters Measured | | | | | |
|------------|------------------|----------------------|---------------------------------|----|----------------|-----------------|-------------------|------------------|
| | | | NO ₂ | CO | O ₃ | SO ₂ | PM _{2.5} | PM ₁₀ |
| T13 | North Delta | 507167, 5445058 | ✓ | | ✓ | | ✓ | |
| T15 | Surrey East | 522307, 5442275 | ✓ | ✓ | ✓ | | ✓ | |
| T17 | Richmond South | 492108, 5443180 | ✓ | ✓ | ✓ | ✓ | ✓ | |
| T18 | Burnaby South | 501041, 5451379 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| T31 | Richmond-Airport | 488895, 5448177 | ✓ | ✓ | ✓ | ✓ | ✓ | ✓ |
| T39 | Tsawwassen | 494004, 5428560 | ✓ | ✓ | ✓ | ✓ | ✓ | |

3.2 Emissions Estimates

3.2.1 Parameters that Influence Emissions and Air Quality

The following parameters that are known to influence emissions from vehicle traffic were accounted for in estimating emissions related to the Project:

- Vehicle volume and distance travelled – The number of vehicles using the road and the distance they travel directly influence the quantity of contaminants emitted to the air. More vehicles mean more contaminant emissions, and the greater the distance travelled, the greater the volume of contaminants emitted.
- Vehicle speed – Depending on its speed, a vehicle will emit each of the contaminants of concern at varying rates. There is an optimum speed at which a vehicle will emit the least contaminants, but this speed is different for each vehicle and vehicle type. There is generally a range within which most vehicles are operating at their optimum performance and thus minimizing combustion emissions.
- Fleet profile – Vehicle types differ in the emissions they produce; therefore, the proportion of vehicles of each type in the fleet can change the emissions inventory. A road with a greater proportion of heavy trucks and/or bus traffic will have greater emissions of certain contaminants and less of others when compared to a road with a lower proportion of heavy vehicles.
- Vehicle fuel efficiency – Newer vehicles tend to have better fuel efficiency and lower emissions than older vehicles. Turnover of older vehicles for new ones in the fleet can change the emission inventory since less fuel is burned in new vehicles and therefore less combustion-related emissions are produced for the same distance travelled.
- Regulation and legislation – Government regulations such as vehicle fuel efficiency requirements, for example, catalytic converters, and fuel cleanliness (lower sulphur content) can change the vehicle emissions.

3.2.2 Vehicle Emissions

Vehicle emission factors were determined using the U.S. EPA MOVES modelling simulator (U.S. EPA 2012). At the core of the methodology is the emission equation:

$$\text{Emission (g)} = \text{activity data (VkmT)} \times \text{emission factor (g/VkmT)}$$

VkmT is the number of vehicle kilometres travelled. Emission calculations for vehicles are complex because of the many methods needed to determine reliable emission factors and activity data. Emission factors can vary significantly depending on:

- Vehicle type (e.g., light duty vs. heavy duty, gasoline vs. diesel)
- Mileage accumulation (age of vehicle)
- Speed (e.g., 20 km/h vs. 100 km/h)
- Control technology (e.g., catalytic converters)
- Other emission-reduction measures

The MOVES model generates emissions factors for highway motor vehicles and motorcycles fuelled by gasoline, diesel, and compressed natural gas (CNG). It also accounts for the effects on emissions caused by changes in vehicle emission standards; changes in vehicle populations and activity; and variation in local conditions such as temperature, humidity, pressure, and fuel quality.

The MOVES emission factors were generated by Sierra Research with support from Metro Vancouver. Although MOVES is a U.S.-based model, model input data from Metro Vancouver were used to ensure a good alignment between the Project and Metro Vancouver's regional mobile emission estimates and forecasts. These data included climate data, fleet age distribution, information on inspection and maintenance programs, and regulatory framework (e.g., renewable fuel requirement in B.C. of five per cent for gasoline and four per cent for diesel). Vancouver-specific data on fuel sales and fuel characteristics, such as Reid vapour pressure, ethanol blend market share, and biodiesel content were also used in the model to closely reflect conditions in the Project airshed.

Vehicle emission factors generated by MOVES take into account improvements in vehicle emission systems and technologies as newer technologies slowly penetrate the vehicle fleets and when newer vehicles with improved performance replace older ones. These vehicle technologies are mainly designed to improve fuel efficiency, reduce emissions, and improve the general safety of the driver.

The MOVES model generates emission factors for 13 types of vehicles, and for three distinct fuels (gasoline, diesel, and CNG), which are summarized, along with the existing 2011 and 2031 fleet profiles, in **Table 3**. The proportions of vehicle types (fleet profile) were also provided by Metro Vancouver, and as used in the *2010 Lower Fraser Valley Air Emissions Inventory and Forecast and Backcast* (Metro Vancouver 2013). Although Metro Vancouver's fleet profiles were developed for 2010 and 2030, they were deemed representative of the Project years of 2011 and 2031, and therefore adopted for use in this study.

As shown in **Table 3**, the fleet profile presents a very similar vehicle class breakdown in both 2011 and 2031. In 2011, light duty vehicles dominate the profile, accounting for 94.7 per cent of all vehicles, with 91.4 per cent being gasoline fuelled. Heavy duty trucks (motorhomes, refuse trucks, single and combination short- and long-haul trucks) account for 2.5 per cent, and buses account for 0.3 per cent of the fleet. Motorcycles account for the remaining 2.4 per cent. Electric vehicles account for 0.03 per cent (passenger cars and transit buses), whereas CNG buses only account for 0.003 per cent of the fleet.

Table 3 Fleet Profile for 2011 and 2031

| Description | | Percentage of Total Vehicles | |
|-----------------------------|------------------------------|------------------------------|--------|
| | | 2011 | 2031 |
| Gasoline | Motorcycle | 2.43 | 2.38 |
| | Passenger Car | 49.52 | 48.44 |
| | Passenger Truck | 31.35 | 30.68 |
| | Light Commercial Truck | 10.57 | 12.19 |
| | Transit Bus | 0.0001 | 0.0002 |
| | School Bus | 0.006 | 0.0045 |
| | Refuse Truck | 0.0003 | 0.0002 |
| | Single Unit Short-Haul Truck | 0.02 | 0.02 |
| | Single Unit Long-Haul Truck | 0.002 | 0.002 |
| | Motor Home | 0.60 | 0.59 |
| Diesel | Passenger Car | 0.72 | 0.72 |
| | Passenger Truck | 1.26 | 1.23 |
| | Light Commercial Truck | 1.31 | 1.51 |
| | Intercity Bus | 0.13 | 0.13 |
| | Transit Bus | 0.10 | 0.08 |
| | School Bus | 0.08 | 0.06 |
| | Refuse Truck | 0.05 | 0.04 |
| | Single Unit Short-Haul Truck | 0.65 | 0.62 |
| | Single Unit Long-Haul Truck | 0.06 | 0.07 |
| | Motor Home | 0.22 | 0.22 |
| | Combination Short-Haul Truck | 0.30 | 0.34 |
| Combination Long-Haul Truck | 0.57 | 0.63 | |
| CNG | Transit Bus | 0.003 | 0.005 |
| Elect | Passenger Car | 0.01 | 0.01 |
| | Transit Bus | 0.02 | 0.02 |

Emission factors for each vehicle type were provided by MOVES for a variety of vehicle speeds for the pollutants listed in **Table 4**. The MOVES-generated emission factors were subsequently multiplied by the traffic volumes to obtain the hourly, daily, and annual emissions for each Project road segment (described in **Section 6.6.5-1** and as follows):

- Segment 1: Bridgeport Road to Westminster Highway
- Segment 2: Westminster Highway to Steveston Highway
- Segment 3: Tunnel / new bridge and approach
- Segment 4: Highway 17A to Highway 17
- Segment 5: Highway 17 to Ladner Trunk Road
- Segment 6: Ladner Trunk Road to Highway 91

Table 4 Motor Vehicle Emissions Simulator Contaminant List

| Contaminants | |
|---|--|
| Volatile organic compounds | Primary PM _{2.5} - brake wear |
| Carbon monoxide | Primary PM _{2.5} - tire wear |
| Oxides of nitrogen | Methane |
| Sulfur dioxide | Nitrous oxide |
| Ammonia | Carbon dioxide |
| Primary PM ₁₀ - organic carbon | Benzene |
| Primary PM ₁₀ - elemental carbon | Naphthalene |
| Primary PM ₁₀ - sulfate particulate | 1,3-butadiene |
| Primary PM ₁₀ - brake wear | Formaldehyde |
| Primary PM ₁₀ - tire wear | Acetaldehyde |
| Primary PM _{2.5} - organic carbon | Acrolein |
| Primary PM _{2.5} - elemental carbon | Benzo(a)pyrene |
| Primary PM _{2.5} - sulfate particulate | |

Vehicle speed can also affect exhaust emissions. The emission rate in grams per kilometre (g/km) for many exhaust contaminants decreases with vehicle speed. The rate depends on the type of vehicle and engine technology.

Development of emission factors based on a variety of speeds allows for the simulation of free-flow and congested road conditions, which is a crucial factor when analyzing air quality conditions in the airshed. For this Project, different speeds were considered for each scenario and each road segment being assessed. While the speeds considered in each scenario are described in **Section 4.1**, **Table 5** and **Table 6** show a sample of CAC emission factors for different vehicle types travelling at a speed of 40 km/h, for the 2011 and 2031 scenarios respectively. Gasoline-fuelled vehicles — heavy duty vehicles in particular — have higher factors for CO, VOCs, NH₃, and SO₂ than other vehicle types. However, NO_x and particulate matter emission factors are highest for diesel heavy duty vehicles. Motorcycles have the highest emission factor for VOCs than any other vehicle type. In general, most emission factors are expected to decline between 2011 and 2031. In Table 5 and Table 6, the VOCs emission factors include exhaust and running evaporative emissions and the PM₁₀ and _{2.5} emission factors include exhaust and brake and tire wear emissions.

Table 5 Example of Emission Factors of CACs by Vehicle Type for 2011 (g/VkmT) for 40 km/h Speed

| 2011 Emission Factors (g/VkmT) | | | | | | | | |
|--------------------------------|------------------------------|--------|-------|-------|-----------------|-----------------|------------------|-------------------|
| Fuel Type | Vehicle Type | CO | NOx | VOCs | NH ₃ | SO ₂ | PM ₁₀ | PM _{2.5} |
| Gasoline | Motorcycle | 11.679 | 0.343 | 1.855 | 0.019 | 0.004 | 0.026 | 0.021 |
| | Passenger Car | 6.132 | 0.478 | 0.507 | 0.021 | 0.005 | 0.031 | 0.015 |
| | Passenger Truck | 8.542 | 0.752 | 0.556 | 0.020 | 0.007 | 0.043 | 0.019 |
| | Light Commercial Truck | 8.286 | 0.670 | 0.469 | 0.018 | 0.007 | 0.041 | 0.018 |
| | Transit Bus | 28.443 | 2.526 | 0.966 | 0.020 | 0.016 | 0.059 | 0.019 |
| | School Bus | 67.555 | 3.271 | 2.666 | 0.019 | 0.012 | 0.078 | 0.037 |
| | Refuse Truck | 30.805 | 3.543 | 1.067 | 0.024 | 0.024 | 0.067 | 0.021 |
| | Single Unit Short-Haul Truck | 31.800 | 2.407 | 1.143 | 0.023 | 0.014 | 0.073 | 0.025 |
| | Single Unit Long-Haul Truck | 23.054 | 2.057 | 0.837 | 0.023 | 0.013 | 0.069 | 0.022 |
| | Motor Home | 47.327 | 3.867 | 2.813 | 0.023 | 0.014 | 0.094 | 0.048 |

| 2011 Emission Factors (g/VkmT) | | | | | | | | |
|--------------------------------|------------------------------|--------|--------|-------|-----------------|-----------------|------------------|-------------------|
| Fuel Type | Vehicle Type | CO | NOx | VOCs | NH ₃ | SO ₂ | PM ₁₀ | PM _{2.5} |
| Diesel | Passenger Car | 0.529 | 0.992 | 0.141 | 0.004 | 0.002 | 0.132 | 0.114 |
| | Passenger Truck | 1.527 | 2.456 | 0.337 | 0.012 | 0.004 | 0.160 | 0.134 |
| | Light Commercial Truck | 1.551 | 2.516 | 0.343 | 0.013 | 0.004 | 0.158 | 0.130 |
| | Intercity Bus | 2.916 | 10.230 | 0.434 | 0.015 | 0.010 | 0.775 | 0.663 |
| | Transit Bus | 2.073 | 5.118 | 0.307 | 0.012 | 0.006 | 0.283 | 0.235 |
| | School Bus | 2.875 | 5.707 | 0.545 | 0.012 | 0.005 | 0.419 | 0.344 |
| | Refuse Truck | 1.465 | 4.866 | 0.288 | 0.015 | 0.009 | 0.416 | 0.319 |
| | Single Unit Short-Haul Truck | 1.802 | 4.262 | 0.446 | 0.014 | 0.006 | 0.282 | 0.218 |
| | Single Unit Long-Haul Truck | 1.493 | 3.661 | 0.370 | 0.014 | 0.006 | 0.237 | 0.175 |
| | Motor Home | 2.412 | 7.597 | 0.757 | 0.014 | 0.006 | 0.448 | 0.392 |
| | Combination Short-Haul Truck | 2.829 | 8.510 | 0.453 | 0.015 | 0.011 | 0.645 | 0.547 |
| | Combination Long-Haul Truck | 3.200 | 9.923 | 0.822 | 0.015 | 0.013 | 0.536 | 0.434 |
| CNG | Transit Bus | 24.373 | 2.307 | 0.000 | 0.000 | 0.000 | 0.057 | 0.017 |

Table 6 Example of Emission Factors of CACs by Vehicle Type for 2031 (g/VkmT) for 40 km/h Speed

| 2031 Emission Factors (g/VkmT) | | | | | | | | |
|--------------------------------|------------------------------|--------|-----------------|-------|-----------------|-----------------|------------------|-------------------|
| Fuel Type | Vehicle Type | CO | NO _x | VOC | NH ₃ | SO ₂ | PM ₁₀ | PM _{2.5} |
| Gasoline | Motorcycle | 9.091 | 0.317 | 1.727 | 0.023 | 0.004 | 0.026 | 0.021 |
| | Passenger Car | 4.591 | 0.129 | 0.239 | 0.012 | 0.004 | 0.027 | 0.012 |
| | Passenger Truck | 5.328 | 0.207 | 0.198 | 0.013 | 0.005 | 0.039 | 0.016 |
| | Light Commercial Truck | 6.054 | 0.261 | 0.190 | 0.013 | 0.005 | 0.038 | 0.015 |
| | Transit Bus | 22.844 | 2.195 | 0.818 | 0.020 | 0.016 | 0.059 | 0.018 |
| | School Bus | 52.843 | 1.671 | 1.012 | 0.019 | 0.012 | 0.061 | 0.021 |
| | Refuse Truck | 27.642 | 3.334 | 0.975 | 0.024 | 0.024 | 0.066 | 0.021 |
| | Single Unit Short-Haul Truck | 27.568 | 1.936 | 0.694 | 0.023 | 0.014 | 0.069 | 0.021 |
| | Single Unit Long-Haul Truck | 20.897 | 1.784 | 0.573 | 0.023 | 0.013 | 0.067 | 0.020 |
| | Motor Home | 32.707 | 2.150 | 1.298 | 0.023 | 0.014 | 0.065 | 0.021 |

| 2031 Emission Factors (g/VkmT) | | | | | | | | |
|--------------------------------|------------------------------|--------|-----------------|-------|-----------------|-----------------|------------------|-------------------|
| Fuel Type | Vehicle Type | CO | NO _x | VOC | NH ₃ | SO ₂ | PM ₁₀ | PM _{2.5} |
| Diesel | Passenger Car | 2.201 | 0.298 | 0.091 | 0.004 | 0.001 | 0.025 | 0.010 |
| | Passenger Truck | 0.852 | 0.805 | 0.062 | 0.012 | 0.003 | 0.037 | 0.015 |
| | Light Commercial Truck | 0.755 | 0.799 | 0.062 | 0.013 | 0.003 | 0.040 | 0.016 |
| | Intercity Bus | 0.552 | 1.506 | 0.059 | 0.015 | 0.009 | 0.181 | 0.087 |
| | Transit Bus | 0.469 | 0.744 | 0.032 | 0.012 | 0.006 | 0.070 | 0.028 |
| | School Bus | 1.306 | 0.841 | 0.060 | 0.012 | 0.004 | 0.104 | 0.038 |
| | Refuse Truck | 0.396 | 0.955 | 0.035 | 0.015 | 0.008 | 0.142 | 0.053 |
| | Single Unit Short-Haul Truck | 0.648 | 0.777 | 0.049 | 0.014 | 0.006 | 0.091 | 0.033 |
| | Single Unit Long-Haul Truck | 0.536 | 0.695 | 0.042 | 0.014 | 0.005 | 0.089 | 0.031 |
| | Motor Home | 1.053 | 1.724 | 0.207 | 0.014 | 0.006 | 0.124 | 0.078 |
| | Combination Short-Haul Truck | 0.659 | 1.233 | 0.046 | 0.015 | 0.010 | 0.138 | 0.056 |
| | Combination Long-Haul Truck | 1.855 | 4.475 | 0.365 | 0.024 | 0.012 | 0.156 | 0.065 |
| CNG | Transit Bus | 10.625 | 1.992 | 0.000 | 0.000 | 0.000 | 0.056 | 0.016 |

3.2.2.1 Traffic Data

A range of future traffic scenarios in terms of tolling, traffic volumes, and congestion levels were considered, and the most conservative scenario was used in predicting future emissions. As discussed in **Section 5.1.2.4** of the Application, average annual daily traffic volumes (AADT) for 2030 were assessed using TransLink’s RTM for two scenarios– with the new bridge in place and no tolls being applied (TL-RTM Untolled), and with a new tolled bridge in place (TL-RTM Tolled). Given the variability in the forecasting, and to ensure a conservative assessment for EA purposes, the upper range of forecast values (TL-RTM untolled, 2030 With the Project) was used as it represents the highest potential volume of traffic

Forecasts of total traffic within the Project area for the years 2011 and 2031 with and without the Project were generated. The traffic numbers were subsequently broken down to the various MOVES vehicle types, based on Metro Vancouver’s fleet profiles. The traffic data and the emission factors from the MOVES model were used to determine the emission rates of the various contaminants for specific segments along the roadway. For each segment of road, the number of vehicles of each type and the associated emission factor were multiplied together to determine an emission rate per kilometre of road per vehicle. The dispersion model uses the emission rates, the road length, road width, and orientation, along with meteorological data, to predict ambient air quality resulting from traffic flowing on each road segment.

3.2.3 Road Dust

Road dust emissions are not generated as part of the MOVES model but were considered as part of the assessment. Therefore, road dust quantification followed the U.S. EPA methods described in *Compilation of Air Pollutant Emission Factors* (U.S. EPA 2011) AP-42, which deals with paved roads. According to AP-42 methods, road dust emissions are estimated using the following equation:

$$E = k \times (sL^{0.91}) \times (W^{1.02}) \times (1-P/4N)$$

where

k = particle size multiplier

sL = road surface silt loading

W = average weight of vehicles, the input of 1.9 tons was reused from 2005 Inventory

P = number of “wet” days with at least 0.254 mm precipitation

N = number of days in the period (1 year = 365 days)

The values for highway silt content and vehicle fleet average weight, as provided by Metro Vancouver, are 0.075 g/m² and 1.9 tonnes respectively. The data for number of wet days was collected from the meteorological station T17 for 2011 and totaled 147 days. The same values for silt loading, fleet weight, and wet days are considered for 2031. The resulting emission factors for road dust are as follows:

- PM = 0.53 g/VkmT
- PM₁₀ = 0.10 g/VkmT
- PM_{2.5} = 0.02 g/VkmT

The emission factors were applied to the total VkmT for the Project to estimate emissions from road dust. Road dust emissions were estimated to increase in direct proportion to the projected traffic volumes.

3.3 Air Quality Dispersion Modelling

Several models are available for air quality dispersion modelling, with each model offering different strengths and weaknesses. The selection of a model depends on several factors, the main ones being the types of sources, topography, accuracy required, and predictions of the parameters necessary to be assessed. The modelling approach used in this evaluation has been applied in other transportation-related projects in the Lower Mainland, and involves the use of a proven dispersion model for roadways, together with a reliable meteorological model for determining the winds near the Project area.

The *British Columbia Air Quality Modelling Guideline (B.C. Modelling Guideline)*, which outlines recommended steps (e.g. development of a conceptual as well as a detailed model plan) for completing modelling projects, was used to guide Project-related air-quality modelling. Metro Vancouver was involved in the model planning discussions from the early stages, and this consultation helped identify and address some of the issues noted in this assessment.

Predictions of ambient concentrations resulting from vehicle exhaust on highways in this and previous transportation-related assessments in B.C. employed the use of the CALINE3 (CALINE) model. Prior to the latest update of December 2015, the B.C. Modelling Guideline had included CALINE as a recommended model. As per Section 2.3.1 of the current version of the Modelling Guideline, CALINE would be considered an Alternate Model, as none of the Guideline-recommended models are specifically designed for traffic modelling.

CALINE is specifically designed for vehicle emissions from exhaust along roads. Other models such as CALPUFF, a Gaussian-Lagrangian puff dispersion model, or the Industrial Source Complex model (ISC3), a Gaussian plume model, can handle a variety of emission source

types, but do not currently have explicit algorithms to address road sources. The BC Ministry does not recommend any particular models for dispersion modelling of road sources (B.C. MOE 2015). The CAL3QHCR model is an alternative dispersion model for road sources which is focused on modelling of CO and queuing of vehicles at traffic lights. As CAL3QHCR utilizes the CALINE3 algorithms for traffic in motion, the CALINE3 model was deemed the most appropriate model selection for this assessment.

CALINE is the model currently recommended by the U.S. EPA for prediction of air quality impacts of roadway (line) emission sources. Because the CALINE model is U.S. EPA-approved, it has gone through rigorous evaluation to ensure that the model is providing conservative, yet accurate results. Due to CALINE's conservatism, its predicted concentrations tend to be higher than observed ambient air quality, but the model will provide a worst-case estimate of a project's effects on local air quality.

Traffic volumes are put into CALINE and are based on the results from the EMME/2 traffic model for the three traffic (2011 – Existing Roads, 2031 – Without Project, 2031 – With Project) scenarios considered. Emission factors were obtained from MOVES (described in **Section 3.2.2**). CALINE uses road segments to define the roadways in the model and includes emission factors (adjusted for various speed categories), traffic volumes, and the road alignment. The emission rates, in grams per mile per vehicle, were developed for each pollutant and each road segment.

Peak morning rush-hour traffic data were used to determine the maximum one-hour emission rates and in turn the one-hour predicted concentrations. For averaging periods longer than one hour, the annual average daily traffic was used to develop appropriate emission rates. The daily and annual average scenarios take into consideration changes in congestion throughout the course of a day and week that will contribute to changes in the amount of emitted pollutants.

CALINE predicts hourly ambient concentrations at designated receptor locations. Receptors are grid points in Universal Transverse Mercator (UTM) coordinates, where the computer model calculates predicted ambient concentrations. Receptors in this study were spaced at 100 m intervals along the roadway and extended perpendicular to and on either side of the road at intervals of 5, 10, 15, 20, 25, 50, 100, 250, 500 and 1,000 metres from the road (**Figure 1**). In addition to the gridded receptors (yellow dots on **Figure 1**), sensitive receptors such as schools, daycares, hospitals, and other sensitive areas were identified and included in the CALINE receptor grid (purple and pink shapes on **Figure 2**).

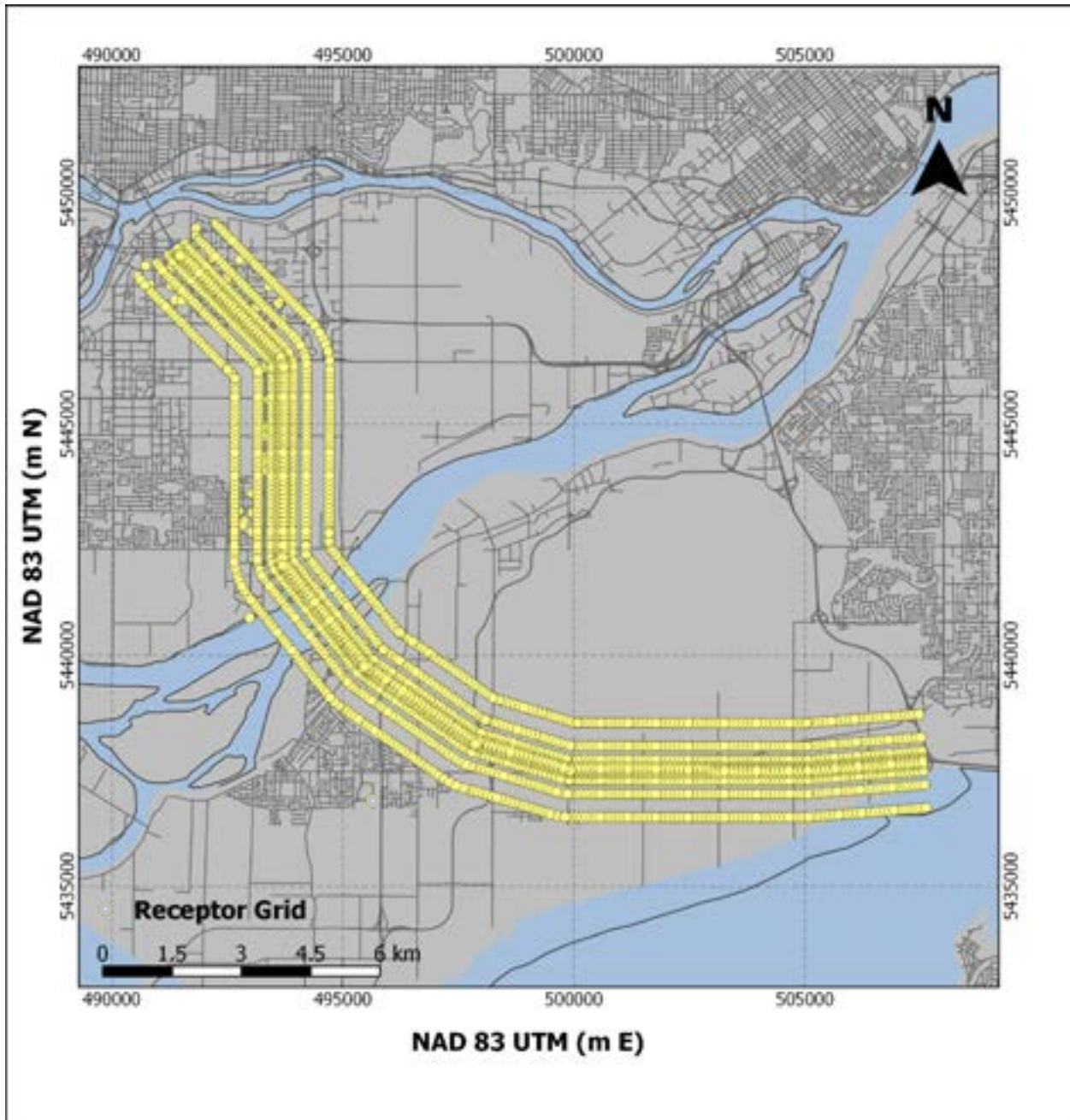


Figure 1 CALINE Receptor Grid

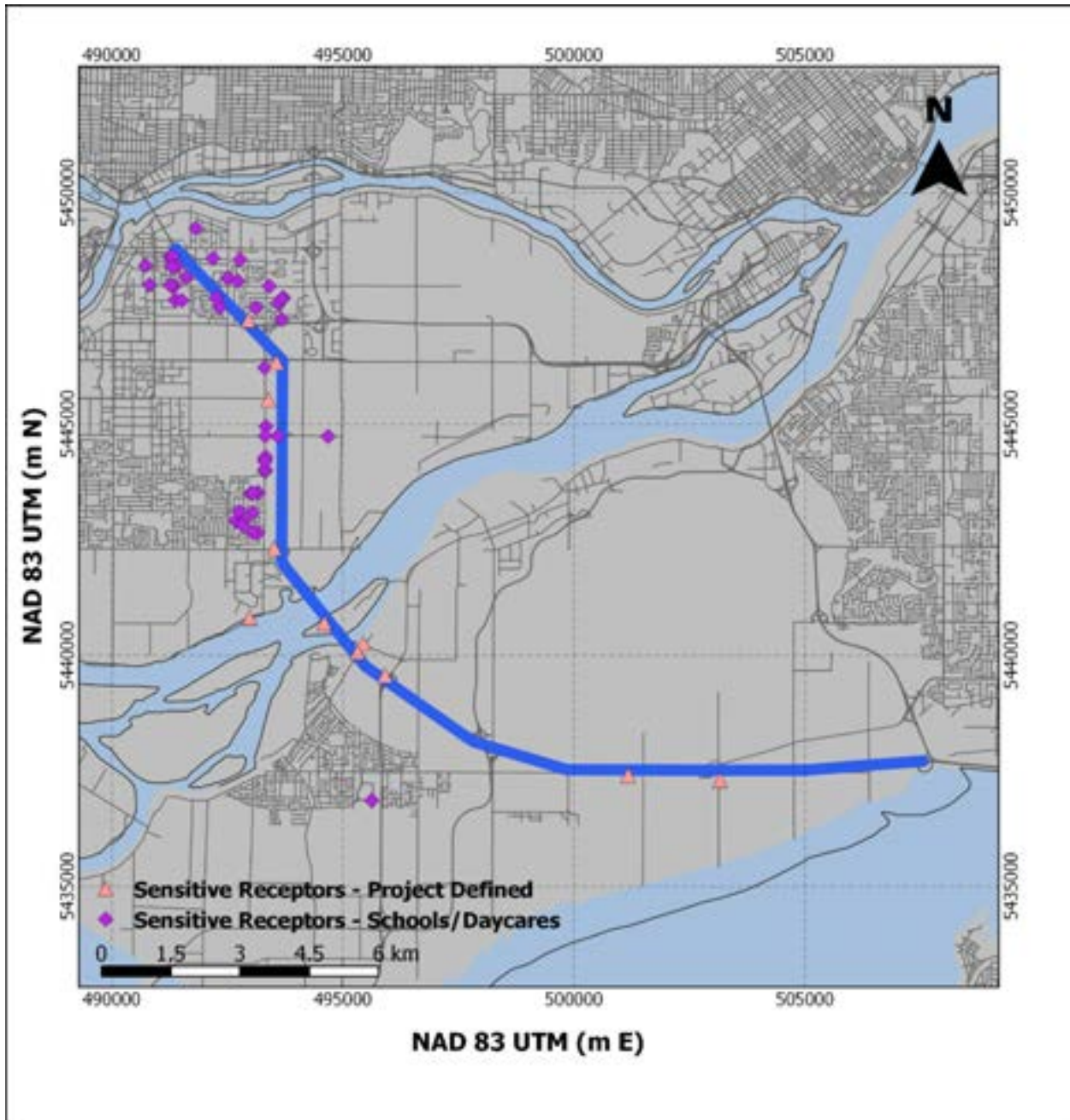


Figure 2 CALINE Sensitive Receptors Only

The CALMET model was used to provide an estimate of the wind fields (see **Section 3.3.1**, below). Meteorological data were extracted from CALMET for a location near the highway. The maximum predicted one-hour, 24-hour, and annual ambient concentrations of all modelled contaminants for traffic emissions were calculated at each receptor and are summarized, tabulated, and discussed in the sections below.

In addition to the maximum values, the maximum 98th percentile of the one-hour and 24-hour predicted ambient concentrations are also tabulated and discussed. The 98th percentile is the value for which ambient concentrations are equal to or less than, 98 per cent of the time. Therefore, if the one-hour 98th percentile for SO₂ concentrations is 8 µg/m³, ambient concentrations will be equal to or less than 8 µg/m³, 98 per cent of the time. The 98th percentile values are important to consider in addition to the maximum because the extreme maximum can often be an anomaly whereas the 98th percentile provides a better representation of maximum effects of the Project on local air quality. The air quality predictions were compared to the strictest applicable federal, provincial or regional (Metro Vancouver) air quality objectives.

3.3.1 Meteorological Data

The CALINE model requires input parameters of wind speed, wind direction, stability class, and mixing height to predict hourly contaminant concentrations. One year of data were extracted from the CALMET model output and used in the CALINE model. CALMET is a U.S. EPA-approved diagnostic meteorological computer model that generates three-dimensional fields of meteorological parameters based on surface and upper air meteorological data, digital land use data, and terrain data.

CALMET was used to characterize the meteorology near each modelled segment of the road for the period from January 1, 2012 to December 31, 2012. The model was run for the entire airshed at a 500 by 500 m grid resolution using a hybrid approach that integrates surface observations with prognostic model data. The surface observations were developed from the stations described in **Table 2**, while the prognostic data were generated from the Weather Research and Forecasting Non-hydrostatic Mesoscale Model, a state-of-the-science forecast model that was used to predict wind fields for the CALMET model. The CALMET model output was extracted at the spatial midpoint of the Project. For each modelled section, an hourly dataset representing one year of data was generated and formatted for input into the CALINE model.

Roughness length, a measurement of length that is used to indicate turbulence characteristics of a particular type of surface, is another parameter required by the model. For example, smooth plains where wind can blow without interference would have a very low roughness length (10 cm), while forested and urban areas with obstacles that can cause higher turbulence and have a longer roughness length. The roughness length for this study was presumed to be typical of an urban area (100 cm). Model results are presented in **Section 5.0**.

3.3.2 CALINE Model Geometry

The local study area extended from Bridgeport Road in Richmond to Highway 91 in Delta, and the EMME/2 traffic model divided the study area into the four road segments used by the CALINE model. For each segment that is modelled, CALINE requires:

- the beginning and end points of the segment (X and Y)
- traffic (number of vehicles per hour)
- emission rate (g/mile)
- whether the area is at grade (AG) or a bridge (BR) segment
- height (height of the bridge for bridge segments, and 0 m for at-grade segments; for the Project, the maximum allowed value of 10 m was used for the bridge segment)
- width of the road based on the existing road for the current and future-without-Project scenarios; for the future-with-Project scenario, incorporated increased lane widths

CALINE uses the UTM coordinates to determine the length and orientation of each segment. To account for dispersion of tailpipe emissions that occur in the turbulent wake behind a moving vehicle, three metres were added to either side of the road width, as recommended in the CALINE user guide (Benson 1979).

The use of the modelled bridge height option of 10 m, though in some cases less than the actual design height for the new bridge, allows the model to calculate the dispersion impact caused by air flowing under the bridge deck. Use of the lower height means the roadside concentrations are slightly higher than would be expected if a higher elevation was used. For modelling the existing Tunnel, the emissions that occurred within the Tunnel were distributed on an immediate segment at the entrance/exit on either side of the Tunnel.

For the two 2031 scenarios considered in this study (i.e., without and with the Project), an additional road segment was added to represent the two kilometres of the South Fraser Perimeter Road (SFPR)/Highway 17 that pass through the Project. Because SFPR was not operational until December, 2013, it was not considered in the 2011 scenario. The results presented in **Section 5** for the 2031 scenarios therefore account for the additional traffic resulting from SFPR.

3.3.3 Conversion for Oxides of Nitrogen

Vehicle emissions of NO_x are primarily in the form of NO (94 per cent) with very little NO₂ (six per cent) present. Since there are no existing objectives for ambient NO_x concentrations (the guidelines refer to NO₂), NO_x concentrations predicted by the model were converted to equivalent NO₂ concentrations using the Ambient Ratio Method (ARM). In accordance with the AQMG, if 100% NO_x conversion leads to exceedances of the AAQO, the Ambient Ratio (AR) method should be implemented to convert predicted NO_x concentrations into NO₂ concentrations. The AR method utilizes representative hourly NO_x and NO₂ monitoring data to characterize the NO₂/NO_x ratio given the ambient NO_x concentration. The method then applies this ratio to the model predicted NO_x emissions from the Project.

Ambient air quality data from Metro Vancouver station T18 (Burnaby South) was used to calculate the ratio of NO₂/NO_x. The resulting ratio was validated against NO₂/NO_x ratios and ambient air quality from Metro Vancouver stations T13 (North Delta) and T17 (Richmond South). For the 1-hour averaging period, an exponential equation of the form $y = ax^b$ was fit to the upper envelope of observed NO₂/NO_x versus NO_x, where a and b are empirically determined constants. The resulting equation was used to determine the ratio of NO₂/NO_x subject to the constraints that the equation is only valid for NO_x values where the corresponding NO₂/NO_x ratio is less than 1. **Figure 3** illustrates the dependence of NO₂/NO_x ratio on ambient NO_x air quality.

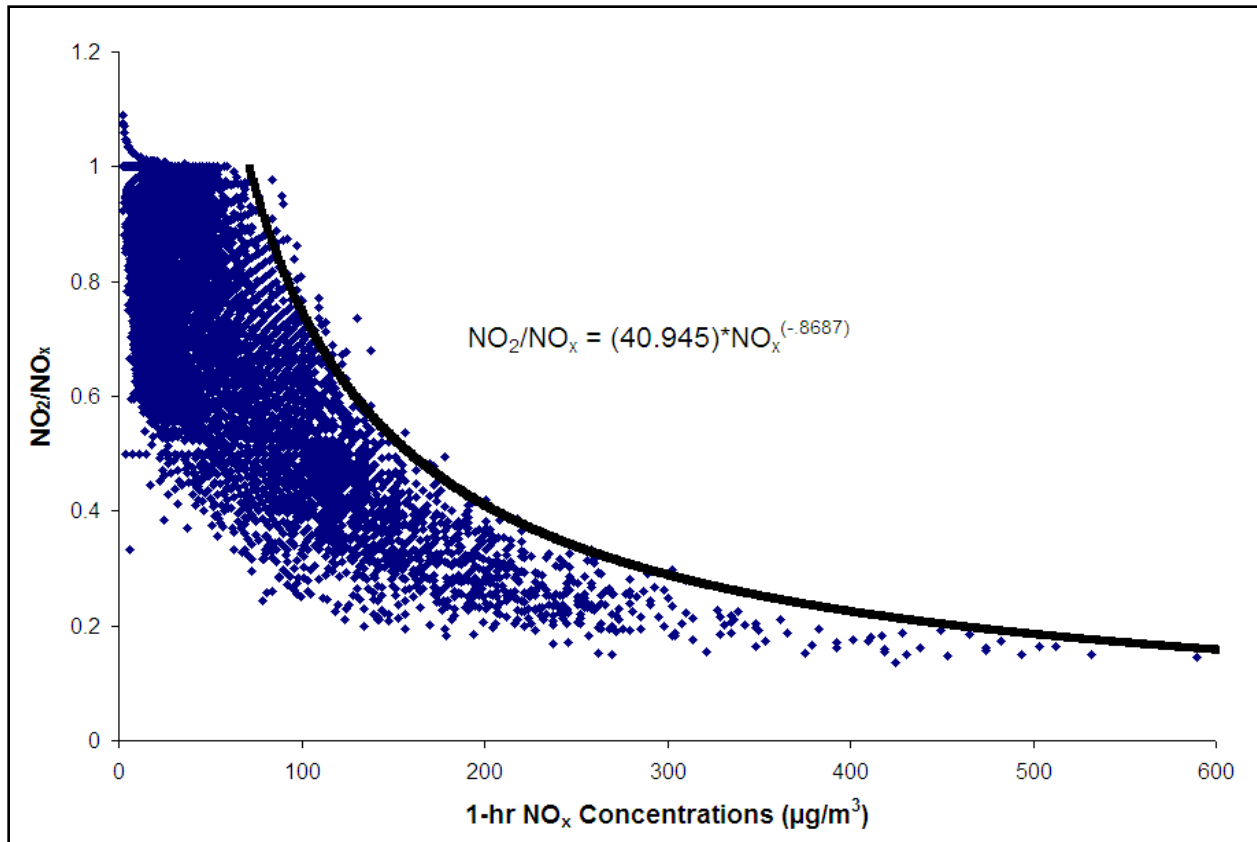


Figure 3 NO₂/NO_x Ratio versus 1-hour Average NO_x Observations from Metro Vancouver Station T18 (Burnaby South)

3.3.4 Ozone

Ground level O₃ is formed through a complex set of atmospheric chemical reactions with NO_x, and VOCs acting as key precursor species. Recent research on ground-level O₃ formation in the Lower Fraser Valley (LFV) (Steyn et al. 2011) revealed that, in the eastern portions of the valley from approximately Abbotsford to Hope, O₃ production is limited by the availability of NO_x; whereas, in western areas of the valley, from approximately Langley to the Georgia Strait, O₃ production is limited by the availability of VOCs. Both the relative amounts of available emissions and their locations affect the potential ground-level O₃ formation.

An estimate was made of potential changes in concentrations of ground-level O₃ based on changes in emissions of NO_x and VOCs. The methodology was based on a simplified model developed for the LFV by Steyn et al. (2011). The projected change in net O₃ concentrations was estimated using the slope of the potential change in O₃ concentration listed in **Table 7**. Modelling of peak ozone is a complex process involving many chemical reactions of various

pollutants and emissions. The US has developed the Community Mesoscale Air Quality Model (CMAQ), which could be used to model peak concentrations of ozone, however, there is no regulatory guidance on how the model should be used, and the possible error in prediction would be more significant than the potential changes in ozone that could be measured in the future.

Table 7 Ozone Concentrations in the Lower Fraser Valley and NOx/VOC Emission Changes

| Parameter | Units | 1985 | 2006 | Change | Slope | |
|---------------------|-------------------|------|------|--------|---|---|
| | | | | | VOC Limited Western LFV | NOx Limited Eastern LFV |
| VOC emissions | t/d | 439 | 296 | -143 | (µg/m ³ O ₃ / tonne per day VOC emission) | (µg/m ³ O ₃ / tonne per day NOx emission) |
| NOx emissions | t/d | 277 | 167 | -110 | | |
| Mean O ₃ | µg/m ³ | 55.4 | 42.2 | -13 | 0.09 | 0.12 |
| Peak O ₃ | µg/m ³ | 138 | 89 | -49 | 0.34 | 0.44 |

- Notes:**
1. Average daily emission rates (metric tonnes per day) within the LfV based on the Metro Vancouver emissions inventories (GVRD 2003, GVRD 2007 as cited in Steyn et al. 2011)
 2. Domain-wide overall ozone performance statistics for all WRF/CMAQ simulations and for the National Research Council (Smyth et al. 2006 as cited in Steyn et al. 2011) MM5/CMAQ 2001 simulation
 3. Table 53 Ozone performance statistics for daily peak ozone concentrations (Steyn et al. 2011)

3.3.5 Secondary Particulate Matter

Based on the overall reduction in emissions attributed to improvements in fleet performance (**Section 4.2.1**), it is anticipated that secondary particulate matter formation will decrease in the future with or without the Project. It should be noted that in locations with net NOx/VOC decreases, airborne radicals that formerly reacted with these compounds become free to react with SO₂, which can cause a small offsetting increase in sulphate aerosols (PM). However, sulphur emissions are also projected to decrease in the scenario of 2031 with the Project. Therefore, the result is expected to be a net reduction in secondary PM formation and is not considered further in this air quality evaluation.

3.3.6 Deposition

While vehicle emissions contribute to ambient air quality, they will eventually settle out of the atmosphere and deposit in areas surrounding the Project through sedimentation and precipitation processes. The CALINE model does not have the ability to model deposition, so the CALPUFF model, using the previously mentioned CALMET modelled data, was used for this purpose. CALPUFF is able to generate predicted wet and dry fluxes of pollutants.

Due to the computationally intensive nature of running CALPUFF, a sub-set of the road network was parameterized and run in the model that contained sensitive receptors, therefore representing a worst-case scenario. A 3.3 kilometer segment of Link 4 was chosen for parameterization in the CALPUFF model. Along this segment, 24 area sources were configured with a width of 14.4 meters and used the same emission factors, receptors and meteorology used in the CALINE model were used to model deposition and arrive at a predicted amount of deposition with distance from the side of the roadway. All other CALPUFF model parameters were set to default in accordance with the BC Air Quality Modelling Guideline.

For each of the three scenarios considered in the study, predicted maximum dry, wet, and total deposition were modelled for PM_{2.5}, PM₁₀, and total PM. The deposition modelling for the 2031 scenario with the Project predicts a maximum deposition of 4.56 g/m²/yr. **Table 8** presents dustfall deposition modelling results for the three scenarios in g/m²/yr.

Table 8 Maximum Predicted Deposition (g/m²/yr)

| Species | 2011 – Existing Roads | | | 2031 – Without Project | | | 2031 – With Project | | |
|-------------------|-----------------------|----------------|------------------|------------------------|----------------|------------------|---------------------|----------------|------------------|
| | Dry Deposition | Wet Deposition | Total Deposition | Dry Deposition | Wet Deposition | Total Deposition | Dry Deposition | Wet Deposition | Total Deposition |
| PM _{2.5} | 9.17E-04 | 4.07E-04 | 1.23E-03 | 9.47E-04 | 4.20E-04 | 1.27E-03 | 8.54E-04 | 4.15E-04 | 1.19E-03 |
| PM ₁₀ | 2.20E-01 | 6.29E-03 | 2.25E-01 | 2.68E-01 | 7.67E-03 | 2.74E-01 | 2.29E-01 | 7.50E-03 | 2.35E-01 |
| PM | 3.92E+00 | 4.56E-02 | 3.95E+00 | 5.09E+00 | 5.92E-02 | 5.13E+00 | 4.52E+00 | 5.46E-02 | 4.56E+00 |

3.4 Greenhouse Gases Evaluation

Greenhouse gases are contributors to the radiative warming effect of the environment that results in global climate change. The major GHGs include CO₂, CH₄ and N₂O, which are emitted from fuel combustion as well as other anthropogenic and natural sources. In addition, the warming effects of black carbon may be significant on a local geographic basis, especially on a shorter time scale¹.

In the context of GHG emissions generated in the Project alignment today, current congestion results in substantially more GHG emissions (CO₂-e) than would occur without such congestion. As illustrated in Table 8, the elimination of the one million vehicle delay hours, that occur annually due to existing congestion, would result in a reduction in CO₂-e emissions by existing traffic of more than 13,000 tonnes.

Table 9 Existing 2011 CO₂-e Emissions, with and without Congestion

| | 2011 Existing Roads | | |
|---|--|--|--------------------------------------|
| | Existing Emissions with Congestion (tonnes/yr) | Emissions without Congestion (tonnes/yr) | Change from Existing with Congestion |
| CO ₂ -e (20-year) ² | 163,157 | 149,774 | -13,383 (-8.2%) |

Considering future GHG emissions in the Project area, **Table 9** summarizes the comparison of emissions for the 2031 scenarios, with and without the Project. For the scenario without the Project, emission estimates have taken into account the effects of traffic congestion during rush hours on a weekday, as described in **Section 4.1**. Emissions for the 2011 existing scenario are also presented, to show the temporal reductions in GHG and black carbon emissions over time.

¹ As described in **Section 2.1.5**, black carbon is present in PM generated by fuel combustion processes, and absorbs solar radiation at all wavelengths. Given its shorter residence time in the atmosphere than GHGs, the use of the 100-year GWP factors to determine CO₂ equivalency may not be appropriate. Hence, published 20-year GWPs for GHGs and black carbon (Solomon et al. 2007, Minjares et al. 2014) were used to estimate the magnitude of the climate change effects of Project-related black carbon emission and its potential contribution to local climate change. Other components such as sulphates, nitrates, and organic carbon (OC) present in particulate matter generally reflect light and have a cooling effect that may partially offset the warming effect of black carbon.

² CO₂e (equivalent) emissions are based on the following respective weighting factors for 20-year and 100-year global warming potential per tonne of emission: CO₂ (1 and 1), CH₄ (72 and 25), N₂O (289 and 298), and black carbon (3,200 and 900).

Table 10 Forecast 2031 CO₂e Emissions, with and without Project (untolled)

| Pollutant | 2011 Existing Roads Emissions (tonnes/yr) | 2031 Emissions (tonnes/yr) | | Change from Without Project Scenario in 2031 |
|---|---|----------------------------|--------------|--|
| | | Without Project | With Project | |
| CO ₂ | 146,939 | 129,338 | 121,493 | -7,845 |
| CH ₄ | 12.2 | 15.0 | 15.1 | 0.1 |
| N ₂ O | 8.0 | 3.5 | 3.5 | 0 |
| Black carbon | 4.1 | 1.1 | 1.2 | 0.1 |
| CO ₂ -e (20-year) | 163,157 | 135,002 | 127,336 | -7,666 (-5.7%) |
| CO ₂ -e (100-year) | 153,287 | 131,753 | 123,973 | -7,780 (-5.9%) |
| Note: Because the new bridge will be tolled, CO ₂ -e reductions with the Project are projected to be greater than those noted above. | | | | |

As illustrated in **Table 10**, a substantial decrease in GHG emissions (CO₂e) on the Highway 99 corridor is forecast between 2011 and 2031, both with and without the Project,³ as newer engine technologies provide significant reductions in overall CO₂e emission levels.

Even if the Project did not include tolling, CO₂-e emissions in 2031 are forecast to decrease by 7,700 to 7,800 tonnes (5.7% to 5.9%) relative to without the Project. This net GHG reduction reflects savings due to congestion relief associated with Project improvements, which more than outweigh emissions associated with higher traffic volumes in an untolled scenario.

The 7,700 to 7,800 tonne annual reduction can be characterized as a “worst case” scenario, since it is based on the Highway 99 corridor being untolled. As the Project will be tolled, GHG reductions are projected to be greater due to the dampening effect on traffic volumes.

³ The only forecast increase in emissions, for CH₄, is due to the combination of increasing traffic and increasing frequency of diesel-engine vehicles, which are projected to outweigh the decrease in CH₄ emission rates for similar-engine vehicles. This CH₄ emissions trend is also observed in Metro Vancouver's 2010 emissions inventory and forecast (Metro Vancouver 2013).

4.0 Emission Estimate Results

4.1 Emission Quantification

To assess the effects of the Project on air quality, the three scenarios (existing 2011 conditions, and future (2031) conditions without, and with the Project) were modelled. In addition to the differences in traffic volumes and road layout among scenarios, speed also changes within each scenario depending on whether peak rush-hour traffic is considered or daily time scales. Vehicle emissions are directly related to vehicle speed and therefore must be considered. The traffic volumes considered in the different scenarios are summarized in **Table 11**.

The emission factors associated with peak traffic periods are a composite which consider 25% of the travel time at low speed to idling conditions and 75% of the time at 10 to 30 km/h. This emission factors were designed to simulate traffic under heavy congestion conditions and was used to estimate emissions for the following scenarios:

- Existing (2011) – peak period consisting of six hours of peak traffic per week day
- Future (2031) without the Project – peak period consisting of 10 hours of peak traffic per week day

Posted speeds were considered when modelling non-peak time periods for weekday and weekend days. Congestion conditions were applied to the Tunnel and adjacent roadway (Segment 3, in **Table 11**). Posted speeds were applied to the rest of the roadway upstream and downstream of the Tunnel as traffic is assumed to move through those sections without major congestion.

Table 11 Estimated Daily^a Traffic Volumes for Each Modelled Scenario

| Link # | Direction | Link Description | Existing Roads (2011) | Future (2031) Without Project | Future (2031) With Project |
|----------------|-------------|-------------------------------|-----------------------|-------------------------------|----------------------------|
| 1 | North Bound | Bridgeport to Westminster | 39,000 | 45,000 | 48,000 |
| 1 | South Bound | Bridgeport to Westminster | 36,500 | 39,500 | 42,000 |
| 2 | North Bound | Westminster to Steveston | 38,500 | 45,500 | 52,000 |
| 2 | South Bound | Westminster to Steveston | 37,000 | 46,500 | 55,000 |
| 3 ^b | North Bound | Tunnel/new Bridge | 41,000 | 47,500 | 53,500 |
| 3 ^a | South Bound | Tunnel/new Bridge | 41,000 | 51,500 | 61,000 |
| 4 | North Bound | Highway 17A to Highway 17 | 25,000 | 28,000 | 33,000 |
| 4 | South Bound | Highway 17A to Highway 17 | 26,000 | 38,500 | 43,000 |
| 5 | North Bound | Highway 17 to Ladner Trunk Rd | 25,000 | 31,000 | 31,500 |
| 5 | South Bound | Highway 17 to Ladner Trunk Rd | 26,000 | 36,500 | 40,500 |
| 6 | North Bound | Ladner Trunk to Highway 91 | 22,500 | 26,000 | 26,000 |
| 6 | South Bound | Ladner Trunk to Highway 91 | 24,500 | 34,000 | 37,500 |

Notes

^a Annual emissions are calculated by multiplying the emissions of a weekday by 261 plus by multiplying the emissions of a weekend by 104.

^b Average daily traffic volumes were not broken down by weekdays and weekend days. While volumes can be expected to be greater on weekdays than on weekend days, for the purposes of calculating vehicle emissions, daily volumes were assumed to be the same throughout the week. Thus although the traffic volumes are similar, the speeds considered during weekdays and weekend days were different.

As presented in **Table 11** congestion is expected to increase in 2031 if no alterations are considered to the existing network. When drivers are faced with long travelling delays, there is a tendency to find alternative routes. This results in a decrease in the expected number of vehicles travelling on that route and an increase of traffic volumes on alternative routes. However, in the case of the projected 2031 scenario with the new bridge, no congestion has been assumed. The configuration with the Project will not only maintain the regular route users, but will also divert additional traffic from other routes.

4.2 Vehicle Emissions

Vehicle-generated emissions of CACs and TACs for the 2031 scenarios with and without the Project are summarized in **Table 12**, which also shows the per cent emission changes that may occur in the future scenarios when compared with the 2011 estimates.

Table 12 Annual Emissions: Existing and Future with and without the Project

| Species | Emissions (tonnes/yr) | | | Change from 2011 (%) | | Difference between Future With and Without the Project (%) |
|-------------------------------|-----------------------|-----------------|--------------|----------------------|--------------|--|
| | Existing Roads | Without Project | With Project | Without Project | With Project | |
| | 2011 | 2031 | 2031 | | | |
| VOCs | 234.4 | 139.9 | 123.5 | -40% | -47% | -12% |
| CO | 3594.5 | 3216.5 | 3444.7 | -11% | -4% | 7% |
| NO _x | 388.4 | 166.1 | 169.6 | -57% | -56% | 2% |
| SO ₂ | 2.7 | 2.8 | 2.6 | 4% | -2% | -6% |
| NH ₃ | 11.8 | 9.8 | 9.6 | -17% | -19% | -2% |
| PM (Vehicles) | 14.9 | 12.8 | 9.4 | -14% | -37% | -27% |
| PM ₁₀ (Vehicles) | 14.9 | 12.8 | 9.4 | -14% | -37% | -27% |
| PM _{2.5} (Vehicles) | 11.0 | 7.2 | 6.3 | -35% | -42% | -11% |
| Diesel PM | 4.1 | 0.4 | 0.4 | -89% | -91% | -18% |
| PM (Road Dust) | 279.5 | 345.4 | 383.2 | 24% | 37% | 11% |
| PM ₁₀ (Road Dust) | 53.6 | 66.3 | 73.5 | 24% | 37% | 11% |
| PM _{2.5} (Road Dust) | 13.0 | 16.0 | 17.8 | 24% | 37% | 11% |
| Benzene | 7.8 | 4.1 | 4.2 | -47% | -47% | 1% |
| Naphthalene | 0.5 | 0.3 | 0.3 | -44% | -46% | -3% |
| 1,3-Butadiene | 0.8 | 0.4 | 0.4 | -49% | -46% | 5% |
| Formaldehyde | 2.8 | 1.7 | 1.7 | -37% | -40% | -5% |
| Acetaldehyde | 2.4 | 1.3 | 1.3 | -44% | -43% | 1% |
| Acrolein | 0.2 | 0.1 | 0.1 | -47% | -50% | -5% |
| Benzo(a)pyrene | 8.4E-04 | 5.7E-04 | 5.9E-04 | -33% | -31% | 3% |

Table 12 shows that, in general, the predicted emissions of most pollutants are lower in 2031 than in 2011. Although traffic in 2031 is projected to have increased by 23 per cent without the Project and 37 per cent with the Project (as described in Section 4.1 and shown in Table 9), reductions in emissions per vehicle by 2031 are large enough to offset increases in traffic volume. The reductions in per-vehicle emission by 2031 are due to the introduction of newer engine technologies in the vehicle fleet that provide better fuel efficiency.

Road dust and SO₂ are the two pollutants that are not projected to decrease by 2031. Road dust emissions are dependent only on VkmT, silt loading, vehicle fleet average weight, and precipitation days per year. Since all parameters are considered constant from 2011 to 2031, except for the VkmT, road dust emissions increase in direct proportion to VkmT growth as a result of increased traffic volume.

SO₂ emissions are highly dependent on fuel quality and consumption. Since there is no new fuel regulation being planned or implemented, the increase that occurs in SO₂ emissions in 2031 without the project is likely due to number of vehicles entering the fleet resulting in higher overall fuel consumption. Although the SO₂ emission factors show a slight decrease from 2011 to 2031, this decrease is not enough to offset the anticipated increase in traffic volumes and congestion in 2031 without the Project. The emissions of SO₂ are lower in 2031 with the Project than without the Project due to the lower levels of congestion expected with the new bridge.

Most pollutants, including TACs, show a declining emissions trend when comparing the 2031 scenario with Project to 2031 without the Project. The decrease in emissions is due to less congestion expected to occur in the road network with the Project. Overall, the reduction in emissions per vehicle is greater than the increase in emissions that would be anticipated to occur as a result of increases in traffic volumes. The only exceptions to this are the emissions of CO, NO_x, benzene, 1,3-butadiene, acetaldehyde and benzo(a)pyrene. The reduction of emissions per vehicle for these pollutants is not large enough to offset increases in traffic volume. Lastly, as mentioned previously, road dust emissions are only dependent on VkmT; therefore, the emissions are projected to increase linearly, in the 2031 with Project scenario, to the traffic growth in the absence of any other mitigating factors.

The declining emissions trend observed for road segment 3 (Tunnel) alone is much more significant when comparing the 2031 scenario with Project to 2031 without the Project. This trend is shown in **Table 13**. For the 2031 with Project scenario, all CAC pollutants associated with segment 3, with the exception of road dust, show a marked decline ranging from 56 per cent for VOC, 6 per cent for CO, 25 per cent for NO_x, 45 per cent for SO₂, 73 per cent for vehicle PM₁₀, 55 per cent for vehicle PM_{2.5} and 64 per cent for diesel PM. Similar trend is also

observed for TAC emissions. This pollutant declining trend is attributable to less congestion on this segment after the Tunnel is replaced with a new bridge. The increase in road dust shown in **Table 13** is primarily due to the increase in VkmT as discussed previously.

Table 13 Annual Emissions: Existing and Future with and without the Project for Road Segment 3 (Tunnel / new bridge and approach)

| Species | Emissions (tonnes/yr) | | | Change from 2011 (%) ¹ | | Difference between Future With and Without the Project (%) |
|-------------------------------|-----------------------|-----------------|--------------|-----------------------------------|--------------|--|
| | Existing Segment 3 | Without Project | With Project | Without Project | With Project | |
| | 2011 | 2031 | 2031 | | | |
| VOCs | 62.5 | 46.3 | 20.5 | -26% | -67% | -56% |
| CO | 683.7 | 604.6 | 570.8 | -12% | -17% | -6% |
| NOx | 78.1 | 37.5 | 28.1 | -52% | -64% | -25% |
| SO ₂ | 0.7 | 0.8 | 0.4 | 21% | -34% | -45% |
| NH ₃ | 2.7 | 2.5 | 1.6 | -5% | -40% | -37% |
| PM (Vehicles) | 4.8 | 5.7 | 1.6 | 18% | -68% | -73% |
| PM ₁₀ (Vehicles) | 4.8 | 5.7 | 1.6 | 18% | -68% | -73% |
| PM _{2.5} (Vehicles) | 2.9 | 2.3 | 1.1 | -20% | -64% | -55% |
| Diesel PM | 1.2 | 0.2 | 0.1 | -87% | -95% | -64% |
| PM (Road Dust) | 45.5 | 54.9 | 63.5 | 21% | 40% | 16% |
| PM ₁₀ (Road Dust) | 8.7 | 10.5 | 12.2 | 21% | 40% | 16% |
| PM _{2.5} (Road Dust) | 2.1 | 2.5 | 2.9 | 21% | 40% | 16% |
| Benzene | 1.7 | 1.0 | 0.7 | -42% | -58% | -28% |
| Naphthalene | 0.1 | 0.1 | 4.3E-02 | -37% | -62% | -40% |
| 1,3-Butadiene | 0.2 | 0.1 | 0.1 | -48% | -56% | -14% |
| Formaldehyde | 0.7 | 0.5 | 0.3 | -26% | -58% | -44% |
| Acetaldehyde | 0.5 | 0.3 | 0.2 | -39% | -56% | -28% |
| Acrolein | 4.0E-02 | 2.3E-02 | 1.3E-02 | -41% | -66% | -43% |
| Benzo(a)pyrene | 2.2E-04 | 1.2E-04 | 9.7E-05 | -44% | -55% | -21% |

Note: The emission numbers in columns 2, 3, and 4 have been rounded off to the tenth decimal place, and may not accurately reflect the percent change from 2011 as presented in this column.

5.0 Dispersion Modelling Results

5.1 Existing Air Quality

Ambient air quality evaluations provide an indication of the overall air quality within a localized area, rather than an analysis of specific emission sources. This type of an evaluation offers an insight into air quality within an area prior to the addition or modification of sources of air contaminants, such as the proposed modifications identified for the Project. The air quality evaluation can then be used to determine the capacity of the airshed to accept additional emission inputs while maintaining a desirable level of air quality.

5.1.1 Summary of Background Ambient Air Quality

The following are key results based on the data recorded at the monitoring stations:

- The measured CO concentrations are similar at T15, T18 and T31, while T39 records relatively low concentrations. Station T17 recorded the highest maximum one-hour concentration but was still well below the most stringent AAQO.
- The measured NO₂ concentrations were consistent across all monitoring stations.
- The measured ground level O₃ concentrations are similar at all locations. Each station recorded exceedances of the one-hour, 24-hour, and annual AAQO, while only T13, T15 and T17 exceeded the 8-hour average AAQO.
- The measured PM₁₀ concentrations were similar at the two locations that monitor for PM₁₀ (T18, T31).
- The measured one-hour PM_{2.5} concentrations vary across stations while the 24-hour and annual concentrations are consistent across stations. T13, T18, T31, and T39 all recorded exceedances of the most stringent 24-hour AAQO.
- The measured SO₂ concentrations at the four stations where SO₂ is recorded (T17, T18, T31 and T39) are similar.

Except where noted, the Metro Vancouver monitoring stations can be considered as representative of the air quality in the Project area, and they can be used to set a baseline air quality against which effects of the proposed Project can be measured.

Baseline values for CO, NO₂, PM₁₀, PM_{2.5}, and SO₂ were established from the ambient air quality data analysis using data from the Metro Vancouver network of monitoring stations. **Table 14** presents the background values that are used as a basis for assessing the potential impact of the Project's emissions on the local air quality. For the non-annual averaging periods, the maximum 98th percentile from the six stations and five years of data analyzed are used as the background. The annual baseline value is the average of the maximum annual average ambient concentrations across all six ambient air quality stations.

Table 14 Background Values for CO, NO₂, PM₁₀, PM_{2.5} and SO₂

| | CO | | | NO ₂ | | | PM _{2.5} | | PM ₁₀ | | SO ₂ | | |
|--------------------------------------|-------|-------|-------|-----------------|------|------|-------------------|-----|------------------|------|-----------------|------|-----|
| | 1-h | 8-h | Yr | 1-h | 24-h | Yr | 24-h | Yr | 24-h | Yr | 1-h | 24-h | Yr |
| Base-line Value (µg/m ³) | 1,271 | 1,116 | 287.6 | 75.2 | 62.3 | 24.6 | 14.6 | 4.4 | 28.9 | 12.8 | 9.9 | 7.0 | 2.0 |

Table 15 provides a summary of the background values for the available TACs, benzene, and 1,3-butadiene. The 24-hour value in both cases is the maximum recorded concentration during the period while the annual concentration is based on the maximum annual average from the Burnaby South National Air Pollution Surveillance monitoring station.

Table 15 Background Values for Toxic Air Contaminants

| | Benzene | | 1,3-butadiene | |
|-------------------------------------|---------|-------|---------------|------|
| | 24-h | Yr | 24-h | Yr |
| Baseline Value (µg/m ³) | 2.44 | 0.635 | 0.43 | 0.08 |

5.2 Results by Pollutant

Presented below are the predicted concentrations of CACs and TACs associated with Highway 99 traffic in the Project area. Each sub-section presents the results from the three traffic scenarios considered in this evaluation. For each pollutant, the most stringent ambient air quality objective is listed; bolded values indicate an exceedance of the applicable AAQO. For all pollutants except VOCs, predicted concentrations are presented for those averaging periods (i.e., 1-hour, 8-hour, 24-hour, or Annual) that have AAQO associated with them. There are no AAQOs for VOCs and formaldehyde; predicted concentrations of these compounds averaged over one hour, 24 hours, and one year are presented to facilitate a comparison of future conditions against current conditions.

5.2.1 Volatile Organic Compounds

Table 16 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for VOCs.

Table 16 Predicted Concentrations of Volatile Organic Compounds

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 2,796.7 | 1,167.9 | 1,832.2 | 764.2 | 393.5 | 134.4 | n/a |
| 24-hour | 256.3 | 162.2 | 193.7 | 123.1 | 49.4 | 32.9 | n/a |
| Annual | 73.4 | n/a | 55.8 | n/a | 13.8 | n/a | n/a |

Note: n/a = not applicable

There are no AAQOs for VOCs, but the 2011 existing scenario has the highest predicted concentrations of the three scenarios, while the 2031 scenario with the Project has the lowest predicted concentrations.

5.2.2 Carbon Monoxide

Table 17 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for CO.

Table 17 Predicted Concentrations of Carbon Monoxide

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 20,325.1 | 8,616.0 | 17,500.5 | 7,422.3 | 10,977.6 | 3,758.8 | 14,300 |
| 8-hour | 4,980.6 | 2,491.8 | 4,470.6 | 2,348.2 | 2,439.8 | 1,222.7 | 5,500 |

Note: Bolded values indicate exceedances of the relevant AAQO

For the existing scenario in 2011 and the 2031 without Project scenario, the maximum one-hour predicted concentration for CO exceeds the most stringent AAQO. None of the maximum 98th percentile 1-hour predications exceed the AAQO. The 2031 with Project 1-hour CO is 77 per cent of the most stringent objective of 14300 µg/m³. There are no exceedances of the most stringent eight-hour AAQO.

5.2.3 Nitrogen Dioxide

Table 18 and **Table 19** presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for NO₂. Modelled concentrations of NO_x were converted to NO₂ using 100% conversion (very conservative) and the Ambient Ratio Method method described in **Section 3.3.3**.

Table 18 Predicted Concentrations of Nitrogen Dioxide, 100% NO_x Conversion

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 2,574.1 | 1,086.0 | 1,252.4 | 526.0 | 539.7 | 184.0 | 188 |
| Annual | 92.8 | n/a | 45.4 | n/a | 18.6 | n/a | 40 |

Notes:
 Bolded values indicate exceedances of the relevant AAQO;
 n/a = not applicable

Table 19 Predicted Concentrations of Nitrogen Dioxide, ARM Conversion

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 115.6 | 104.1 | 105.9 | 96.0 | 96.3 | 87.3 | 188 |

Notes:
 Bolded values indicate exceedances of the relevant AAQO;
 n/a = not applicable

When NO_x is converted to NO₂ with the 100% conversion method, all three scenarios exceed the one-hour objective with the exception of the 1-hour 98th percentile for the 2031 with Project scenario. This is a very conservative approach as all emitted NO_x does not convert to NO₂. Applying the more refined ARM method of NO_x conversion, there are no exceedances of the 1-hour ambient air quality objectives. The ARM method is restricted to only 1-hour concentrations as there is not sufficient annual data to develop an ARM curve for annual concentrations.

Under ARM, the 2011 scenario is 61 per cent of the most stringent objective while the 2031 without project is 56 per cent of the objective. The 2031 with project is 51 per cent of the most stringent 1-hour objective.

5.2.4 Sulphur Dioxide

Table 20 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for SO₂.

Table 20 Predicted Concentrations of Sulphur Dioxide

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 27.6 | 11.6 | 29.9 | 12.5 | 8.3 | 2.8 | 196 |
| 24-hour | 2.7 | 1.7 | 3.3 | 2.2 | 1.0 | 0.7 | 125 |
| Annual | 0.8 | n/a | 1.0 | n/a | 0.3 | n/a | 25 |

Note: n/a = not applicable

No exceedances were predicted for SO₂ in any of the three scenarios modelled. For the existing scenario, the maximum predicted one-hour concentration is 14 per cent of the objective, while the maximum predicted 24-hour and annual concentrations are two and three per cent of their respective objectives. The 2031 scenario without the Project has a maximum predicted one-hour concentration that is 15 per cent of the most stringent AAQO. The maximum 24-hour and annual concentrations are three and four per cent of their respective objectives. The 2031 scenario with the Project has a maximum predicted one-hour concentration of four per cent of the one-hour objective, while the maximum predicted 24-hour concentration and annual concentration are one percent of the objective.

5.2.5 Ammonia

Table 21 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for NH₃.

Table 21 Predicted Concentrations of Ammonia

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 11.0 | 6.9 | 10.5 | 6.9 | 3.8 | 2.5 | 100 |

For each of the three scenarios modelled, there are no exceedances of the 24-hour objective for NH₃. The 2011 scenario has a maximum predicted 24-hour concentration, which is 11 per cent of the objective. For the 2031 without the Project, the maximum 24-hour predicted concentration is 10 per cent of the objective, while the 2031 with the Project is four per cent of the objective.

5.2.6 Fine Particulate Matter

Table 22 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for PM_{2.5}.

Table 22 Predicted Concentrations of Fine Particulate Matter

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 12.1 | 7.6 | 9.6 | 6.4 | 2.5 | 1.7 | 25 |
| Annual | 3.5 | n/a | 2.8 | n/a | 0.7 | n/a | 8 |

Note: n/a = not applicable

No exceedances were predicted for PM_{2.5} in any of the three scenarios modelled. For the existing scenario, the maximum predicted 24-hour concentration is 48 per cent of the objective. The maximum predicted annual average is 39 per cent for the 2031 without the Project and 10 per cent of the objective in the 2031 with Project scenario.

5.2.7 Inhalable Particulate Matter

Table 23 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for PM₁₀.

Table 23 Predicted Concentrations of Inhalable Particulate Matter

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 19.5 | 12.4 | 23.1 | 15.3 | 3.8 | 2.5 | 50 |
| Annual | 5.6 | n/a | 6.8 | n/a | 1.1 | n/a | 20 |

Note: n/a = not applicable

The predicted maximum 24-hour and annual concentrations for the 2011 existing scenario are under the most stringent AAQOs, and are 39 per cent and 28 per cent of the objectives, respectively. For the 2031 scenario without the Project, there are no predicted exceedances of the 24-hour or annual objective. The predicted maximum 24-hour concentration is 46 per cent of the most stringent objective, while the maximum predicted annual concentration is 34 per cent of the most stringent AAQO. With the Project operational in 2031, the maximum predicted 24-hour and maximum predicted annual concentrations are eight per cent and six per cent of the most stringent objectives, respectively.

5.2.8 Road Dust

Table 24 and Table 25 present the predicted maximum and maximum 98th percentile concentrations from the dispersion model for the PM₁₀ and PM_{2.5} component of road dust.

Table 24 Predicted Concentrations of Inhalable Particulate Matter from Road Dust

| Averaging Period | 2011 - Existing Roads | | 2031 - Without Project | | 2031 - With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 37.1 | 23.1 | 45.1 | 29.2 | 29.5 | 19.6 | 50 |
| Annual | 11.7 | n/a | 14.2 | n/a | 8.1 | n/a | 20 |

Note: n/a = not applicable

None of the scenarios are predicted to exceed the AAQOs.

The maximum predicted 24-hour average concentration for the 2011 existing scenario is 74 per cent of the most stringent AAQO, while the maximum predicted annual average concentration is 59 per cent of the objective. In the 2031 scenario without the Project, the maximum predicted 24-hour average concentration is 90 per cent of the objective. The maximum predicted annual average concentration is 71 per cent of the most stringent AAQO. For the operational phase of the Project in 2031, the maximum predicted 24-hour average concentration is 59 per cent of the objective, while the maximum predicted annual average concentration is 40 per cent of the objective.

Table 25 Predicted Concentrations of Inhalable Fine Particulate Matter from Road Dust

| Averaging Period | 2011 - Existing Roads | | 2031 - Without Project | | 2031 - With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 9.0 | 5.6 | 10.9 | 7.1 | 7.1 | 4.7 | 25 |
| Annual | 2.8 | n/a | 3.4 | n/a | 2.0 | n/a | 8 |

Note: n/a = not applicable

There are no predicted exceedances of the PM_{2.5} objectives for any of the three modelled scenarios. The maximum predicted 24-hour average concentration for the 2011 existing scenario is 36 per cent of the most stringent AAQO, while the maximum predicted annual average concentration is 35 per cent of the objective. In the 2031 scenario without the Project, the maximum predicted 24-hour average concentration is 44 per cent of the objective. The maximum predicted annual average concentration is 43 per cent of the most stringent AAQO. For the operational phase of the Project in 2031, the maximum predicted 24-hour average concentration is 28 per cent of the objective, while the maximum predicted annual average concentration is 24 per cent of the objective.

5.2.9 Benzene

Table 26 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for benzene.

Table 26 Predicted Concentrations of Benzene

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 58.0 | 24.4 | 32.4 | 13.6 | 13.3 | 4.5 | 30 |
| 24-hour | 6.9 | 4.3 | 4.0 | 2.6 | 1.7 | 1.1 | 2.3 |
| Annual | 2.0 | n/a | 1.2 | n/a | 0.5 | n/a | 0.45 |

Notes:
 Bolded values indicate exceedances of the relevant AAQO
 n/a = not applicable

For the existing scenario in 2011, the predicted maximum one-hour average concentration exceeds the AAQO, but the 98th percentile does not exceed the objective. The 24-hour and annual concentrations also exceed the AAQO. The 2031 scenario without the Project has exceedances for the maximum predicted 24-hour and annual averaging periods. The maximum predicted 98th percentile does not exceed the AAQO. In the 2031 with the Project operational, there are predicted exceedances for the annual objective only. The maximum predicted one-hour concentration is 44 per cent of the objective.

5.2.10 Naphthalene

Table 27 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for naphthalene.

Table 27 Predicted Concentrations of Naphthalene

| Averaging Period | 2011 - Existing Roads | | 2031 - Without Project | | 2031 - With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 0.5 | 0.3 | 0.3 | 0.2 | 0.1 | 0.1 | 22.5 |

For each of the three scenarios modelled, there are no exceedances of the 24-hour objective for naphthalene. The 2011 existing scenario has a maximum predicted 24-hour concentration that is two per cent of the objective. For the 2031 scenario without the Project, the maximum 24-hour predicted concentration one per cent of the objective, while the 2031 with the Project is less than one per cent of the objective.

5.2.11 1,3-butadiene

Table 28 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for 1,3-butadiene.

Table 28 Predicted Concentrations of 1,3-Butadiene

| Averaging Period | 2011 - Existing Roads | | 2031 - Without Project | | 2031 - With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 0.7 | 0.4 | 0.4 | 0.2 | 0.2 | 0.1 | 10 |
| Annual | 0.2 | n/a | 0.1 | n/a | 0.0 | 4.9E-02 | 2 |

Note: n/a = not applicable

The 24-hour average concentration is seven per cent of the most stringent AAQO, while the maximum predicted annual average concentration is 10 per cent of the objective. In the 2031 scenario without the Project, the maximum predicted 24-hour average concentration is four per cent of the objective. The maximum predicted annual average concentration is five per cent of the most stringent AAQO. For the 2031 scenario with the Project, both the maximum predicted 24-hour average concentration are two per cent of the objective.

5.2.12 Formaldehyde

Table 29 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for formaldehyde. There are no ambient air quality objectives available for formaldehyde.

Table 29 Predicted Concentrations of Formaldehyde

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 26.3 | 11.0 | 18.1 | 7.6 | 0.8 | 0.3 | 60 |

Note: n/a = not applicable

There are no exceedances of the BC Action air quality objective for formaldehyde on the 1-hour averaging period. The 2011 scenario maximum concentration is 44 per cent of the objective. The 2031 without Project scenario and the 2031 with Project scenario are 30 per cent and 1 per cent of the objective, respectively.

5.2.13 Acetaldehyde

Table 30 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for acetaldehyde.

Table 30 Predicted Concentrations of Acetaldehyde

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 18.1 | 7.6 | 10.5 | 4.4 | 4.3 | 1.5 | 90 |
| 24-hour | 2.1 | 1.3 | 1.3 | 0.9 | 0.5 | 0.4 | 500 |

No exceedances were predicted for acetaldehyde in any of the three scenarios modelled. For the existing scenario, the maximum predicted one-hour concentration is 20 per cent of the objective, while the maximum predicted 24-hour is less than one per cent of the objective. The 2031 scenario without the Project has a maximum predicted one-hour concentration that is 12 per cent of the most stringent AAQO. The maximum 24-hour is less than one per cent of the objective. The 2031 scenario with the Project has a maximum predicted one-hour concentration that is five per cent of the one-hour objective, while the maximum predicted 24-hour concentration is less than one per cent of the objective.

5.2.14 Acrolein

Table 31 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for acrolein.

Table 31 Predicted Concentrations of Acrolein

| Averaging Period | 2011 - Existing Roads | | 2031 – Without Project | | 2031 – With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 1-hour | 1.7 | 0.7 | 0.9 | 0.4 | 0.3 | 0.1 | 4.5 |
| 24-hour | 0.2 | 0.1 | 0.1 | 0.1 | 3.2E-02 | 2.1E-02 | 0.4 |

No exceedances were predicted for acrolein in any of the three scenarios modelled. For the existing scenario, the maximum predicted one-hour concentration is 37 per cent of the objective, while the maximum predicted 24-hour concentration is 41 per cent of the objective. The 2031 scenario without the Project has a maximum predicted one-hour concentration that is 19 per cent of the most stringent AAQO. The maximum 24-hour concentration is 24 per cent of the objective. The 2031 scenario with the Project has a maximum predicted one-hour concentration of six per cent of the one-hour objective, while the maximum predicted 24-hour is 8 per cent of the objective.

5.2.15 Benzo(a)pyrene

Table 32 presents the predicted maximum and maximum 98th percentile concentrations from the dispersion model for benzo(a)pyrene. For all three scenarios, the predicted maximum 24-hour and annual concentrations exceed the AAQO.

Table 32 Predicted Concentrations of Benzo(a)pyrene

| Averaging Period | 2011 - Existing Roads | | 2031 - Without Project | | 2031 - With Project | | Ambient Air Quality Objective |
|------------------|-----------------------|-----------------------------|------------------------|-----------------------------|---------------------|-----------------------------|-------------------------------|
| | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | Maximum Predicted | 98 th Percentile | |
| 24-hour | 8.9E-04 | 5.7E-04 | 5.1E-04 | 3.3E-04 | 2.3E-04 | 1.6E-04 | 5.00E-05 |
| Annual | 2.6E-04 | n/a | 1.5E-04 | n/a | 6.4E-05 | n/a | 1.00E-05 |

Notes:

Bolded values indicate exceedances of the relevant AAQO

n/a = not applicable

5.2.16 Ozone

Estimations of the change in O₃ concentrations are summarized for 2031 with and without the Project are summarized in **Table 33** (Steyn et al. 2011). The analysis suggests that in the western portion of the LFV, which is VOC-limited, a reduction in NO_x and VOC emissions without the Project would result in a very slight increase (less than 0.1 µg/m³) in O₃ concentrations in 2031 compared with 2011 existing concentrations. A reduction in NO_x and VOC emissions with the Project would result in a very slight increase (less than 0.1 µg/m³) in O₃ concentrations in 2031 compared with 2011 existing concentrations. When comparing 2031 with and without the Project, the change in NO_x and VOC emissions is so small that there is a negligible difference in expected O₃ concentrations.

Overall, the change in O₃ concentrations is negligible, with a worst-case estimate of a peak change of less than 0.1 µg/m³ in 24-hour average concentrations. These changes in ground-level O₃ are considered to be negligible because they fall within the range of accuracy of O₃ sampling equipment (i.e., ±1 ppb or ±2 µg/m³). Therefore, the change in O₃ levels, with or without the Project, would fall within the noise levels of O₃ monitoring equipment, resulting in no measurable change in O₃ levels in the LFV.

Table 33 Predicted Maximum Concentrations (µg/m³) for Ozone

| Criteria | 100 µg/m ³ | 121.6 µg/m ³ | 30 µg/m ³ | 30 µg/m ³ |
|-----------------------------------|---|-------------------------|----------------------|----------------------|
| | O ₃ Concentration, µg/m ³ | | | |
| Emissions Scenario | 1 h | 8 h | 24 h | Annual |
| 2011 O ₃ concentration | 88.7 | 84.7 | 81.6 | 47.2 |
| 2031 without the Project | 88.7 | 84.7 | 81.6 | 47.2 |
| 2031 with the Project | 88.7 | 84.7 | 81.6 | 47.2 |

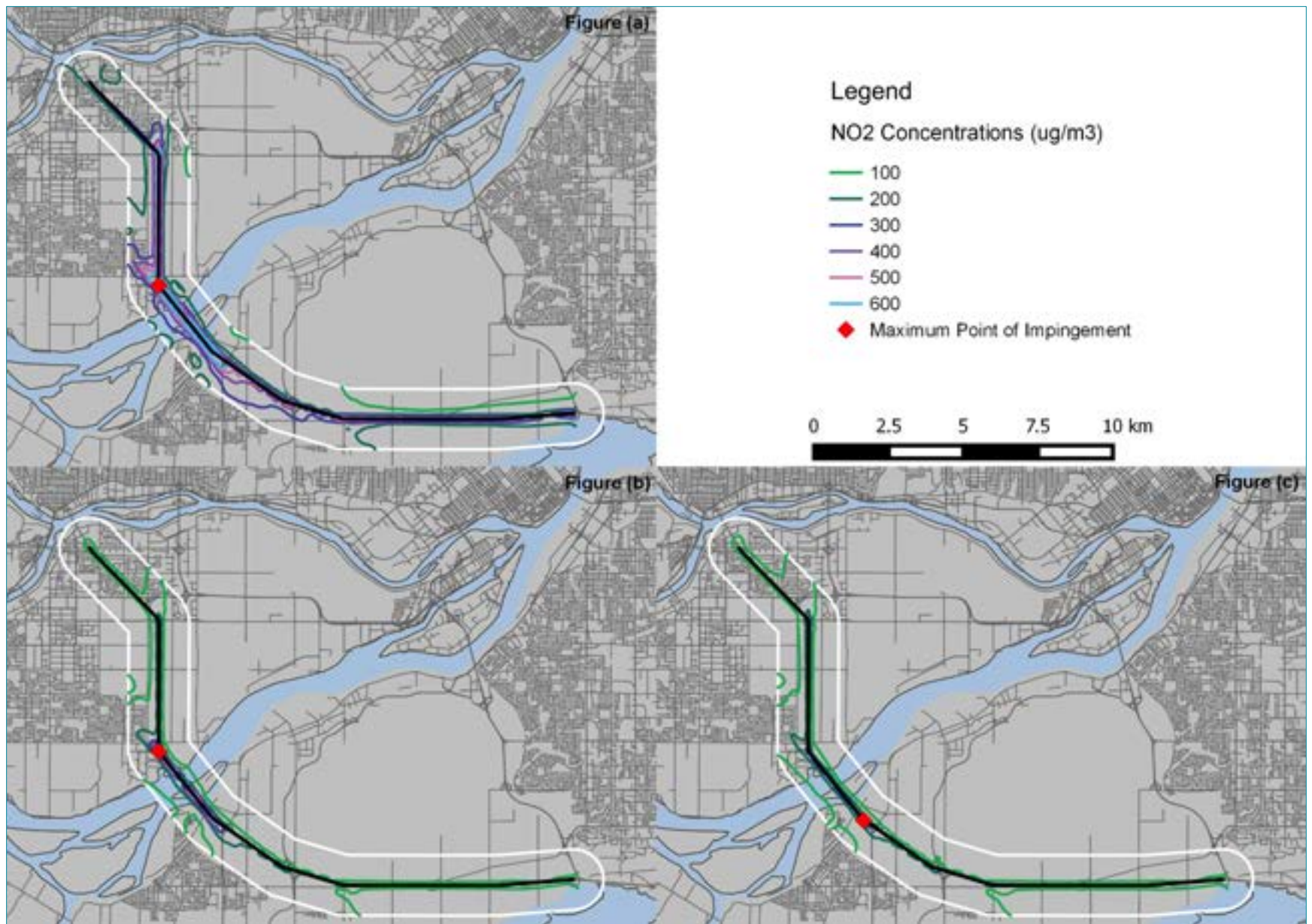
5.3 Spatial Variability of Predicted Concentrations

In the previous sections, tabular results were presented for the maximum predicted concentration for each pollutant under each of the three scenarios (**Table 16** to **Table 32**). The tabular results demonstrate the worst-case predictions at specific locations; however, to illustrate the spatial variability associated with dispersion, contour plots for NO₂ are presented in this section (**Figure 4** to **Figure 6**). These contour plots illustrate the decrease in concentration as a function of distance from the roadway. The contour plots clearly show that the highest concentrations are located in areas where there are a high number of vehicles, and that predicted concentrations are related to the distance from the road, with the highest values being recorded by the receptors that are five to 15 m from the road edge.

For the current scenario and the 2031 scenario without the Project, there are areas of higher concentrations located at the either entrance to the Tunnel. The 2031 scenario with the Project shows higher concentrations near at the southern end of the bridge, near Highway 17A.

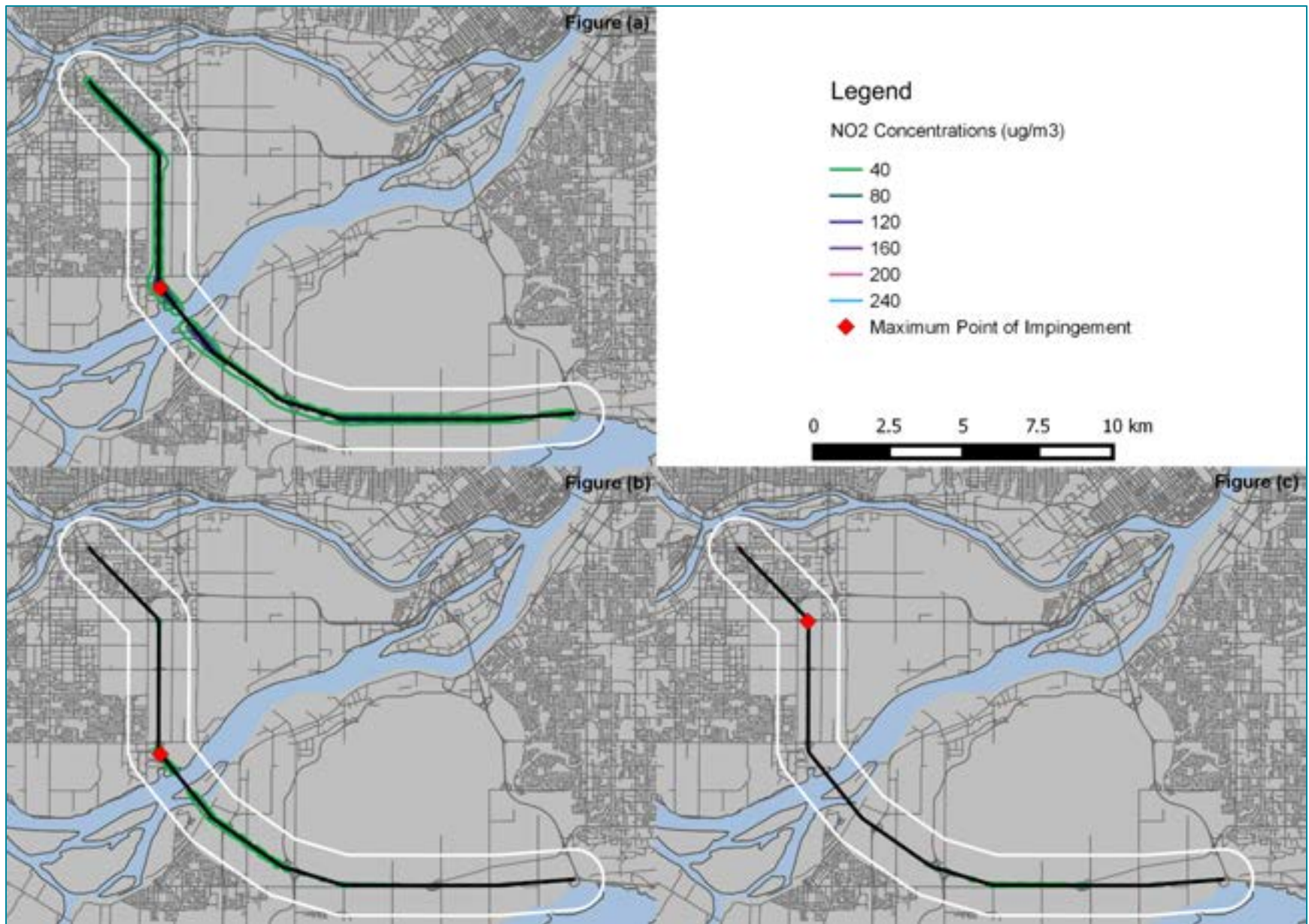
The locations of the maximum predicted values for one-hour, 24-hour, and annual averaging periods are also shown on **Figure 4** to **Figure 6**. While the figures present the maximum values for NO_x, other pollutants exhibit similar patterns. Generally, in 2011 and 2031 without the project, concentrations are near the entrance to the Tunnel for all three averaging periods. Concentrations tend to decrease away from the road.

For the 2031 scenario with the Project, the maximum one-hour emission is located near the south side of the new bridge. Peak one-hour traffic is significantly higher on the new bridge than through the Tunnel, which likely contributes to the maximum one-hour emission occurring near the new bridge approaches. The 24-hour and annual averaging periods predict the maximum emission occur near Westminster Highway due to the increased traffic along that link. Because, for the purposes of this study, the new bridge has been modelled at a constant height of 10 m, this increases the dispersion that occurs before the plume reaches a receptor. This, along with the increase vehicle traffic, leads to the maximum 24-hour and annual concentration predictions to occur on near Westminster Highway and not on the new bridge.



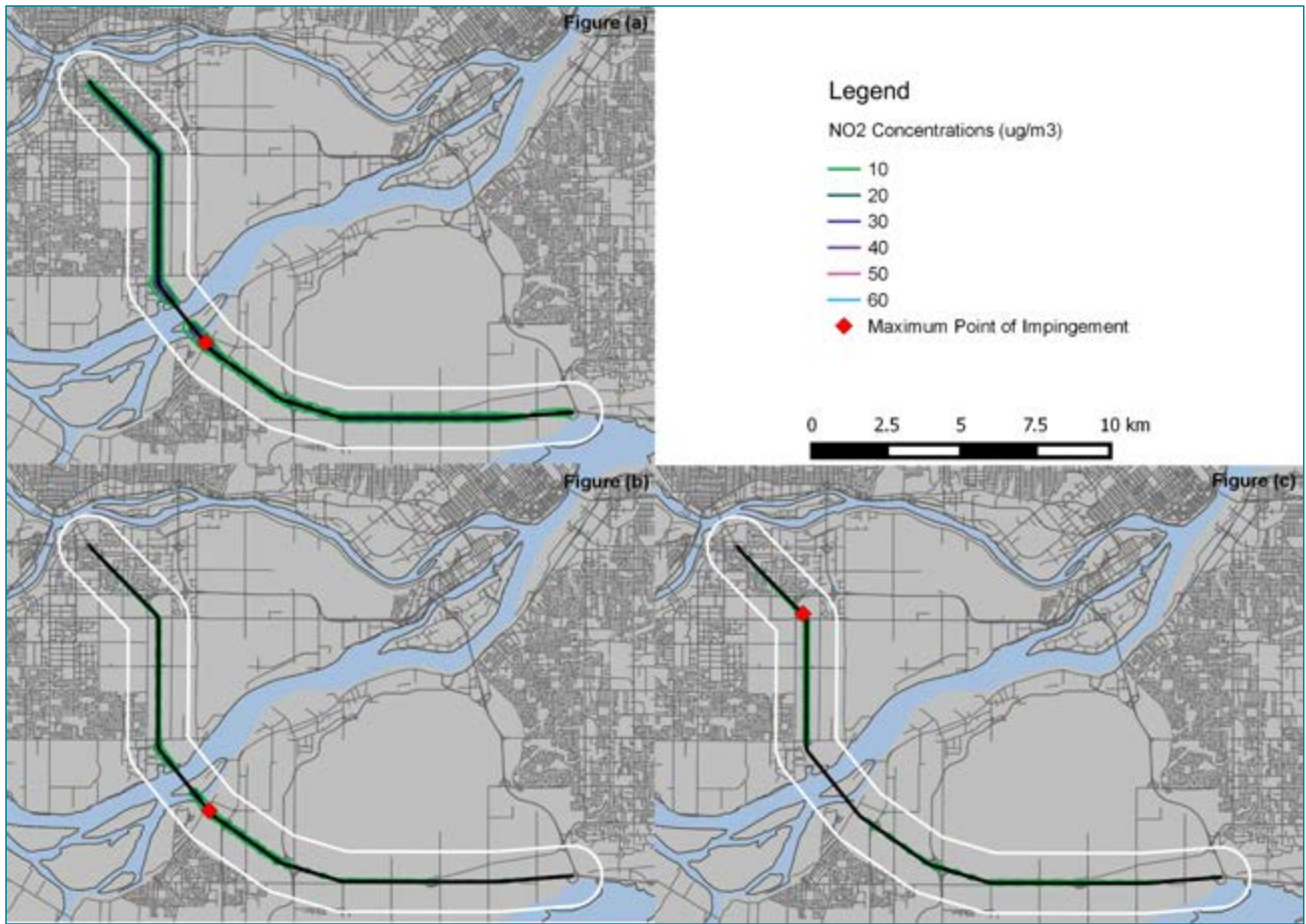
Notes: Figure (a): predicted NO₂ concentrations for current conditions, Figure (b): predicted NO₂ concentrations for future conditions without the Project, Figure (c): predicted NO₂ concentrations for future conditions with the Project

Figure 4 Spatial Variability of the Maximum Predicted 1-hour Nitrogen Dioxide Concentrations



Notes: Figure (a): predicted NO₂ concentrations for current conditions
Figure (b): predicted NO₂ concentrations for future conditions without the Project
Figure (c): predicted NO₂ concentrations for future conditions with the Project

Figure 5 Spatial Variability of the Maximum Predicted 24-Hour Nitrogen Dioxide Concentrations



Notes: Figure (a): predicted NO₂ concentrations for current conditions
Figure (b): predicted NO₂ concentrations for future conditions without the Project
Figure (c): predicted NO₂ concentrations for future conditions with the Project

Figure 6 Spatial Variability of the Maximum Predicted Annual Nitrogen Dioxide Concentrations

5.4 Summary

Table 34 shows predicted maximum concentrations of Highway 99-related emissions of key pollutants, based on dispersion modelling results. Of the three scenarios, the 2031 scenario with the Project has the lowest predicted maximum concentrations for all pollutants and averaging periods. While more vehicle traffic is predicted to use the road due to increased capacity, improvements in fleet technology, combined with a higher average travel speed and improved dispersion of pollutants, is expected to lead to reduced ambient concentrations, especially for 1-hour concentrations, in the study area.

Table 34 Summary of Maximum Predicted Highway 99-related Emission Concentrations

| Pollutant | Averaging Period | 2011 Existing ($\mu\text{g}/\text{m}^3$) | 2031 Without Project ($\mu\text{g}/\text{m}^3$) | 2031 With Project ($\mu\text{g}/\text{m}^3$) |
|-----------------------------------|------------------|--|---|--|
| CO | 1-hour | 20,325.1 | 17,500.5 | 10,977.6 |
| | 8-hour | 4,980.60 | 4,470.60 | 2,439.78 |
| NO ₂ (100% conversion) | 1-hour | 2,574.1 | 1,252.4 | 539.7 |
| | 24-hour | 327.2 | 157.1 | 67.8 |
| | Annual | 92.8 | 45.4 | 18.6 |
| SO ₂ | 1-hour | 27.6 | 29.9 | 8.3 |
| | 24-hour | 2.7 | 3.3 | 1.0 |
| | Annual | 0.8 | 1.0 | 0.3 |
| PM ₁₀ (vehicles) | 24-hour | 19.5 | 23.1 | 3.8 |
| | Annual | 5.6 | 6.8 | 1.1 |
| PM ₁₀ (road dust) | 24-hour | 37.1 | 45.1 | 29.5 |
| | Annual | 11.7 | 14.2 | 8.1 |
| Total PM ₁₀ | 24-hour | 56.7 | 68.2 | 33.2 |
| | Annual | 17.4 | 21.1 | 9.2 |
| PM _{2.5} (vehicles) | 24-hour | 12.1 | 9.6 | 2.5 |
| | Annual | 3.5 | 2.8 | 0.7 |
| PM _{2.5} (road dust) | 24-hour | 9.0 | 10.9 | 7.1 |
| | Annual | 2.8 | 3.4 | 2.0 |
| Total PM _{2.5} | 24-hour | 21.1 | 20.6 | 9.6 |
| | Annual | 6.3 | 6.3 | 2.7 |
| Benzene | 24-hour | 6.9 | 4.0 | 1.7 |
| | Annual | 2.0 | 1.2 | 0.5 |
| 1,3-butadiene | 24-hour | 0.7 | 0.4 | 0.2 |
| | Annual | 0.2 | 0.1 | 0.0 |

6.0 Regional Air Quality Evaluation

6.1 Regional Emissions

This section discusses the potential effects of the proposed Project on regional air quality in 2031. Consideration is given to Project-related air emissions, as well future changes in regional emissions that may occur as a result of other transportation projects or changes in regulatory policies and programs, including those outlined in Section 6.2. Forecast 2031 LFV emissions include projected emissions from these other transportation projects (Hou, personal communication, 2014) (Table 35). On a regional level, the Project pollutant emission contributions compared to the total forecast vehicle emissions in the LFV airshed are very small.

Table 35 Contribution of Project Emissions to the Lower Fraser Valley Vehicle Emissions

| Pollutant | 2031 Emissions (tonnes/yr) | | Proportion of 2031 with Project to Overall LFV Vehicle Emissions (%) |
|-------------------------------|----------------------------|-----------------------|--|
| | With Project | LFV Vehicle Emissions | |
| VOCs | 123.5 | 6,514.0 | 2% |
| CO | 3444.7 | 131,461.1 | 3% |
| NOx | 169.6 | 9,167.1 | 2% |
| SO ₂ | 2.6 | 56.7 | 5% |
| NH ₃ | 9.6 | 436.9 | 2% |
| PM (vehicles) | 9.4 | 332.2 | 3% |
| PM ₁₀ (vehicles) | 9.4 | 332.2 | 1% |
| PM _{2.5} (vehicles) | 6.3 | 307.7 | 3% |
| PM (road dust) | 383.2 | 38,559.6 | 1% |
| PM ₁₀ (road dust) | 73.5 | 7,400.5 | 2% |
| PM _{2.5} (road dust) | 17.8 | 1,794.6 | 1% |
| Benzene | 4.2 | - | - |
| Naphthalene | 0.3 | - | - |
| 1,3-butadiene | 0.4 | - | - |
| Formaldehyde | 1.7 | - | - |
| Acetaldehyde | 1.3 | - | - |
| Acrolein | 0.1 | - | - |
| Benzo(a)pyrene | 5.9E-04 | - | - |

Notes: "-" = Information not available

Total estimated emissions of CACs from traffic in the 2031 scenario with the Project are between one and five per cent of the LFV total vehicle emissions. It is projected that, traffic being diverted from other routes (e.g., the Alex Fraser Bridge) will result in an additional reduction to emissions in the region due to the ease of traffic congestion. This anticipated decline in emissions represents a beneficial effect of the Project in the context of regional air quality, with forecast LFV emissions projected to be slightly lower than forecasted without the Project in full operation.

As discussed in **Section 4.1.1**, most pollutants show a declining emissions trend when comparing the 2031 with Project to the without Project scenario. This decrease in emissions, resulting from less congestion in the road network following the implementation of the Project, helps to further reduce the originally estimated 2031 LFV emission forecast prepared by Metro Vancouver.

6.2 Regional Air Quality

While it is not feasible to contemplate all projects and changes that may occur in the future, Metro Vancouver's emissions inventory does incorporate reasonable assumptions as to what future emissions will be, based on foreseeable changes within the LFV. Forecasted policy measures and new emission sources quantified in the inventory include Metro Vancouver Permit changes, a new waste-to-energy facility, and the Metro Vancouver Boiler and Heater Regulation (Metro Vancouver 2013).

Other reasonably foreseeable industrial projects that would result in emissions were also reviewed; none were considered to result in volumes of air emissions that might substantially influence local air quality. Those projects that could influence vehicle emissions are addressed within the context of the traffic modelling that incorporates certain land-use and marine activities. It was therefore assumed that modelling predicted concentrations, based on emissions in 2031 with the Project, when added to the existing background concentrations to account for contributions from all other sources, would appropriately describe potential effects of the Project on future regional air quality.

While some emissions are anticipated to remain steady, or to increase slightly in the future, conservative background concentration values were assumed to account as a reasonable surrogate for the contribution of those emissions, should there be additional emissions contributing to the ambient air quality in the vicinity of the Project in the future.

Table 36 provides an overview of regional air quality in 2031 with and without the Project in terms of maximum overall pollutant concentrations—i.e. predicted maximum Project-related emission concentrations plus background concentrations. Bolded values indicate an exceedance of the most stringent AAQO. Overall ambient concentrations of all pollutants in the region are predicted to be lower for the 2031 scenario with the Project when compared to the scenario without the Project in 2031.

Table 36 Predicted Regional Air Quality With and Without the Project in 2031

| Pollutant | Averaging Period | Background Concentration ($\mu\text{g}/\text{m}^3$) | Overall Concentration in 2031 without Project ($\mu\text{g}/\text{m}^3$) | Overall Concentration in 2031 with Project ($\mu\text{g}/\text{m}^3$) | Most Stringent AAQO ($\mu\text{g}/\text{m}^3$) |
|-------------------------|------------------|---|--|---|--|
| CO | 1-hour | 1271 | 18,771.5 | 12,248.6 | 14,300 |
| | 8-hour | 1,116 | 5,586.6 | 3,555.8 | 5,500 |
| NO ₂ (ARM) | 1-hour | - | 105.9 | 96.3 | 188 |
| | Annual | 25 | 70.4 | 43.6 | 40 |
| SO ₂ | 1-hour | 10 | 39.9 | 18.3 | 450 |
| | 24-hour | 7 | 10.3 | 8.0 | 125 |
| | Annual | 2 | 3.0 | 2.3 | 25 |
| Total PM ₁₀ | 24-hour | 29 | 97.2 | 62.2 | 50 |
| | Annual | 13 | 34.1 | 22.2 | 20 |
| Total PM _{2.5} | 24-hour | 15 | 35.6 | 24.6 | 25 |
| | Annual | 4 | 10.3 | 6.7 | 8 |
| Benzene | 24-hour | 2 | 6.0 | 3.7 | 2.3 |
| | Annual | 1 | 2.2 | 1.5 | 0.45 |
| 1,3-butadiene | 24-hour | 0.4 | 0.8 | 0.6 | 10 |
| | Annual | 0.1 | 0.2 | 0.1 | 2 |

Note: Bolded values indicate an exceedance of the most stringent AAQO

6.2.1 Summary of Key Findings

The air quality evaluation shows that local and regional air quality are predicted to be lower with the Project as compared to without it. Of the three scenarios considered, the 2031 scenario with the Project has the lowest predicted maximum concentrations for all pollutants and averaging periods. The 2031 with Project will increase vehicle capacity, and have a higher average travel speed and increased dispersion of pollutants near the bridge.

When comparing the existing (2011) road configuration scenario to 2031 without the Project (i.e., with the Tunnel still operational), there is a predicted improvement in some of the concentrations due to reduction in vehicle emissions through more stringent regulations, better technology, and turnover of the vehicle fleet.

When compared to the 2031 scenario without the Project, the 2031 scenario with the Project is predicted to result in further improvements in local air quality. While the 2031 scenarios with and without the Project both benefit from the same fleet emission improvements, the 2031 scenario with the Project also benefits from less congestion and higher vehicle speeds associated with the proposed Highway 99 improvements and Tunnel replacement. Some of the improvements related to the reduction in congestion have not been accounted for in this modelling, meaning the 2031 with Project scenario is a conservative estimate of the impact on air quality.

In the 2011 and 2031 scenarios without the Project, maximum predicted pollutant concentrations generally occur nearest the entrances to the Tunnel. Because the Tunnel is an enclosed structure, vehicle emissions can only exit through the Tunnel openings and exhaust fan towers. All of the emissions occurring inside the Tunnel are therefore concentrated and released over a small area. The new bridge, being elevated, will enable increased airflow along the entire crossing, resulting in improved dispersion of emissions and consequent improvement in local air quality near the bridge. The model shows that the locations of the maximum 1-hour concentration in the 2031 with Project occurs in the area south of the Bridge, near Highway 17A. The 24-hour and annual maximum concentrations with the Project are located in the area of Westminster Highway, which is a result of increased vehicle capacity resulting in more vehicles using Highway 99.

Overall ambient concentrations of certain pollutants exceed the most stringent AAQO under all three scenarios considered in this study; however, the number of pollutants that show an exceedance, as well as the degree of exceedance are similar in both of the 2031 scenarios, while the 2031 with Project scenario has significantly higher vehicle capacity and reduced congestion for the region.

7.0 References

Air Resources Board of California (ARB). 1998. Report to the Air Resources Board on the proposed identification of diesel exhaust as a toxic air contaminant (Part A). Exposure Assessment. As approved by the Scientific Review Panel on April 22, 1998. Available at http://www.arb.ca.gov/toxics/dieseltac/part_a.pdf. Accessed July 2014.

ATTACHMENT A

Dispersion Modelling Plan

Dispersion Modelling Plan

An electronic version of this plan is available from:

www.bcairquality.ca/reports/model-plans-instructions.html

GENERAL

Date: **February 15, 2016**

Facility Name, Company, Location (Lat, Long): **George Massey Tunnel Replacement Project**

Air Quality Consultant and Contact Name: **WSP**

Ministry Contact Name:

Li Huang

Air Quality Meteorologist

Clean Air Environmental Standards Branch

Ministry of Environment

3rd Floor, 2975 Jutland Road

Victoria, BC V8T 5J9

Tel: (250) 953-3433 Fax: (250) 356-5496

Level of Assessment (1, 2 or 3) and also provide rationale for the proposed level of assessment:

Level 3 - This project is going through the BC environmental assessment process and covers a large spatial area.

Does this plan follow a modelling approach similar to that taken in a previous air quality assessment already reviewed and accepted by the Ministry? If so, provide the project name and Ministry contact:

Yes, this project follows methodologies developed for other large transportation infrastructure projects including the Sea to Sky Highway, Low Level Road Replacement, Port Mann Highway 1 and South Fraser Perimeter Road.

PROJECT DESCRIPTION AND GEOGRAPHIC SETTING

Provide an overview of the project description, including process description and the purpose of the dispersion modelling study.

To assess the impacts from vehicle traffic on air quality as it relates to the replacement of the George Massey Tunnel. This assessment will model three scenarios

- 1. Current configuration of Highway 99 between Bridgeport and Highway 91**
- 2. Current configuration with 2031 traffic of Highway 99 between Bridgeport and Highway 91**

3. Highway 99 between Bridgeport and Highway 91 with a 10-lane bridge replacing the tunnel with 2031 traffic

Future vehicle traffic volumes were obtained via traffic modelling while the fleet profiles were developed based on data from Metro Vancouver.

Provide a description of the following:

- ◆ Terrain characteristics within domain: flat terrain or complex terrain (i.e., will complex flow need to be considered?)
- ◆ Dominant land cover: urban, rural, industrial, agricultural, forested, rock, water, grassland

Within the 1-kilometer Local Assessment Area (LAA), which extends 1-kilometer from the modeled road link, the dominant land cover is agricultural and urban. Much of the urban land cover occurs in the northern portion of the LAA. The area is characterized as flat terrain at or near sea-level. Complex air flow will not be considered.

DISPERSION MODEL

Selected Dispersion Model:

- ◆ List model(s) and version to be used (see Section 2).

CALMET v6.334

CALINE3

- ◆ Specify any non-guideline models or versions (i.e., beta-test versions) planned for use (Section 2.3.1). Provide rationale.

CALINE3 was included in the previous version of the dispersion modelling guideline. It is currently EPA approved for transportation related dispersion modelling. The CAL3QHC model is built on the CALINE3 algorithms and was not used in this modelling assessment as it is for specialized modelling.

- ◆ If modifications to any of the models are planned, provide a description and the rationale (Section 2.3.2).

The CALINE3 model has been modified to allow for more receptors. No other changes to the source code have been made.

Default Switch Settings

- ◆ For AERMOD identify any switch settings that will be different than the recommended defaults (Section 7.7). Provide rationale.

N/A

- ◆ For CALMET/CALPUFF identify any key switch settings in CALMET and CALPUFF that will be different from the “black (do not touch)” defaults as per Tables 6.2 and 7.1. Provide rationale.

No CALMET switches have been changed.

- ◆ If the CALMET model is used, provide:
 - a CALMET domain map that also shows the locations of surface meteorological stations and upper air stations **Provided below.**
 - anticipated grid resolution: 500 (m)
 - number of grids in X and Y direction (NX = 340 , NY = 220)
 - vertical levels (m): 0 , 20 , 40 , 80 , 160 , 320 , 600 , 1500 , 3000

CALMET is used only to generate a single point of meteorology near the project site. Metro Vancouver operates ambient air quality monitoring stations which also record surface meteorology. Six Metro Vancouver stations were used along with a WRF prognostic data set. In addition to the six Metro Vancouver stations, the Environment Canada surface meteorology station located at the Vancouver International Airport was used in order to provide all of the parameters required by CALMET. The stations used were:

- **T13 – North Delta**
- **T15 – Surrey East**
- **T17 – Richmond South**
- **T18 – Burnaby South**
- **T38 – Annacis Island**
- **T39 – Tsawwassen**
- **Vancouver Airport – Environment Canada station**

AERMOD and Receptors

If the AERMET/AERMOD model is used, provide the following:

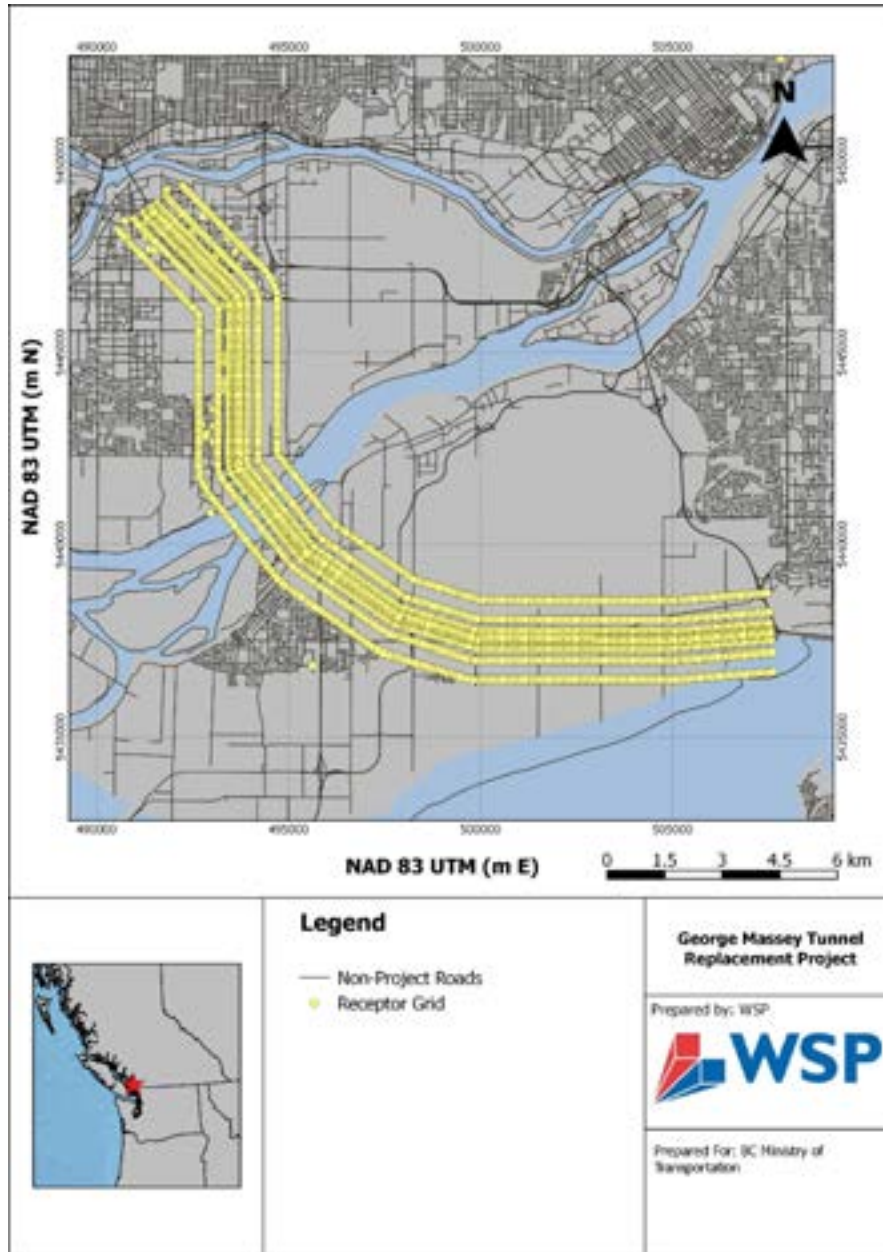
- ◆ proposed receptor grid spacing (see Section 7.2):
- ◆ an AERMET/AERMOD domain map that shows the locations of surface meteorological stations, upper air stations and receptor grid
- ◆ anticipated sensitive receptors (see Section 7.4) and also indicate them on the domain map (if applicable)
- ◆ receptor (flagpole) height (m) (see Section 7.5):

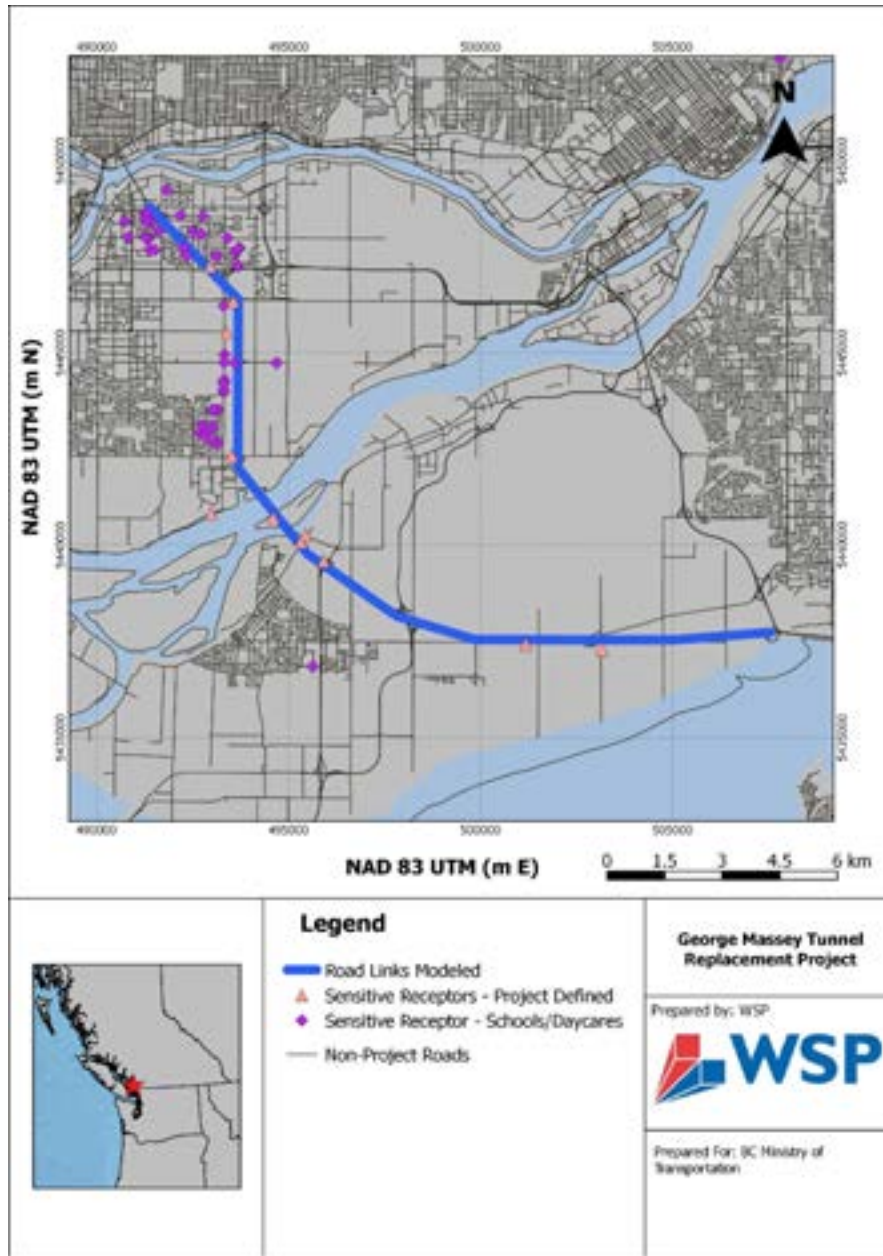
CALPUFF and Receptors

If the CALPUFF model is used, provide the following:

- ◆ proposed receptor grid spacing (see Section 7.2):
- ◆ a map of the CALPUFF domain and receptor grid
- ◆ anticipated sensitive receptors (see Section 7.4)) and also indicate them on the CALPUFF domain map (if applicable)
- ◆ receptor (flagpole) height (m) (see Section 7.5):

CALPUFF is not used but the receptor grid used in CALINE is shown below. Receptors are placed at intervals of 5, 10, 15, 20, 25, 50, 100, 250, 500 and 1000 meters perpendicular to the road. These lines of receptors are spaced in 100 meter intervals along the roadway. Sensitive receptors are shown in the second figure below. The sensitive receptors are all of the schools, daycares, care homes and hospitals occurring within the LAA as well as sensitive receptors identified by the project team. All receptors are placed at 0m.





PLANNED MODEL OUTPUT: AIR QUALITY ASSESSMENT NEEDS

Output Requirements for

What model output is required for decision makers and stakeholders? (i.e. what is the purpose of the assessment?). Circle as appropriate.

- ♦ Air Quality concentrations, depositions, visibility, fogging, icing, other (specify)

Tables and Figures for Level 1 Assessment:

- ◆ **maximum concentration of contaminants predicted including location and corresponding meteorological conditions**
- ◆ printout of AERSCREEN model output

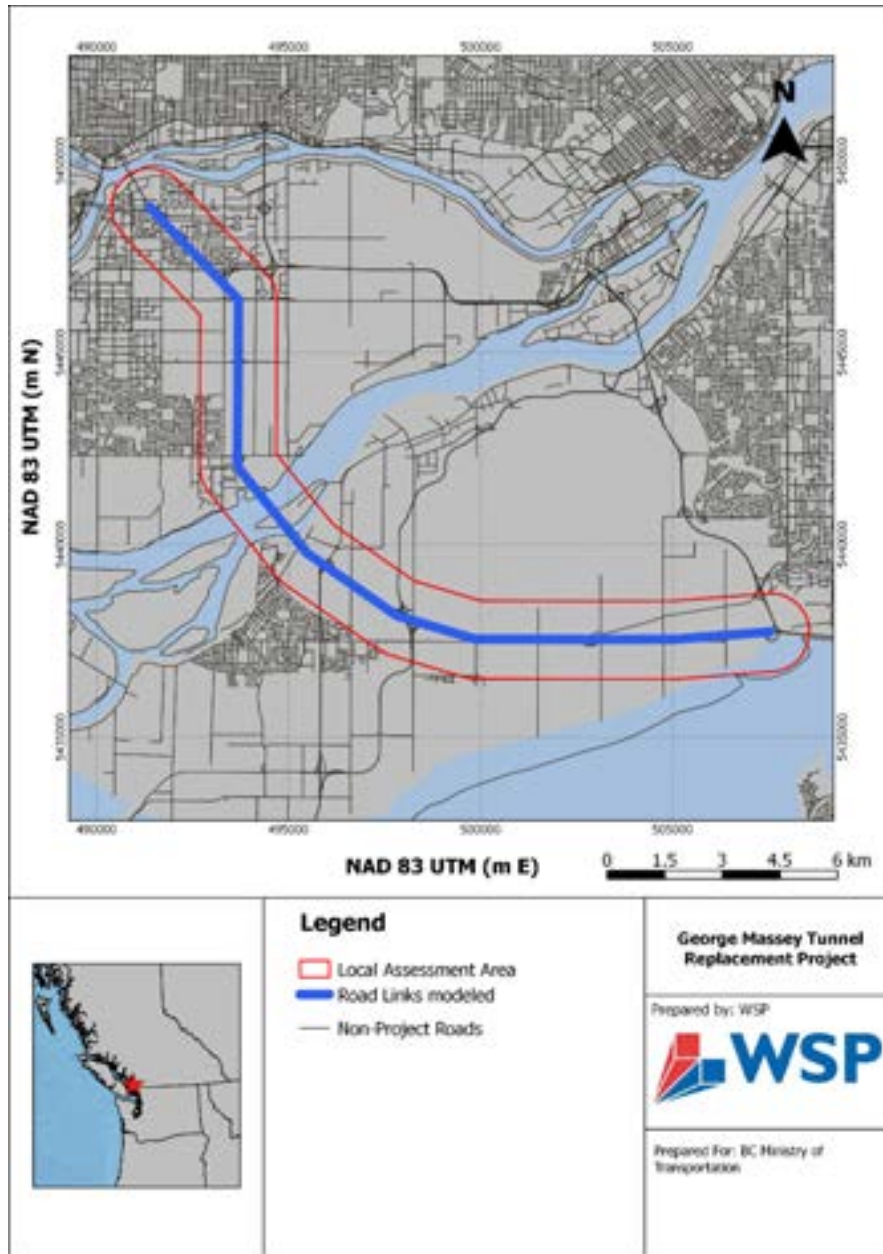
Tables and Figures for Level 2 and 3 Assessments (see detailed list in Section 8.3.2):

- ◆ **spatial distribution maps of air quality parameters (maximums, exceedance frequencies, annual averages)**
- ◆ **tables of maximum short and long time average air quality parameters (locations and associated meteorological conditions)**
- ◆ **tables of air quality parameters at select receptors of interest (maximums, frequency distributions)**
- ◆ tables of air quality parameters under certain emission situations (upsets, start-up)
- ◆ output spatial scale: **near-field (<10 km)**, local (<50 km), regional (>50 km)
- ◆ special output required for vegetation, health risk or visibility assessments
- ◆ other (specify):

EMISSION SOURCES AND CHARACTERISTICS

Provide a map showing the source locations, buildings, and facility fence line.

The LAA and road links are shown in the figure below.



Model Emission Scenarios

If applicable, describe the different model emission scenarios required for the assessment if multiple options are under consideration. For example, different source characteristics (stack dimensions, emission rates) or source arrangements (locations, types, buildings) may need separate modelling runs to examine the air quality implications of different scenarios.

To assess the impacts from vehicle traffic on air quality as it relates to the replacement of the George Massey Tunnel. This assessment will model three scenarios

1. **Current configuration of Highway 99 between Bridgeport and Highway 91**

2. Current configuration with 2031 traffic of Highway 99 between Bridgeport and Highway 91
3. Highway 99 between Bridgeport and Highway 91 with a 10-lane bridge replacing the tunnel with 2031 traffic

Future vehicle traffic volumes were obtained via traffic modelling while the fleet profiles were developed based on data from Metro Vancouver. Congestion is considered in the 2011 and 2031 without project scenarios along Link 2 (the tunnel) while traffic is free flowing in the 2031 with project scenario for all links.

CALINE has the ability to model a few types of roads including roads that are at grade and bridge links. Based on an investigation of the source code, these two road types result in identical executions of the code. Additionally, CALINE restricts the road height to 10 meters above ground level. In reality, the bridge will be at a height higher than 10 meters. It is expected that as the height of the bridge increases, dispersion improves and concentrations would be lower at ground level receptors. Therefore 10 meters is a conservative estimate of the predicted concentrations near the bridge.

Contaminants Emitted for Each Emission Scenario

Provide the following details of the sources to be modelled:

Specify Source, Type, Contaminants (extend Table as necessary)

| Emission Number | Description | Type: Point (P), Area (A), Line (L), Volume (V) | Contaminants (SO ₂ , NO _x , PM _{2.5} . .) | Basis of Emissions (Section 5.3) |
|-----------------|---|--|--|---|
| Link 1 | Bridgeport to Westminster Highway | L | VOC, CO, NO ₂ , SO ₂ , NH ₃ , PM ₁₀ , PM _{2.5} , Benzene, Naphthalene, 1,3-butadiene, Formaldehyde, Acetaldehyde, Acrolein, Benzo(a)pyrene | <input type="checkbox"/> current emission limits <input type="checkbox"/> proposed emission limits <input checked="" type="checkbox"/> other (specify & justify) Emissions are based on fleet profiles from the EMME/2 traffic model and Metro Vancouver fleet profiles. Emission factors are from the MOVES2012b vehicle emission simulator. |
| Link 2 | Westminster Highway to George Massey Tunnel/Replacement | L | VOC, CO, NO ₂ , SO ₂ , NH ₃ , PM ₁₀ , PM _{2.5} , Benzene, Naphthalene, 1,3-butadiene, | <input type="checkbox"/> current emission limits <input type="checkbox"/> proposed emission limits <input checked="" type="checkbox"/> other (specify & justify) |

| | | | | |
|--------|---|---|--|---|
| | | | Formaldehyde, Acetaldehyde, Acrolein, Benzo(a)pyrene | Emissions are based on fleet profiles from the EMME/2 traffic model and Metro Vancouver fleet profiles. Emission factors are from the MOVES2012b vehicle emission simulator. |
| Link 3 | George Massey Tunnel/Replacement to Highway 17A | L | VOC, CO, NO ₂ , SO ₂ , NH ₃ , PM ₁₀ , PM _{2.5} , Benzene, Naphthalene, 1,3-butadiene, Formaldehyde, Acetaldehyde, Acrolein, Benzo(a)pyrene | <p>___current emission limits ___proposed emission limits</p> <p><u> X </u>other (specify & justify)</p> <p>Emissions are based on fleet profiles from the EMME/2 traffic model and Metro Vancouver fleet profiles. Emission factors are from the MOVES2012b vehicle emission simulator.</p> |
| Link 4 | Highway 17A to Highway 17 | L | VOC, CO, NO ₂ , SO ₂ , NH ₃ , PM ₁₀ , PM _{2.5} , Benzene, Naphthalene, 1,3-butadiene, Formaldehyde, Acetaldehyde, Acrolein, Benzo(a)pyrene | <p>___current emission limits ___proposed emission limits</p> <p><u> X </u>other (specify & justify)</p> <p>Emissions are based on fleet profiles from the EMME/2 traffic model and Metro Vancouver fleet profiles. Emission factors are from the MOVES2012b vehicle emission simulator.</p> |
| Link 5 | Highway 17 to Ladner Trunk Road | L | VOC, CO, NO ₂ , SO ₂ , NH ₃ , PM ₁₀ , PM _{2.5} , Benzene, Naphthalene, 1,3-butadiene, Formaldehyde, Acetaldehyde, Acrolein, Benzo(a)pyrene | <p>___current emission limits ___proposed emission limits</p> <p><u> X </u>other (specify & justify)</p> <p>Emissions are based on fleet profiles from the EMME/2 traffic model and Metro Vancouver fleet</p> |

| | | | | |
|--------|---------------------------------|---|---|---|
| | | | | profiles. Emission factors are from the MOVES2012b vehicle emission simulator. |
| Link 6 | Ladner Trunk Road to Highway 91 | L | VOC, CO, NO ₂ , SO ₂ , NH ₃ , PM ₁₀ , PM _{2.5} , Benzene, Naphthalene, 1,3-butadiene, Formaldehyde, Acetaldehyde, Acrolein, Benzo(a)pyrene | <input type="checkbox"/> current emission limits <input type="checkbox"/> proposed emission limits <input checked="" type="checkbox"/> other (specify & justify) Emissions are based on fleet profiles from the EMME/2 traffic model and Metro Vancouver fleet profiles. Emission factors are from the MOVES2012b vehicle emission simulator. |

* for PM emissions indicate whether it is filterable, or filterable + condensable, or if unknown (see Section 3.6)

Source Emission Rate Variability

Do emissions have sub-hourly variation (e.g., blow-down flares with high emission peaks during the hour)? If so, describe the approach to assess air quality implications of those sub-hourly high emission peaks.

Not considered.

Describe the approach to assess air quality implications under the 25, 50, 75% emission scenario. See Section 3.4.2.

N/A

If there are batch processes, provide a temporal emission profile (emission rate vs time) for each batch process.

N/A

Describe anticipated abnormal emission scenarios (e.g., start-up and shut-down) and their anticipated frequency of occurrence. See Section 3.4.3.

N/A

BASELINE CONCENTRATION

- ◆ Indicate method used to determine baseline concentrations for each pollutant (Section 8.1):

monitoring data (Section 8.1.1 and 8.1.2)

_____ establish monitoring program (Section 8.1.3)

_____ modelled sources (Section 8.1.5)

_____ other method (describe)

- ◆ If existing monitoring data to be used, complete the following Table:

Representative Air Quality Measurements

| Station Name (Lat./Long./ or indicate on map) | Period of Record (start/end date) | Contaminants Measured |
|---|-----------------------------------|---|
| T13 – North Delta | 2008 - 2012 | NO ₂ , O ₃ , PM _{2.5} |
| T15 – Surrey East | 2008 - 2012 | NO ₂ , CO, O ₃ , PM _{2.5} |
| T17 – Richmond South | 2008 - 2012 | NO ₂ , CO, O ₃ , SO ₂ , PM _{2.5} |
| T18 – Burnaby South | 2008 - 2012 | NO ₂ , CO, O ₃ , SO ₂ , PM _{2.5} , PM ₁₀ |
| T31 – Richmond Airport | 2008 - 2012 | NO ₂ , CO, O ₃ , SO ₂ , PM _{2.5} , PM ₁₀ |
| T39 - Tsawwassen | 2008 - 2012 | NO ₂ , CO, O ₃ , SO ₂ , PM _{2.5} |

- ◆ If baseline concentrations are anticipated to change in the future due to planned significant reductions or increases in emissions, provide a description of how these will be accounted for (e.g., construction of a nearby new facility or the planned decommissioning of a currently operating facility) and the uncertainties involved in estimating future emissions.

BUILDING DOWNWASH

- ◆ Potential for building downwash. Please provide rationale if building downwash is not modelled.

N/A

- ◆ If building downwash included, provide a site map to indicate buildings to be processed by BPIP-PRIME, and also complete the following Table:

| Source Height (m) | Distance from the Source to the Nearest Building (m) | Building Length (m) | Building Height (m) | Building Width (m) |
|-------------------|--|---------------------|---------------------|--------------------|
| | | | | |
| | | | | |
| | | | | |

GEOPHYSICAL DATA INPUT

Topography and Land Use Data

- ◆ Terrain data (specify source of data) and an elevation map for the model domain:

GeoGratis – Canadian Digital Elevation Data (CDED) at 1:50,000

- ◆ Land use data (specify source of data) and a land use map for the model domain:

Baseline Thematic Mapping digital land use data at 1:250,000 scale from the BC Land and Resource Data Warehouse

Surface Characteristics

For AERSCREEN, provide seasonal values of surface characteristics (surface roughness, albedo and Bowen ratio) for input to MAKEMET.

N/A

For Level 2 and 3 Assessments, Indicate if recommended seasonally varied surface characteristics (surface roughness, albedo, Bowen ratio, etc.) (see Section 4.3 and 4.4) are used for the dispersion modelling study. If not, provide the proposed surface characteristics and the rationales.

No as there is not a substantial change in the land use between seasons along the project.

METEOROLOGICAL DATA INPUT (FOR LEVEL 2 AND 3 ASSESSMENTS ONLY)

Surface Meteorological Data

If surface observation data are used, provide a map with the location of each surface meteorological station identified and also provide the following:

Surface data was not used. A single point of meteorology was required for use in CALINE and CALMET was run in NOOBS mode in order to provide a grid point near the project.

| Surface Met Data and Location (lat/long or indicate on map) | Data Source MOE, MV, MSC, Site Specific, other (specify) ¹ | Period of Record (start/end data) ² | % of Wind Speeds = 0.0 ³ | Anemometer Height (m) | Parameters |
|---|---|--|-------------------------------------|-----------------------|--|
| T13 (see map below) | MV | Jan 1, 2012 – Dec 31, 2012 | 0.93% | 14.3 | Wind Speed, Wind Direction, Temperature, Relative Humidity |
| T15 (see map below) | MV | Jan 1, 2012 – Dec 31, 2012 | 0.51% | 16.9 | Wind Speed, Wind Direction, Temperature |
| T17 (see map below) | MV | Jan 1, 2012 – Dec 31, 2012 | 2.6% | 12.5 | Wind Speed, Wind Direction, Temperature |
| T18 (see map below) | MV | Jan 1, 2012 – Dec 31, 2012 | 0.07% | 19.9 | Wind Speed, Wind Direction, Temperature, Relative Humidity |
| T38 (see map below) | MV | Jan 1, 2012 – Dec 31, 2012 | 0.85% | 10.0 | Wind Speed, Wind Direction, Temperature, Relative Humidity |
| T39 (see map below) | MV | Jan 1, 2012 – Dec 31, 2012 | 9.01% | 10.8 | Wind Speed, Wind Direction, Temperature, |

| | | | | | |
|---------------------|-----|----------------------------|------|------|---|
| | | | | | Relative Humidity |
| YVR (see map below) | MSC | Jan 1, 2012 – Dec 31, 2012 | 0.2% | 10.0 | Wind Speed, Wind Direction, Temperature, Relative Humidity, Pressure, Ceiling Height, Cloud Cover |

1. If data from a non - Ministry, MV or MSC station are planned to be used, follow guidance in Section 5.2.3
2. For data completeness and data filling, follow guidance in Section 5.5
3. For light and no wind conditions, follow guidance in Section 5.6



Upper-Air Meteorological Data

If upper air meteorological data are used provide the following:

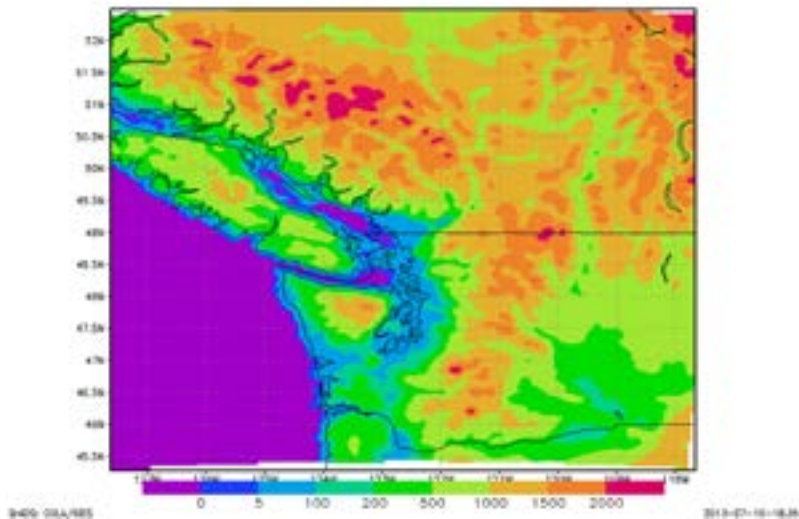
| Station Name | Period of Record (start/end date) ¹ | Distance between the Upper Air Station and Project (km) |
|--------------|--|---|
| | | |
| | | |

¹. For data completeness and data filling, follow guidance in Section 5.5.

NWP Model Output

If NWP output (different than the province-wide WRF output) used provide the following:

- ◆ Mesoscale Meteorological Model (Name\Version\Model Configuration): **WRF-NMM**
- ◆ Model Output Provider: **SENES Consultants Ltd**
- ◆ Domain (attach a map showing the horizontal extent):



- ◆ Horizontal and Vertical Grid Resolution and Height of Each Vertical Level: **~3km horizontal resolution with 18 sigma levels**
- ◆ Data Period (start/end date): **January 1, 2011 – December 31, 2011**
- ◆ Four Dimensional Data Assimilation is applied (Yes or No): **Yes**

NWP model output use (circle one below for the selected dispersion model):

- ◆ AERMET/AERMOD:
 - Extract pseudo surface station and pseudo upper air sounding (as input to AERMET), or
 - Create .SFC and .PFL files (AERMOD-ready files, skip AERMET)

- ◆ CALMET:
 - NWP only, or
 - Surface station and NWP, or
 - Surface station, upper air sounding, and NWP, or
 - Other (specify):

TREATMENTS

NO to NO₂ Conversion:

Identify the method to be used (Section 8.2).

X Ambient Ratio Method

- ◆ indicate monitoring station(s)

Data from T18 – Burnaby South were used to develop the curve. Other data from T13 – North Delta and T17 – Richmond South were used to validate the curve

____ OLM:

- ◆ specify O₃ concentration and how it was selected,
- ◆ if non default in-stack ratios are used, specify and provide rationale.

____ PVMRM (for AERSCREEN and AERMOD only):

- ◆ specify O₃ concentration and how it was selected,
- ◆ if non default equilibrium ratios and/or in- stack ratios are used, specify and provide rationale.

Chemical Transformation:

- ◆ Specify transformation method and provide details on inputs if Secondary PM_{2.5}, Acid Deposition or Visibility effects are to be estimated. Depending on the transformation method, this could include ammonia, ozone, hydrogen peroxide concentrations, nighttime loss and formation rates for nitrates and sulphates.

N/A

Particle Deposition:

- ◆ If non-recommended particle size distributions (see Section 3.6) are used, provide Table of particle emission (including heavy metals if modelled) size/density distribution and indicate the basis for the Table.

N/A

Stagnation:

- ◆ Provide an estimate of the frequency of stagnation based local meteorological data if available. If AERMOD is proposed, provide methodology on how stagnation periods will be treated (see Section 10.2).

N/A

Shore/Coastal Effects:

- ◆ If included, indicate whether sub-grid-scale Thermal Internal Boundary Layer option is selected along with the required input coastline coordinate data (see Section 10.3).

N/A

Plume Condensation (Fogging) and Icing:

- ◆ Indicate if this will be included (Section 10.6).

N/A

QUALITY MANAGEMENT PROGRAM

Model Input Data

Indicate the tests that will be undertaken to assure the quality of the inputs.

For the geophysical input data:

- ◆ **contour plot of topography**
- ◆ **plots of land use and land cover**

For the meteorological data:

- ◆ **wind rose (annual and/or seasonal)**
- ◆ **frequency distribution of surface wind speeds**
- ◆ **average hourly temperature plot (annual and/or seasonal)**

If NWP output is used, describe the tests undertaken to assure the quality of the output (Section 6.1)

- ◆ **wind rose at selected locations and heights (annual and/or seasonal)**
- ◆ **average hourly temperature plot at selected locations and heights (annual and/or seasonal)**
- ◆ **wind field plots for selected periods that indicate topographic influences such as channeling and thermally generated flows**

Model Output Data

For CALMET/CALPUFF applications, provide a list of the tests conducted to confirm the quality of the model output (intermediate pre-processing files and concentration/deposition predictions).

With respect to the pre-processed files that are prepared for CALPUFF input, there are several tests listed in Section 9.1.1 and 9.1.2 to check the output from the pre-processing utility programs to confirm that they have been properly processed. These are related to checking:

- ◆ terrain, land use
- ◆ sources (locations and elevation) and emission characteristics
- ◆ meteorological data (locations) and tests to confirm proper processing of the raw meteorological data (units, parameters)
- ◆ receptor locations and elevations

For CALMET output there are several tests listed in Section 9.1.3 to test the quality of the generated meteorological fields. These are related to reviewing the following:

- ◆ wind field maps (surface and different elevations) for select periods where topographic influences (channeling, thermally driven flows) would be evident
- ◆ wind roses and selected locations and elevations (annual, seasonal)
- ◆ frequency distributions of various meteorological parameters (annual, seasonal) such as PG-stability class, mixing heights
- ◆ plots of hourly average parameters such as temperature, mixing height, precipitation at key locations (seasonal and annual)

Note: The Ministry may require all computer files associated with the modelling to be submitted upon request.

MINISTRY REVIEW OF PLAN AND REVISIONS

A modelling plan can change over the course of developing the air quality assessment so acceptance of the initial submission of the plan is on the basis of the best information provided to date. Changes to the plan (additions, modifications) should be noted and agreed to with the Ministry as necessary. An updated Dispersion Modelling Plan may be necessary.

**George Massey Tunnel
Replacement Project**



**BC JOBS
PLAN**



Ministry of
Transportation
and Infrastructure

Section 16.6

ATMOSPHERIC NOISE STUDY

Technical Volume

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Abbreviations and Acronyms

| Term | Description |
|--------------|---|
| AADT | annual average daily traffic |
| ADT | average daily traffic |
| ANSI | American National Standards Institute |
| BAM | baseline adjustment method |
| CMHC | Canada Mortgage and Housing Corporation |
| dB | decibel |
| dBA | A-weighted decibel |
| dB(C) | C-weighted decibel |
| EA | environmental assessment |
| EPA | U.S. Environmental Protection Agency |
| FHWA | U.S. Federal Highways Administration |
| Hz | Hertz |
| ISO | International Standards Organization |
| L_d | daytime equivalent sound level |
| L_{dn} | day-night equivalent sound level |
| $L_{eq}(24)$ | 24-hour equivalent sound level |
| L_n | nighttime equivalent sound level |
| Ministry | Ministry of Transportation and Infrastructure |
| RMS | root mean square |
| SFPR | South Fraser Perimeter Road |
| TNM | Traffic Noise Model |
| Tunnel | George Massey Tunnel |
| YVR | Vancouver International Airport |

Glossary

| Term | Definition |
|---|--|
| ambient noise level | The total noise level in the acoustic environment, including the source(s) of interest. |
| atmospheric noise | airborne anthropogenic noise. |
| A-weighted decibel (dBA) | An A-weighted decibel is a unit of sound that has been compensated for the sensitivity of the ear to different frequencies by a dBA filter. |
| day-night equivalent sound level (L_{dn}) | A 24-hour noise exposure expressed in dBA. In computing L_{dn} , all noise levels occurring between 10 p.m. and 7 a.m. are increased by 10 dBA to reflect the greater sensitivity of residential communities to noise at night. |
| daytime equivalent sound level (L_d) | Equivalent Sound Level (L_{eq}) for the time period from 7 a.m. to 10 p.m. |
| decibel (dB) | Standard unit of measurement for sound pressure level. |
| equivalent sound level (L_{eq}) | That steady sound level which, over a given time period, would result in the same overall sound energy exposure as would the actual fluctuating level. Expressed in units of dBA. |
| nighttime equivalent sound level (L_n) | Equivalent Sound level (L_{eq}) for the time period from 10 p.m. to 7 a.m. |
| noise | In general, noise is considered to be unwanted sound. |
| noise-sensitive receptor | Humans who might experience sound and vibration energies. A noise-sensitive receptor is a person who is most influenced by such noise or vibration by virtue of where they live relative to the sources. Specific behaviour and physiology (e.g., age, general health) may make a person more vulnerable to noise and vibration. |
| Project Area | The Project footprint plus the Project disturbance area. |
| Project disturbance area | All lands and lands under water, except the Project footprint, which are subject to disturbance during Project construction and required for maintenance activities during Project operation. |
| Project footprint | The land and water surface occupied by the Project facilities and structures. |

| Term | Definition |
|-------------------------|---|
| sound | Minute fluctuations in atmospheric (air) pressure usually created by vibrating objects or moving fluids such as loudspeakers, drums, or moving vehicles. Humans interpret these pressure fluctuations occurring over the audible frequency range (approximately 20 Hz to 20,000 Hz) as sound. |
| sound level | The intensity of sound expressed on a logarithmic scale. The basic unit of sound level is the decibel (dB). |
| sound level meter | An instrument that measures and logs sound pressure levels. A Type 1 sound level meter is the industry standard for precision field measurements used in environmental noise assessments, and is accurate to +/- 1 dBA. |
| sound-level contour map | Spatial representation of ranges of noise levels, analogous to the ground-elevation contours found on topographical maps. |
| sound pressure level | Sound pressure level = $20 \log_{10} (p/p^0)$ dB: The sound pressure level of a sound in decibels is equal to 20 times the logarithm to base 10 of the ratio of the RMS sound pressure to the reference sound pressure 20 mPa (2×10^{-5} Pa). |
| usage factor | A term used in the prediction of Project construction noise that refers to the percentage of time during a construction shift when a particular piece of construction equipment typically operates and produces noise. |

1.0 Scope of Study

This document provides technical details on the atmospheric noise study undertaken to support the environmental assessment of the George Massey Tunnel Replacement Project (Project). An overview of the key study components and their major objectives is provided in **Table 1**. A review of available information pertaining to atmospheric noise conditions along the Project alignment was undertaken to inform the study and identify the need for additional data.

Table 1 Atmospheric Noise Study Components and Major Objectives

| Component | Major Objective(s) | Brief Overview |
|--|---|--|
| Existing noise monitoring | Establish existing (i.e., pre-Project) ambient noise environments | Continuous monitoring (24-hour, 48-hour, and shorter periods) of noise levels at locations representative of noise-sensitive land uses within the Project alignment. |
| Post-construction (i.e., operation phase) traffic noise forecast | Predict operation and total noise exposures for 2030 ¹ | Noise modelling using the projected future traffic data to predict Project-related changes in traffic noise exposures over a 10-year design horizon at noise-sensitive receptors along the Project alignment. |
| Construction phase noise forecasts | Estimate the range of potential effects of Project-related construction noise at adjacent noise-sensitive receptors | Estimation of Project-related construction noise using a generic construction noise prediction methodology used in the environmental impact assessment of several previous major B.C. highway projects and evaluating noise levels received by sensitive receptors from construction activities. |

¹ the year for which future traffic volume projections were available

1.1 Regulatory/Policy Context and Assessment Guidelines

1.1.1 The Ministry's Noise Policy

The atmospheric noise study for the Project was guided primarily by the Ministry's *Policy for Assessing and Mitigating Noise Impacts from New and Upgraded Numbered Highways* (Wakefield Acoustics Ltd. 2014), hereafter referred to as the Ministry's 2014 noise policy. The Ministry's 2014 noise policy is a tool that promotes the protection of public health by identifying highway traffic-related noise impacts from construction of new highways and upgrading of existing highways, and the potential need for mitigation measures.

The Ministry's 2014 noise policy provided the methods for the following aspects of the study:

- Choice of appropriate and representative baseline noise monitoring sites
- Baseline noise monitoring with the day-night equivalent sound level (L_{dn}) noise metric
- Prediction of future noise levels due to the Project at baseline monitoring locations
- Total future noise level determination in situations where the baseline conditions are not dominated by the Project
- Moderate and severe Project-related noise impact identification
- Noise mitigation requirements

In accordance with the Ministry's 2014 noise policy, 2030 was adopted in this study as the assessment year for projected future conditions with the Project. The Ministry's 2014 noise policy does not address potential noise impacts related to highway construction. Guidance on the control of construction noise and minimization of construction noise impacts are provided in the relevant section of the Ministry's *Standard Specifications for Highway Construction* (B.C. MOTI 2012). Best practices for the control of highway construction noise will be applied.

1.1.2 European Environment Agency Guidance

The European Environment Agency's (EEA) *Good Practice Guide on Noise Exposure and Potential Health Effects* identifies noise indicators that are relevant to human health, as defined by the World Health Organization (WHO 1946 as cited in EEA 2010). These indicators are the day-night equivalent sound level (L_{dn}), the daytime equivalent sound level (L_d), and the nighttime equivalent sound level (L_n). WHO (1946) provides the appropriate baseline noise metrics for the atmospheric noise study.

1.1.3 United States Environmental Protection Agency Guidance

Noise levels required to protect public health and welfare against hearing loss, annoyance, and activity interference were identified by the United States Environmental Protection Agency (U.S. EPA) in 1974. These noise levels are contained in the document titled *Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety* (U.S. EPA 1974). As with the EEA 2010 guide, this document identifies the L_{dn} , L_d and L_n as the appropriate baseline noise metrics for environmental noise impact assessments; these metrics were therefore used in this atmospheric noise study.

1.1.4 Canada Mortgage and Housing Corporation Guidance

Guidance from the Canada Mortgage and Housing Corporation (CMHC) includes a manual on procedure for modelling traffic noise exposures at wayside locations under relatively simple highway configurations (CMHC 1981). The CMHC noise model (specifically, the baseline adjustment method (BAM)) was used in the atmospheric noise study to estimate future noise levels for the Project, where conditions permit its use.

1.1.5 Highway 17/South Fraser Perimeter Road Project Data

The *South Fraser Perimeter Road Noise Impact Assessment Technical Volume 13* (Wakefield Acoustics Ltd. 2006) of the EA Application prepared for the Ministry for the South Fraser Perimeter Road (SFPR) project has been adopted as a reference for the Project. In the SFPR noise impact assessment, two approaches to construction noise impact assessment were presented: the EPA method and the International Standards Organization (ISO 1996) method. The generic construction noise estimation technique used on the SFPR and other recent major B.C. highway projects has been used in the Project atmospheric noise study to estimate construction noise exposures from the Project.

1.1.6 Highway 99/Ladner Trunk Road Interchange Upgrade Project Data

The Ministry commissioned the Highway 99/Ladner Trunk Road interchange upgrades in 2012. Noise exposures were assessed at fronting residential units in the northeast quadrant at Delta View. Residential noise impacts were not identified at Delta View under the 1993 noise policy, nor was mitigation required under that policy. The noise assessment is provided in *Report 13-M259-1 Burns Drive/Highway 99 Community Noise Assessment* (Wakefield Acoustics Ltd. 2013).

The principal noise metric obtained for the Project, through monitoring, is the day-night average sound level (L_{dn}), which is the primary noise metric used in the Ministry's 2014 noise policy. Noise monitoring also provided the daytime average sound level (L_d), which is the equivalent sound level (L_{eq}) between 7 a.m. and 10 p.m., and the nighttime average sound level (L_n), which is the L_{eq} between 10 p.m. and 7 a.m. While these latter two noise metrics are not used directly in the Ministry's 2014 noise policy, they provide important information relevant to the human health effects assessment

2.0 Study Methods

2.1 Study Area Considerations

Noise monitoring was conducted along the Highway 99 corridor from the Bridgeport Road interchange in City of Richmond (Richmond) to the Highway 91 interchange in Corporation of Delta (Delta). The boundaries of the study area were determined based on two considerations:

1. The lateral distance beyond which noise impacts, as defined in the Ministry's 2014 noise policy, are not likely to occur.
2. The lateral distance beyond which daily-average noise levels from traffic related to the Project would not be expected to exceed what is considered by CMHC and U.S. EPA to be acceptable for residential land uses.

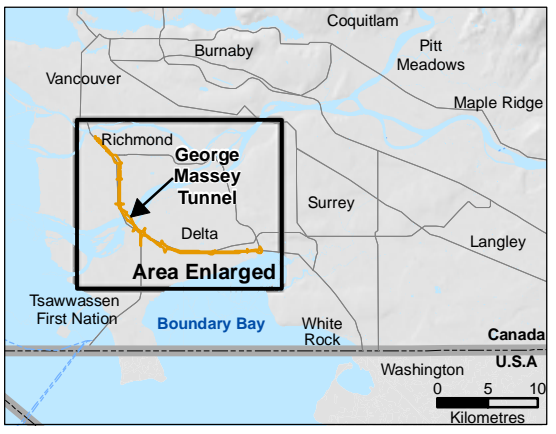
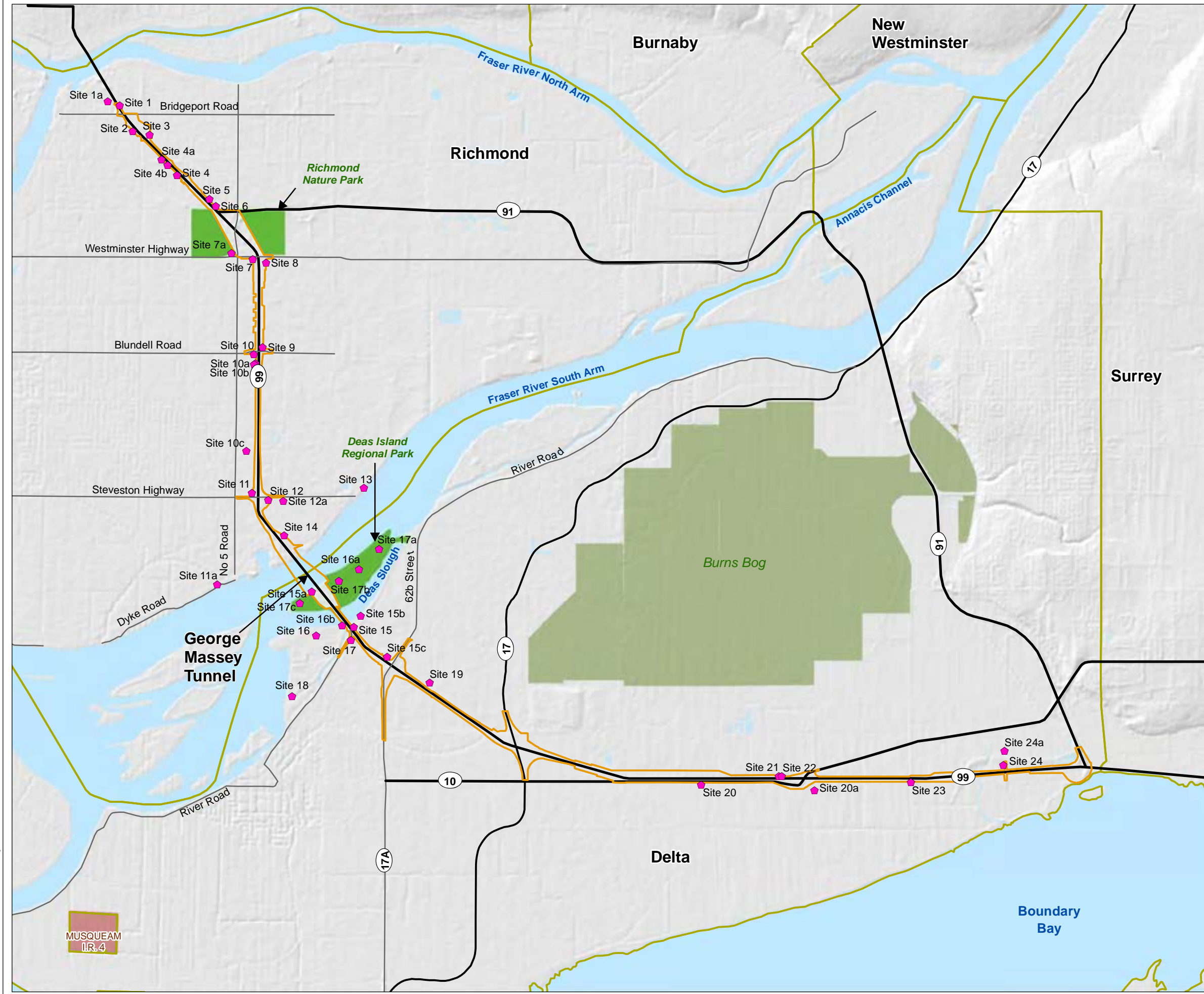
The distance at which these two conditions would be met depends on traffic volume, average speed, and heavy truck component of the future traffic stream on Highway 99. The distance also depends on the elevation of the traffic above the ground and the nature of the ground surface between the highway and the noise-sensitive receptors. Where sound travels close to the ground, and in particular where the intervening surface is acoustically absorptive or soft (e.g., grass, farmland, wooded areas), the reduction of sound levels over moderate distances is relatively high. Where the sound source is elevated well above the ground, and in particular where the intervening surface is acoustically reflective or hard (e.g., pavement, water), the rate of attenuation of sound levels with distance is generally much lower.

For these reasons, for the majority of the study area within which Highway 99 is close to natural ground level and largely bordered by agricultural or undeveloped lands, the study area width extends 500 m from either side of the Project footprint. This width is sufficient to capture the following:

- Residences north of the Fraser River on both sides of No. 5 Road, which parallels Highway 99 to the west, and Sidaway Road, which parallels Highway 99 to the east.
- Residences south of the Fraser River along 64th, 72nd, 80th, 88th, 96th Streets, Burns Drive, and Ladner Trunk Road.

In the vicinity of the new bridge, where Highway 99 traffic will be elevated well above natural ground level, and where much of the surrounding surfaces are water, the study area extends approximately 1,600 m from either side of the Project footprint, since the rate of decrease in sound levels over these acoustically reflective surfaces is lower. This distance is sufficient to capture the following:

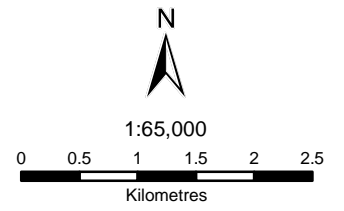
- Condominium buildings located along Riverport Way in Richmond on the north bank of the Fraser River to the east of Highway 99 and the new bridge.
- Townhouses along Regatta Way, Delta, to the west of Highway 99.
- Residences and parks along Dyke Road and residences along Rice Mill Road in Richmond.
- Residences along River Road and Admiral Way in Delta.



- Legend**
- ◆ Atmospheric Noise Monitoring Site
 - Project Alignment
 - First Nation Reserve
 - Municipal Boundaries
 - Burns Bog Ecological Conservancy Area
 - Waterbody
 - Canada - U.S. Border
 - Highway
 - Arterial/Collector Road

SOURCES

Parks and Protected Lands, First Nations Reserves from GeoBC, United States basemap data courtesy of USGS. Burns Bog courtesy of The Corporation of Delta and based on the Metro Vancouver Burns Bog Ecological Conservancy Area Management Plan - May 2007, all other data courtesy of Canvec - GeoGratis.



| | |
|---|------------|
| GEORGE MASSEY TUNNEL REPLACEMENT PROJECT | |
| NOISE MONITORING SITES OVERVIEW | |
| Figure 1 | 18/05/2016 |
| | |

Path: C:\1217-299\285077\03\mxd\Noise\TV\fig1_285_077_03_EA_Noise_160518.mxd

2.2 Temporal Scope

The atmospheric noise study was designed to document the existing baseline noise environment at representative residential and non-residential noise-sensitive locations within the study area in 2013 and 2014². The baseline noise levels include pre-Project Highway 99 noise as well as noise from all other sources.

The temporal boundary for the atmospheric noise study is based on the maturation of the traffic regime, which, in accordance with the Ministry's 2014 noise policy, is taken to be 10 years after Project completion. The anticipated Project completion date of 2022 puts the 10-year post-completion horizon year at 2032; however, 2030, the year for which future traffic volume projections were available, was used as the horizon year for this assessment. The difference in forecasted noise levels due to traffic growth from one year to the next is negligible. The relevant noise metrics for the atmospheric noise study include L_{dn} , L_d , and L_n . These three metrics were measured at all long-term monitoring noise sites and were estimated at short-term monitoring sites. Future noise levels with the Project were predicted using either a baseline adjustment method or highway noise modelling software. The following methods and procedures were used to achieve this:

1. Baseline (pre-Project) noise monitoring (yielding the L_{dn} , L_d and L_n) was conducted at 41 sites along Highway 99 between Bridgeport Road in Richmond and Highway 91 in Delta.
2. The CMHC baseline adjustment method was used to predict post-Project noise exposures in terms of L_{dn} , L_d and L_n for 2030 at noise-sensitive locations within the portions of the Project where the planned changes to the horizontal and vertical alignments of Highway 99 will be minor.

² Baseline noise monitoring was mainly conducted in autumn 2013. Additional noise monitoring was conducted in spring 2014. Relevant baseline monitoring had also been conducted in 2012 on earlier Highway 99 improvement projects (see **Section 2.3**).

3. DataKustik's CadnaA noise prediction software version 4.3.143 was used to model post-Project noise exposures in terms of L_{dn} , L_d and L_n for 2030 at noise-sensitive locations in the vicinity of the new bridge and its approaches, where the planned changes in the vertical alignment of Highway 99 will be major.
4. Construction noise exposures at noise-sensitive locations were estimated in terms of L_{dn} , L_d and L_n using a generic method³ previously used in other major highway projects in B.C.

2.2.1 Baseline Noise Measurements 2012 - 2014

The continuous baseline noise monitoring was conducted using four Larson-Davis model 820 and model 812 environmental noise monitors, a Larson-Davis SoundTrack LxT®, and two Larson-Davis SoundExpert™ LxT sound level meters (see **Appendix A** for instrumentation details), with one instrument set up per site. These digital instruments meet or exceed American National Standards Institute (ANSI) S1.4: Specifications for Sound Level Meters (1983), including Type 1 sound level meters, and are capable of sampling the ambient sound level many times per second and storing the resulting sound level data for subsequent analysis and display. The instruments were set to collect a complete statistical description of the noise environment every 15 minutes. At each site, these instruments store, among many other noise descriptors, the day-night equivalent sound level (L_{dn}). The L_{dn} is a single-number descriptor of the average sound energy level over a 24-hour period with a 10 decibel (dB) adjustment applied to the noise levels measured during nighttime hours. L_{dn} is expressed in units of A-weighted decibels (dBA) and is the noise metric employed in the Ministry's 2014 noise policy.

Microphones were mounted on poles approximately 1.7 m above ground level in positions where overall noise exposures were considered to be representative of the residential façades that will, in the future, be most directly exposed to noise from Highway 99 traffic.

The baseline noise monitoring was conducted between October 2 and November 22, 2013 and between April 7 and 9, 2014 at 41 noise-sensitive locations (sites) along the Highway 99 alignment between Bridgeport Road in Richmond and Highway 91 in Delta. Continuous unattended noise monitoring was conducted at 41 long-term sites (i.e., over 24-hour periods at 22 sites, and over a 48-hour period at one quality control site). Additional baseline noise data was obtained from an earlier study done in relation to the Highway 99/Burns Drive improvement

³ This procedure has been used in previous applications for the Sea-to-Sky Highway Improvement Project, SFPR project and Port Mann/Trans-Canada Highway project.

project. This study focused on project noise effects at the Delta View Life Enrichment Centre located near the Ladner Trunk Road Interchange. Since the study was conducted in 2013, the traffic noise levels obtained are considered sufficiently current to serve, as appropriate, as baseline data for the current Project. To supplement the long-term noise monitoring conducted at the 23 sites, short-term (typically 30 minutes) attended daytime monitoring sessions were conducted from October 2013 to April 2014 at an additional 18 sites.

In accordance with the Ministry's 2014 noise policy, baseline noise monitoring sites were selected to be representative of residential enclaves, schools, Places of Worship, and passive parks. The large majority of sites were residential and typically a baseline monitoring site was selected to be representative of a group of residences having similar highway noise exposures. In each case, the microphone was placed outdoors near a residence fronting onto the Project and in a location having the greatest exposure to noise due to the Project. The principal noise metric collected at these monitoring sites was the L_{dn} , the primary noise metric utilized in the Ministry's 2014 noise policy, and widely in use internationally. The 24-hour monitoring also yielded the L_d , and the L_n .

Short-term noise monitoring was conducted at 18 sites. Each short-term monitoring session was conducted concurrently with a long-term session at a control site located within the same contiguous segment of Highway 99. Short-term sites and their nearby control sites may have had different setbacks or elevations with respect to the highway, but their noise exposures were considered to be similarly dominated by Highway 99 traffic. Short-term monitoring was conducted only in locations where existing and expected future noise environments are dominated by Highway 99 traffic noise. The appropriate L_{dn} for each short-term site was then obtained by comparing the equivalent sound level (L_{eq}) measured over the specific 30-minute monitoring period at the short-term site with the L_{eq} measured during the identical 30-minute period at the control site. Specifically, the difference between the two 30-minute L_{eq} values was then applied to the L_{dn} measured at the control site to obtain the L_{dn} at the short-term site.

The noise level data obtained at the twenty-three 24-hour and 48-hour monitoring sites are presented in **Appendix B**, along with photos and descriptions of the sites and the dominant source(s) of baseline noise at in each site.

2.2.2 Prediction of Future Noise Conditions

Baseline Adjustment Method

The baseline adjustment method (BAM) is a means of predicting the effects of a highway improvement project on noise levels at a representative location. The BAM can be used most effectively in situations where the highway alignment (horizontal and vertical) is not changing to any substantial degree; for example, where additional through lanes are being added to one or both sides of a fixed highway centreline; where the horizontal or vertical alignment is being modified only slightly; or where the traffic volume, posted speed, and/or level of service will change. The north and south segments of the study area, excluding the proposed bridge and its approaches, lend themselves to the BAM approach. For purposes of applying the BAM, the study area was divided into segments as presented in **Table 2**.

Table 2 Highway 99 Segments for Assessment of Operational Noise

| Highway 99 Mainline Segments | Site Numbers |
|---|--|
| A. Bridgeport Road to Westminster Highway | 2, 3, 4a, 4b, 4, 5, 6, and 7a |
| B. Westminster Highway to Steveston Highway | 7, 8, 9, 10, 10a, 10b, 10c, 11, and 13 |
| C. Steveston Highway to Highway 17A | 11a, 12, 12a, 14, 15, 15a, 15b, 15c, 16a, 16b, 17, 17a, 17b, 17c, and 18 |
| D. Highway 17A to Highway 17 | 19 |
| E. Highway 17 to Ladner Trunk Road | 20, 21, 22 |
| F. Ladner Trunk Road to Highway 91 | 20a, 23, 24, 24a |

In applying the BAM, reliance has been placed principally on the manual highway noise prediction procedure contained in the CMHC document Road and Rail Noise; Effects on Housing (CMHC 1981). This procedure allows 24-hour average highway noise exposures to be estimated based on the following traffic parameters:

- Average daily traffic volume
- Heavy truck mix
- Posted speed
- Highway grade
- Receptor setback distance from highway centreline
- Elevation of highway and receptors above surrounding ground surface
- Nature (i.e., acoustically hard or soft) of the intervening ground surface

Using these input parameters, the 24-hour Equivalent Sound Level, or $L_{eq}(24)$, at the receptor location may be estimated. Similarly, if one or more of these parameters is to be changed as a result of a proposed highway improvement project, then the effects of any such changes on the $L_{eq}(24)$ can be predicted. Assuming the distribution of traffic between the 15 daytime hours (07:00 to 22:00) and nine nighttime hours (22:00 to 07:00) does not change, the predicted change in L_{dn} (the noise metric used in the Ministry's 2014 noise policy) will be the same as that in $L_{eq}(24)$.

As an example, consider the hypothetical situation in which a new lane is to be added on each side of an existing two-lane highway around a fixed centreline, and, as a result, the total traffic volume will increase by 30%, the heavy truck mix will increase from 5% to 8% and the posted speed will increase from 80 to 100 kmph. The $L_{eq}(24)$ at residences set back more than about 30 m from the highway would then be expected to increase by approximately 4.0 dBA (1.0 dBA from volume growth, 1.0 dBA from heavy truck mix growth and 2.0 dBA from the speed increase). Therefore, if the baseline noise level at a particular location was, for example, L_{dn} 63 dBA, the post-Project level would be expected to be approximately L_{dn} 67.0 dBA.

The BAM was used to predict Project noise effects in all but segment C. Further details of the BAM are provided in **Appendix C**. The existing and future traffic data on which the BAM estimates are based are also presented in **Appendix C**.

Traffic Noise Modeling

Where the planned improvements to Highway 99 include major and complex changes to the horizontal and vertical alignment, such as will occur at the new bridge and its approaches, the BAM is not appropriate since it cannot account for the effects of such substantive changes in highway geometry. Therefore, a three-dimensional computer-based highway noise model was developed to predict the noise levels that will exist 10 years after Project completion (2030) throughout the portion of the study area that includes the new bridge and its approaches (segment C in **Table 2**). The computer-based noise model runs a proprietary version of the U.S. Federal Highways Administration (FHWA) Traffic Noise Model (TNM®) Version 2.5 (U.S. FHWA 2004). The input parameters required for the TNM 2030 noise model are as follows:

- Proposed horizontal and vertical alignment of the bridge including the north and south approaches
- Forecast annual average daily traffic volumes (AADT) in 2030, and day-night traffic split

- Proposed posted speed (km/hr)⁴
- Expected distribution of traffic in the proposed lanes across the 10-lane bridge, taking into account the percentage of heavy trucks and the day-night traffic split
- Proposed pavement type
- Noise receptor locations within the study area
- Nature of intervening ground (acoustically hard water and pavement versus acoustically soft grass)
- Presence of noise-shielding elements such as bridge deck parapet
- Presence of natural noise-shielding elements such as forest belts
- Relevant ground elevation contours within the study area
- Average weather conditions

Further details on noise modeling are provided in **Appendix C**.

2.2.3 Construction Noise

The levels of construction noise that may be generated by the Project were estimated using a generic construction noise prediction methodology that has been employed during the environmental impact assessment phases of several previous major B.C. highway projects, including the Sea to Sky Highway Improvement Project, PMH1 and the SFPR project. Construction noise analysis was carried out for all mainline segments as shown in **Table 3**. Further details are presented in **Appendix D**.

Table 3 Segments for Estimating Construction Noise

| Mainline Segments | Site Numbers |
|--|--|
| A - Bridgeport Road to Westminster Highway | 2, 3, 4a, 4b, 4, 5, 6, and 7a |
| B - Westminster Highway to Steveston Highway | 7, 8, 9, 10, 10a, 10b, 10c, 11, and 13 |
| C - Steveston Highway to Highway 17A | 11a, 12, 12a, 14, 15, 15a, 15b, 15c, 16a, 16b, 17, 17a, 17b, 17c, and 18 |
| D - Highway 17A to Highway 17 | 19 |
| E - Highway 17 to Ladner Trunk Road | 20, 21, 22 |
| F – Ladner Trunk Road to Highway 91 | 20a, 23, 24, 24a |

⁴ Light vehicles are assumed to travel at the posted speed. Heavy trucks assumed to travel at posted speed on level ground but at reduced speeds on grades.

2.2.4 Quality Control

Baseline noise data were collected in a consistent fashion at all sites with 24-hour noise-monitoring sessions being repeated at certain locations to verify the reproducibility of the noise levels. Instrumentation was consistently field-calibrated and time-synchronized.

The Larson Davis model 820 and model 812 environmental noise monitors, and the Brüel & Kjær Type 2250 sound level meter, were recently calibrated by a certified National Voluntary Laboratory Accreditation Program calibration laboratory. The Larson Davis SoundExpert™ LxT sound level meters were new from the factory. Instruments were field-calibrated before and after each monitoring period using the appropriate field calibrator (Larson Davis CA250 Acoustic Calibrator, and Brüel & Kjær 4231).

3.0 Application of the Ministry's Noise Policy 2014

The Ministry's 2014 noise policy provides a procedure to assess if the noise environments which will exist within adjacent communities of a highway project, ten years after completion, warrant mitigation consideration. Mitigation consideration will depend on both the absolute post-project noise levels and whether they will exceed certain fixed upper limits, and on the magnitudes of project-related changes in noise levels relative to pre-project (baseline) conditions. The key features of the 2014 noise policy are listed below:

- The principal noise metric for residential areas is the Day-Night Average Noise Level, or L_{dn} .
- Two fixed upper noise limits are defined – L_{dn} 65 dBA for Moderate Impacts and L_{dn} 75 dBA for Severe Impacts.
- If post-project noise levels exceed either the 65 or 75 dBA fixed limit, the current project does not need to have increased residential noise exposures for mitigation consideration to be warranted. It is enough that post-project levels exceed one of the fixed thresholds.
- To be considered effective, mitigation measures must be capable, individually or in combination, of reducing post-project noise exposures by 5 dBA or more.
- For noise-sensitive land uses (e.g., residential developments) to be eligible for mitigation consideration, they must have received planning approval from the relevant local authority prior to the first public announcement of the highway project or the designation (through gazetting) of the affected lands as potential future highway right-of-way (ROW).
- Mitigation measures may be considered for implementation either within or outside the highway ROW.
- Mitigation in the form of vertical noise barriers (walls) are limited in height to 5 m, while earth berms and berm-wall combinations may be of any practical height.
- Mitigation costs and benefits are site- and project-specific. However, benchmark mitigation cost guidelines have been established as \$25,000 (in 2014 dollars) per directly-benefiting household where project-related noise impacts are Moderate, and \$40,000 where they are Severe.
- Mitigation measures may be considered for residences, schools, hospitals, Places of Worship, libraries, museums and passive parks (not including golf courses, active parks and playing fields). Mitigation for residences and schools is always considered if noise exposures warrant. Mitigation for other land uses is considered on a case-by-case basis.

Figure 2 and **Figure 3** present the mitigation thresholds from the 2014 noise policy in graphical form. In **Figure 2**, pre-project noise levels (L_{dn}) are plotted on the horizontal axis while total, post-project (10 years after project completion) noise levels are plotted on the vertical axis. Mitigation consideration is warranted for noise impact situations (intercept of pre-project and post-project noise levels) which fall within either Moderate or Severe impact zones. Mitigation is only carried out by the Ministry where total post-project noise levels are clearly dominated by highway traffic.

In **Figure 3**, pre-Project noise levels are shown on the horizontal axis while the Project-related increases in total noise exposure required to warrant mitigation consideration are plotted on the vertical axis. The Moderate and Severe noise impact threshold values of both **Figure 2** and **Figure 3** are presented in **Table 4**.

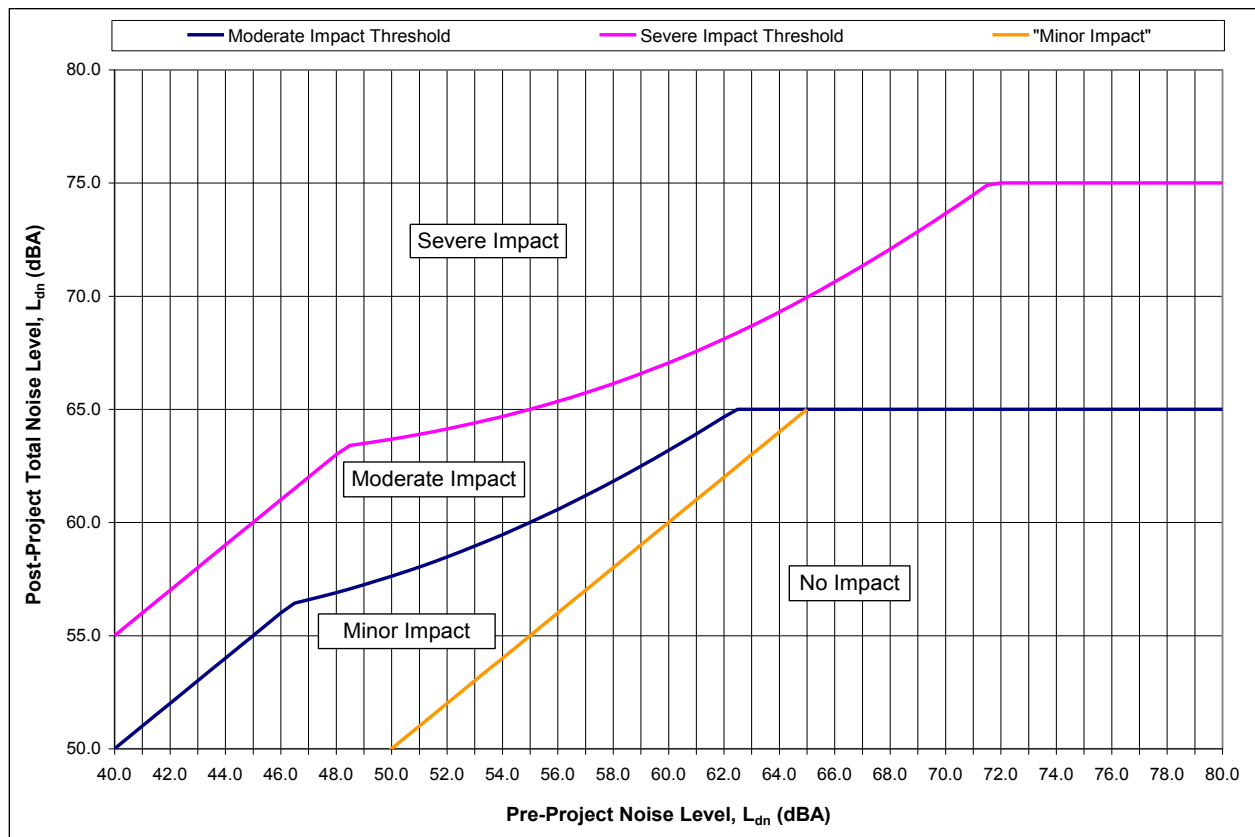


Figure 2 Project-related Traffic Noise Impact Thresholds

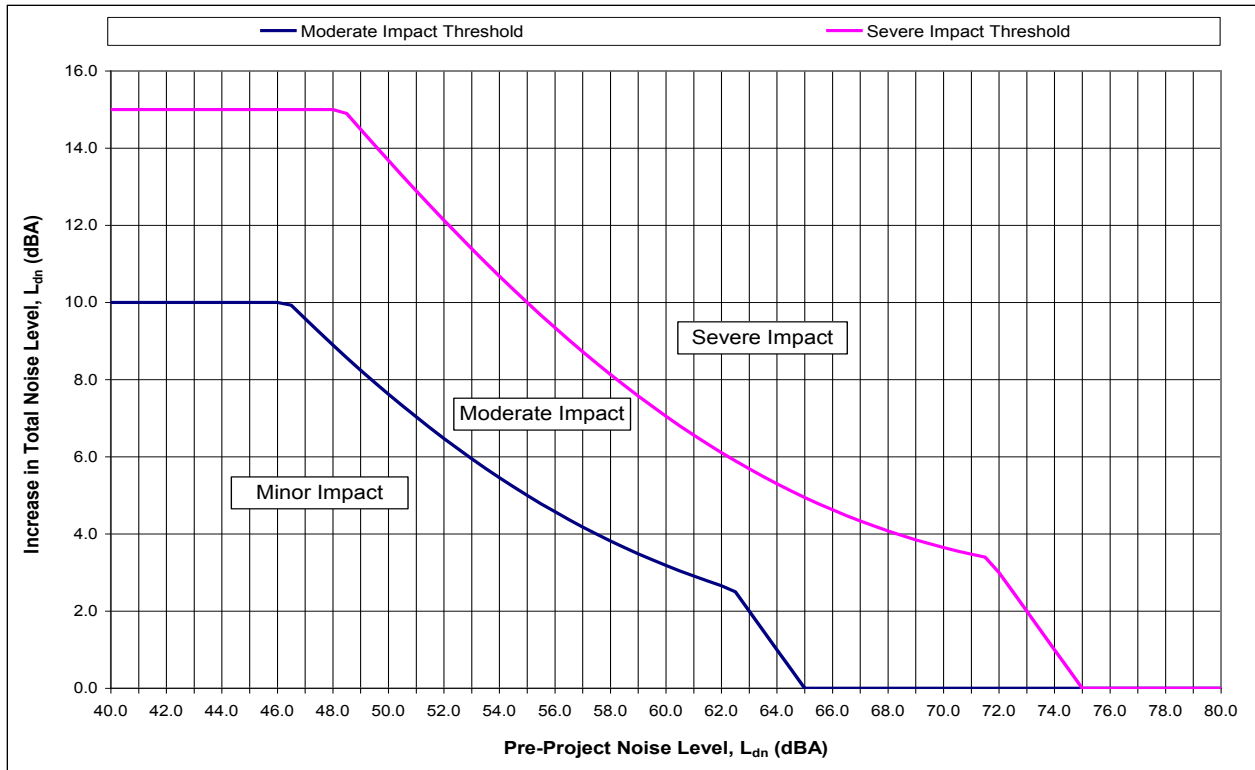


Figure 3 Increases in Total Noise Levels Permitted by Impact Thresholds of Figure 2

Table 4 Post-Project Total L_{dn} Values and Increases in Total L_{dn} Corresponding to Noise Impact Thresholds of Figures 2 and 3 Respectively

| Pre-Project L _{dn} (dBA) | Post-Project Total L _{dn} (dBA) (Figure 2) | | | Increase in Total L _{dn} (dBA) (Figure 3) | | |
|-----------------------------------|--|-----------------|---------------|---|-----------------|---------------|
| | Minor Impact | Moderate Impact | Severe Impact | Minor Impact | Moderate Impact | Severe Impact |
| 40.0 | 40.0 | 50.0 | 55.0 | 0.0 | 10.0 | 15.0 |
| 41.0 | 41.0 | 51.0 | 56.0 | 0.0 | 10.0 | 15.0 |
| 42.0 | 42.0 | 52.0 | 57.0 | 0.0 | 10.0 | 15.0 |
| 43.0 | 43.0 | 53.0 | 58.0 | 0.0 | 10.0 | 15.0 |
| 44.0 | 44.0 | 54.0 | 59.0 | 0.0 | 10.0 | 15.0 |
| 45.0 | 45.0 | 55.0 | 60.0 | 0.0 | 10.0 | 15.0 |
| 46.0 | 46.0 | 56.0 | 61.0 | 0.0 | 10.0 | 15.0 |
| 47.0 | 47.0 | 56.6 | 62.0 | 0.0 | 9.6 | 15.0 |
| 48.0 | 48.0 | 56.9 | 63.0 | 0.0 | 8.9 | 15.0 |
| 49.0 | 49.0 | 57.2 | 63.5 | 0.0 | 8.2 | 14.5 |
| 50.0 | 50.0 | 57.6 | 63.7 | 0.0 | 7.6 | 13.7 |
| 51.0 | 51.0 | 58.0 | 63.9 | 0.0 | 7.0 | 12.9 |
| 52.0 | 52.0 | 58.5 | 64.1 | 0.0 | 6.5 | 12.1 |
| 53.0 | 53.0 | 59.0 | 64.4 | 0.0 | 6.0 | 11.4 |
| 54.0 | 54.0 | 59.5 | 64.7 | 0.0 | 5.5 | 10.7 |
| 55.0 | 55.0 | 60.0 | 65.0 | 0.0 | 5.0 | 10.0 |
| 56.0 | 56.0 | 60.6 | 65.3 | 0.0 | 4.6 | 9.3 |
| 57.0 | 57.0 | 61.2 | 65.7 | 0.0 | 4.2 | 8.7 |
| 58.0 | 58.0 | 61.8 | 66.1 | 0.0 | 3.8 | 8.1 |
| 59.0 | 59.0 | 62.5 | 66.6 | 0.0 | 3.5 | 7.6 |
| 60.0 | 60.0 | 63.2 | 67.1 | 0.0 | 3.2 | 7.1 |
| 61.0 | 61.0 | 63.9 | 67.6 | 0.0 | 2.9 | 6.6 |
| 62.0 | 62.0 | 64.7 | 68.1 | 0.0 | 2.7 | 6.1 |
| 63.0 | 63.0 | 65.0 | 68.7 | 0.0 | 2.0 | 5.7 |
| 64.0 | 64.0 | 65.0 | 69.3 | 0.0 | 1.0 | 5.3 |
| 65.0 | - | 65.0 | 69.9 | - | 0.0 | 4.9 |
| 66.0 | - | 65.0 | 70.6 | - | 0.0 | 4.6 |
| 67.0 | - | 65.0 | 71.3 | - | 0.0 | 4.3 |
| 68.0 | - | 65.0 | 72.1 | - | 0.0 | 4.1 |

| Pre-Project Ldn (dBA) | Post-Project Total L _{dn} (dBA) (Figure 2) | | | Increase in Total L _{dn} (dBA) (Figure 3) | | |
|-----------------------|--|-----------------|---------------|---|-----------------|---------------|
| | Minor Impact | Moderate Impact | Severe Impact | Minor Impact | Moderate Impact | Severe Impact |
| 69.0 | - | 65.0 | 72.8 | - | 0.0 | 3.8 |
| 70.0 | - | 65.0 | 73.6 | - | 0.0 | 3.6 |
| 71.0 | - | 65.0 | 74.5 | - | 0.0 | 3.5 |
| 72.0 | - | 65.0 | 75.0 | - | 0.0 | 3.0 |
| 73.0 | - | 65.0 | 75.0 | - | 0.0 | 2.0 |
| 74.0 | - | 65.0 | 75.0 | - | 0.0 | 1.0 |
| 75.0 | - | 65.0 | 75.0 | - | 0.0 | 0.0 |
| 76.0 | - | 65.0 | 75.0 | - | - | 0.0 |
| 77.0 | - | 65.0 | 75.0 | - | - | 0.0 |
| 78.0 | - | 65.0 | 75.0 | - | - | 0.0 |
| 79.0 | - | 65.0 | 75.0 | - | - | 0.0 |
| 80.0 | - | 65.0 | 75.0 | - | - | 0.0 |

To be considered effective under the 2014 noise policy, mitigation measures should reduce total post-Project noise exposures by at least 5dBA.

4.0 Results

4.1 Baseline Noise Monitoring Results

The baseline noise monitoring results are presented in **Table 5** through **Table 7** and include the following:

- Noise monitoring site number
- Noise monitoring dates including start and stop times
- Noise monitoring duration
- Location of noise-sensitive receptor (microphone location)
- The existing land use of the site
- L_{dn} , L_d , and L_n

Further details of the noise monitoring sites, including site photos and noise level time histories, are provided in **Appendix B**.

Table 5 Results of Baseline Noise Monitoring (Sites 2 to 11a)

| Site # | Date | Duration ¹ | Noise Sensitive Receptor Location | Land Use | Ldn (dBA) | Ld (dBA) | Ln (dBA) |
|----------------|---------------------|-----------------------|---|----------------|-----------|----------|----------|
| 2 ² | Nov. 4 to 5, 2013 | 24 hrs | 22 Capella Garden, 9731 Capella Drive, Richmond, B.C. | Residential | 72.2 | 69.9 | 64.5 |
| 3 | Nov. 4 to 5, 2013 | 24 hrs | 10168 Caithcart Road, Richmond, B.C. | Residential | 69.7 | 68.2 | 61.4 |
| 4 | Nov. 4 to 5, 2013 | 24 hrs ³ | 9 Florence Estates, 10411 Hall Avenue, Richmond, B.C. | Residential | 72.0 | 69.6 | 63.8 |
| 4a | Nov. 4, 2013 | Short | Richmond Estates, 10511, Kilby Drive, Richmond, B.C. | Residential | 70.1 | 66.4 | 63.0 |
| 4b | Nov. 4, 2013 | Short | 10333 Bryson Drive, Richmond, B.C. | Residential | 68.8 | 69.2 | 58.1 |
| 5 | Nov. 5 to 6, 2013 | 24 hrs | 4591 Dallyn Road, Richmond, B.C. | Residential | 68.7 | 66.7 | 60.8 |
| 6 | Apr. 8 to 9, 2014 | 24 hrs | 11600 Dewsbury Drive, Richmond, B.C. | Residential | 74.1 | 70.1 | 67.1 |
| 7 | Apr. 9, 2014 | 24 hrs | 12260 Old Westminster Highway, B.C. | Residential | 67.0 | 63.7 | 59.9 |
| 7a | Apr. 9, 2014 | Short | Richmond Nature Park, 11851 Westminster Highway, Richmond, B.C. | Municipal-park | - | 58.0 | - |
| 8 | Oct. 29 to 30, 2013 | 24 hrs | 12250 Old Westminster Highway, Richmond, B.C. | Residential | 64.2 | 61.1 | 56.9 |
| 9 | Oct. 29 to 30, 2013 | 24 hrs | 12431 Blundell Road, Richmond, B.C. | Daycare | 72.5 | 66.9 | 65.9 |
| 9 | Oct. 30 to 31, 2013 | 24 hrs | 12431 Blundell Road, Richmond, B.C. | Daycare | 70.4 | 67.8 | 62.8 |

| Site # | Date | Duration ¹ | Noise Sensitive Receptor Location | Land Use | Ldn (dBA) | Ld (dBA) | Ln (dBA) |
|--------|-------------------------|-----------------------|--|----------------|-----------|----------|----------|
| 10 | Oct. 31 to Nov. 1, 2013 | 24 hrs | 12280 Blundell Road, Richmond, B.C. | Daycare | 67.3 | 64.5 | 59.9 |
| 10a | Nov. 1, 2013 | Short | Mosque, 12300 Blundell Road, Richmond, B.C. | Worship | - | 71.8 | - |
| 10b | Nov. 1, 2013 | Short | School, 12300 Blundell Road, Richmond, B.C. | School | - | 71.0 | - |
| 10c | Nov. 1, 2013 | Short | Ling Yen Mountain Temple, 10060 No. 5 Road, Richmond, B.C. | Worship | - | 61.7 | - |
| 11 | April 7 to 8, 2014 | 24 hrs | 10640 No. 5 Road, Richmond, B.C. | Residential | 65.7 | 62.6 | 58.3 |
| 11a | April 9, 2014 | Short | 11551 Dyke Road, Richmond, B.C. | Municipal-park | - | 46.4 | - |

Notes:

- ¹ Actual run times may vary. Short-term measurements were typically 30 minutes. At short-term sites representing residences, the L_{dn}, L_d, and L_n were estimated through comparison with the full 24-hour noise histories measured at the relevant control site.
- ² In many residential land use situations, the receptor location is representative of a group of residences which are similarly exposed to Highway 99 noise. Such receptors are located in the fronting row of residences as per the Ministry's 2014 noise policy and, as such, generally receive the highest noise exposures of the group. In other cases, particularly in rural areas, the receptor represents one or two isolated residences. Highway noise exposures in the second row of residences are typically 3 to 5 dBA lower than in the fronting row.
- ³ Measurement duration was 13.75 hours instead of 24 hours.

Table 6 Results of Baseline Noise Monitoring (Sites 12 to 19)

| Site # | Date | Duration | Noise Sensitive Receptor Location | Land Use | L _{dn} (dBA) | L _d (dBA) | L _n (dBA) |
|--------|--------------------------|--------------------|---|--------------|-----------------------|----------------------|----------------------|
| 12 | Nov. 1, 2013 | 24 hrs | 12900 Steveston Highway, Richmond, B.C. | Commercial | - | 67.7 ¹ | - |
| 12a | Nov. 22, 2013 | Short | 13060 Steveston Highway, Richmond, B.C. | Residential | 59.3 | 59.2 | 49.4 |
| 13 | Oct. 31 to Nov. 1, 2013 | 24 hrs | 103-14100 Riverport Way, Richmond, B.C. | Multi-family | 61.9 | 58.4 | 54.5 |
| 14 | Nov. 21 to Nov. 22, 2013 | 24 hrs | 12951 Rice Mill Road, Richmond, B.C. | Residential | 63.1 | 57.5 | 56.5 |
| 15 | Apr. 8 to 9, 2014 | 24 hrs | 12 River Woods, 6105 River Road, Delta, B.C. | Multi-family | 68.4 | 64.2 | 61.5 |
| 15a | Apr. 9, 2014 | Short | Central, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 53.9 | - |
| 15b | Apr. 9, 2014 | Short | River Watch, 6251 River Road Delta, B.C. | Multi-family | 59.7 | 56.7 | 52.3 |
| 15c | Apr. 9, 2014 | Short ² | Town & Country Inn, 6005 Highway 17A, Delta, B.C. | Hotel | 70.1 | 65.6 | 63.2 |
| 16 | Nov. 22, 2013 | 24 hrs | 37 Woodward's Landing, 5300 Admiral Way, Delta, B.C. | Multi-family | 57.6 | 53.6 | 50.6 |
| 16a | Nov. 6, 2013 | Short | East of Parking, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 46.4 | - |
| 16b | Nov. 22, 2013 | Short ³ | Captain's Cove Marina, 6100 Ferry Road, Delta, B.C. | Multi-family | 66.8 | 61.8 | 60.1 |
| 17 | Nov. 20-21, 2013 | 24 hrs | 5954 River Road, Delta, B.C. | Residential | 67.6 | 64.4 | 60.3 |
| 17a | Nov. 21, 2013 | Short | Burr House, Deas Island Regional Park Delta, B.C. | Reg. Park | - | 46.7 | - |
| 17b | Nov. 21, 2013 | Short | First Fork, Deas Island Regional Park Delta, B.C. | Reg. Park | - | 45.9 | - |

| Site # | Date | Duration | Noise Sensitive Receptor Location | Land Use | L _{dn} (dBA) | L _d (dBA) | L _n (dBA) |
|-----------------|---------------------|----------|--|-------------|-----------------------|----------------------|----------------------|
| 17c | Nov. 21, 2013 | Short | Second Fork, Deas Island Regional Park Delta, B.C. | Reg. Park | - | 46.0 | - |
| 18 ⁴ | Nov. 6, 2013 | 24 hrs | Ernie Burnett Park, 5400 Ferry Road, Delta, B.C. | Residential | 51.5 | 51.7 | 41.3 |
| 19 ⁵ | Nov. 21 to 22, 2013 | 24 hrs | 5631 64th Street, Delta, B.C | Residential | 57.4 | 56.3 | 48.7 |

Notes

- ¹ Due to the location of this site on the western property line of the Richmond Country Farm, noise levels there were influenced by traffic on the northbound off-ramp from Highway 99 to Steveston Highway. At more representative locations further east within this commercial property, noise from Highway 99 would have become more dominant.
- ² L_d (7.8 hours) 65.6 dBA measured Wednesday, Apr. 9, 2014.
- ³ L_d based on noise monitoring conducted at Control site 16, and site 16b on Nov. 6, and Nov. 22, 2013.
- ⁴ The noise monitoring conducted at Site 18 (Ernie Burnett Park) was intended to represent the nearby residences on Regatta Way.
- ⁵ Daytime noise levels at site 19 were affected by a traffic slowdown on Highway 99. Based on the levels observed after the slowdown cleared, it has been estimated that the average daytime noise level would have been approximately 8 dBA higher for much of the day without the slowdown. The baseline L_d, and L_{dn} for site 19 have therefore been adjusted upwards to correct for this traffic slowdown effect, which did not extend south past the Delta Works Yard.

Table 7 Results of Baseline Noise Monitoring (Sites 20 to 24a)

| Site # | Date | Duration | Noise Sensitive Receptor Location | Land Use | L _{dn} (dBA) | L _d (dBA) | L _n (dBA) |
|--------|-------------------------|----------|--|--------------|--------------------------|-------------------------|-------------------------|
| 20 | Apr. 7 to 8, 2013 | 24 hrs | 8640 Ladner Trunk Road, Delta, B.C. | Residential | 67.5 | 65.2 | 59.8 |
| 20a | Apr. 8, 2013 | 24 hrs | 4714 96 Street, Delta, B.C. | Residential | 53.6 | 52.8 | 44.6 |
| 21 | Sep. 26 to 27, 2013 | 24 hrs | Delta View Life Enrichment Centre, Delta, B.C. | Multi-family | 75.0 | 71.8 | 67.8 |
| 22 | Sep. 26 to 27, 2013 | 24 hrs | Delta View Life Enrichment Centre, Delta, B.C. | Multi-family | 74.5 | 70.4 | 67.4 |
| 23 | Oct. 30 to 31, 2013 | 24 hrs | 4779 104th Street, Delta, B.C. | Residential | 69.1 | 66.2 | 61.7 |
| 23 | Oct. 31 to Nov. 1, 2013 | 24 hrs | 4779 104th Street, Delta, B.C. | Residential | 69.5 | 67.0 | 61.9 |
| 24 | Oct. 30 to 31, 2013 | 24 hrs | 4949 112th Street, Delta, B.C. | Residential | 73.7 | 66.7 | 67.3 |
| 24a | Oct. 31, 2013 | Short | 5054 112th Street, Delta, B.C. | Residential | 75.5 | 59.2 | 69.7 |

4.2 Noise Modelling Results

The noise modelling results are presented in **Table 8** and **Table 9**, which include the following:

- Noise monitoring site number
- The noise-sensitive receptor location
- The existing land use of the site
- Baseline (2013) noise levels including L_{dn} , L_d , and L_n
- Total⁵ (2030) noise levels estimated by BAM or modelled by TNM, including L_{dn} , L_d , and L_n

Note that, at the majority of baseline noise monitoring sites, total baseline noise exposures are completely dominated by Highway 99 traffic. Therefore, in assessing the effects of the Project at these sites, total noise exposures in 2030 may be assumed to be numerically equal to Highway 99 traffic noise levels in 2030. However, at a small number of monitoring sites baseline noise levels were not completely dominated by Highway 99 traffic (i.e., there were noise contributions from non-Highway 99 sources). In such cases, total future (2030) noise exposures will not be exactly the same as 2030 Highway 99 traffic noise levels. The contributions of non-Highway 99 noise sources at a given site that will persist at least until 2030 must then be assessed and combined with predicted 2030 Highway 99 noise levels to obtain the total 2030 noise levels at that site⁶.

⁵ Total (2030) noise levels will be equivalent to traffic noise levels from the Project at Highway 99 traffic noise dominated sites.

⁶ These corrections have not been applied at this point, and as a result, Project-related noise impacts have been slightly overestimated at these locations.

Table 8 Baseline (2013)¹ and Total Future (2030) Noise Levels Estimated at BAM Sites

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline Noise Levels (dBA) | | | Total (2030) Noise Levels (dBA) | | |
|--------|--|----------------|-----------------------------|----------------|----------------|---------------------------------|-------------------|----------------|
| | | | L _{dn} | L _d | L _n | L _{dn} | L _d | L _n |
| 2 | 22 Capella Garden, 9731 Capella Drive, Richmond, B.C. | Residential | 72.2 | - | 64.5 | 74.1 | - | 66.4 |
| 3 | 10168 Caithcart Road, Richmond, B.C. | Residential | 69.7 | - | 61.4 | 71.6 | - | 63.3 |
| 4 | 9 Florence Estates, 10411 Hall Avenue, Richmond, B.C. | Residential | 72.0 | - | 63.8 | 72.7 | - | 64.5 |
| 4a | Richmond Estates, 10511, Kilby Drive, Richmond, B.C. | Residential | 70.1 | - | 63 | 71.3 | - | 64.2 |
| 4b | 10333 Bryson Drive, Richmond, B.C. | Residential | 68.8 | - | 58.1 | 70.0 | - | 59.3 |
| 5 | 4591 Dallyn Road, Richmond, B.C. | Residential | 68.7 | - | 60.8 | 70.3 | - | 62.4 |
| 6 | 11600 Dewsbury Drive, Richmond, B.C. | Residential | 74.1 | - | 67.1 | 75.9 | - | 68.9 |
| 7 | 12260 Old Westminster Highway, Richmond, B.C. (2014) | Residential | 67.0 | 63.7 | 59.9 | 71.1 | 67.8 | 64.0 |
| 7a | Richmond Nature Park, 11851 Westminster Highway, Richmond, B.C. (2014) | Municipal park | - | 58.0 | - | - | 61.7 ² | - |
| 8 | 12250 Old Westminster Highway, Richmond, B.C. | Residential | 64.2 | 61.1 | 56.9 | 67.6 | 64.5 | 60.3 |
| 9 | 12431 Blundell Road, Richmond, B.C. (<u>first 24-hrs</u>) | Res./Daycare | 72.5 | 66.9 | 65.9 | 76.6 | 71.0 | 70.0 |
| 9 | 12431 Blundell Road, Richmond, B.C. (<u>second 24-hrs</u>) | Res./Daycare | 70.4 | 67.8 | 62.8 | 74.5 | 71.9 | 66.9 |
| 10 | 12280 Blundell Road, Richmond, B.C. | Res./Daycare | 67.3 | 64.5 | 59.9 | 70.3 | 67.5 | 62.9 |
| 10a | Mosque, 12300 Blundell Road, Richmond, B.C. | Worship | - | 71.8 | - | - | 75.2 | - |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline Noise Levels (dBA) | | | Total (2030) Noise Levels (dBA) | | |
|--------|--|--------------|-----------------------------|-------------------|-------------------|---------------------------------|----------------|----------------|
| | | | L _{dn} | L _d | L _n | L _{dn} | L _d | L _n |
| 10b | School, 12300 Blundell Road, Richmond, B.C. | School | - | 71.0 | - | - | 74.5 | - |
| 10c | Ling Yen Mountain Temple, 10060 No. 5 Rd, Richmond, B.C. | Worship | - | 61.7 | - | - | 65.3 | - |
| 11 | 10640 No. 5 Road, Richmond, B.C. “The Gardens” (2014) | Multi-family | 65.7 | 62.6 | 58.3 | 70.6 | 67.5 | 63.2 |
| 19 | 5631 64th Street, Delta, B.C. ³ | Residential | 61.0 ³ | 62.0 ³ | 48.7 ³ | 64.3 | 65.3 | 52.0 |
| 20 | 8640 Ladner Trunk Road, Delta, B.C. | Residential | 67.5 ⁴ | 65.2 ⁴ | 59.8 ⁴ | 68.5 | 66.2 | 60.8 |
| 20a | 4714 96 Street, Delta | Residential | 53.6 | 52.8 | 44.6 | 56.1 | 55.3 | 47.1 |
| 21 | Delta View Life Enrichment Centre, Delta, B.C. (2012) | Residential | 75.0 | 71.8 | 67.8 | 77.3 | 74.1 | 70.1 |
| 22 | Delta View Life Enrichment Centre, Delta, B.C. (2012) | Residential | 74.5 | 70.4 | 67.4 | 76.8 | 72.7 | 69.7 |
| 23 | 4779 104th Street, Delta, B.C. | Residential | 69.1 | - | 61.7 | 71.0 | - | 63.6 |
| 24 | 4949 112th Street, Delta, B.C. | Residential | 73.7 | - | 67.3 | ⁻⁵ | - | ⁻⁵ |
| 24a | 5054 112th Street, Delta, B.C. | Residential | 75.5 | - | 69.7 | ⁻⁵ | - | ⁻⁵ |

Notes

¹ The baseline year is 2013 unless otherwise noted.

² This is the 2030 noise level that would be expected at site 7a if its total noise exposure was controlled by Highway 99 traffic. Since it is not, it is expected that the 2030 level will be much closer to the baseline level of 58 dBA, unless very substantial traffic growth occurs on Westminster Highway and No. 5 Road.

³ Daytime noise levels at site 19 were affected by a traffic slowdown on Highway 99. Based on the levels observed after the slowdown cleared, it has been estimated that daytime noise levels would have been approximately 8 dBA higher for much of the day without the slowdown. The baseline L_d, and L_{dn} for Site 19 have therefore been adjusted upwards to correct for this traffic slowdown effect.

⁴ Noise levels at site 20 were influenced by traffic on Ladner Trunk Road so that the baseline noise levels shown here are only partly due to Highway 99 traffic. Traffic on Ladner Trunk Road is expected to have subsequently been reduced with the opening of the SFPR. To correct for this effect, the baseline adjustment of 2.3 dBA has been only applied to the estimated Highway 99 component of the overall traffic noise.

⁵ Overall noise exposures at these sites were controlled by railway activities, so that Project noise effects will be negligible.

Table 9 Baseline (2013)¹ and Total Future (2030) Noise Levels at TNM/CadnaA Modelling Sites

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline Noise Levels (dBA) | | | Total (2030) Noise Levels (dBA) | | |
|--------|--|----------------|-----------------------------|-------------------|-------------------|---------------------------------|----------------|----------------|
| | | | L _{dn} | L _d | L _n | L _{dn} | L _d | L _n |
| 11a | 11551 Dyke Road, Horseshoe Slough Trail, B.C. (2014) | Municipal park | - | 46.4 | - | - | 49.5 | - |
| 12 | Richmond Country Farm, 12900 Steveston Highway, Richmond, B.C. | Commercial | - | 67.7 ² | - | - | 68.8 | - |
| 12a | 13060 Steveston Highway, Richmond, B.C. | Residential | 59.3 ³ | 59.2 ³ | 49.4 ³ | 61.5 | 60.8 | 52.3 |
| 13 | 103-14100 Riverport Way, Richmond, B.C. | Multi-family | 61.9 | 58.4 | 54.5 | 62.0 | 58.6 | 54.6 |
| 14 | 12951 Rice Mill Road, Richmond, B.C. | Residential | 63.1 | 57.5 | 56.5 | 65.2 | 61.8 | 58.0 |
| 15 | 12 River Woods, 6105 River Road, Delta, B.C. (2014) | Multi-family | 68.4 | 64.2 | 61.5 | 67.5 | 66.1 | 59.1 |
| 15a | Central, Deas Island Regional Park, Delta, B.C. (2014) | Regional Park | - | 53.9 | - | - | 56.5 | - |
| 15b | River Watch, 6251 River Road, Delta, B.C. (2014) | Multi-family | 59.7 | 56.7 | 52.3 | 61.5 | 59.9 | 53.2 |
| 15c | Town & Country Inn, 6005 Highway 17A, Delta, B.C. (2014) | Commercial | 70.1 | 65.6 | 63.2 | 69.4 | 67.8 | 61.2 |
| 16 | 37 Woodward's Landing, 5300 Admiral Way, Delta, B.C. | Multi-family | 57.6 | 53.6 | 50.6 | 57.4 | 55.8 | 49.1 |
| 16a | East of Parking, Deas Island Regional Park, Delta, B.C. | Regional Park | - | 46.4 | - | - | 53.4 | - |
| 16b | Captain's Cove Marina, 6100 Ferry Road, Delta, B.C. | Multi-family | 66.8 | 61.8 | 60.1 | 67.9 | 66.5 | 59.6 |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline Noise Levels (dBA) | | | Total (2030) Noise Levels (dBA) | | |
|--------|---|---------------|-----------------------------|----------------|----------------|---------------------------------|----------------|----------------|
| | | | L _{dn} | L _d | L _n | L _{dn} | L _d | L _n |
| 17 | 5954 River Road, Delta, B.C. | Residential | 67.6 | 64.4 | 60.3 | 65.9 | 64.4 | 57.7 |
| 17a | Burr House, Deas Island Regional Park, Delta, B.C. | Regional Park | - | 46.7 | - | - | 50.8 | - |
| 17b | First Fork, Deas Island Regional Park, Delta, B.C. | Regional Park | - | 45.9 | - | - | 56.7 | - |
| 17c | Second Fork, Deas Island Regional Park, Delta, B.C. | Regional Park | - | 46.0 | - | - | 56.4 | - |
| 18 | Ernie Burnett Park, 5400 Ferry Road, Delta, B.C. | Residential | 51.5 | 51.7 | 41.3 | 52.5 | 52.4 | 42.9 |

Notes

- ¹ The baseline year is 2013 unless otherwise noted.
- ² Due to its location on the west property line of this commercial property, baseline noise exposures at site 12 were influenced by traffic on the northbound off-ramp from Highway 99 to Steveston Highway. As such, the baseline level was higher than that predicted from the new bridge. At locations further east within this property, baseline levels would have been influenced more by Highway 99 through traffic, and somewhat larger Project effects would have been expected.
- ³ Noise levels at site 12a were influenced by Steveston Highway traffic. For this reason, predicted Project noise levels are slightly lower than the measured baseline levels.

5.0 Discussion

The key results of the atmospheric noise study, as well as discussions of reproducibility and data gaps, are presented in this section.

5.1 Key Findings

Existing levels of noise at noise-sensitive receptor locations within the study area as measured during the study period (2013) vary widely depending primarily on the setback distance of the monitoring sites from Highway 99 but also on the traffic conditions that prevailed within the immediately adjacent highway segment. The noise level histories obtained at these sites (presented in **Appendix B**) were generally consistent with noise environments dominated by highway traffic. At a few sites, noise contributions were made by non-Highway 99 sources. However, since these sources are typically arterial or local road traffic, they tended to display temporal patterns similar to those of highway traffic.

The key measurement results are summarized as follows:

- Existing noise levels measured at residential sites were as follows:
 - L_{dn} ranging from 51.5 to 75 dBA, with an average of 66.3 dBA
 - L_n ranging from 41.3 to 67.8 dBA, with an average of 59.2 dBA
- Existing noise levels measured within passive parks were as follows:
 - L_d ranging from 45.9 to 58, with an average of 49 dBA
- Existing noise measured at the schools and worship facilities were as follows:
 - L_d ranging from 61.7 to 71.8, with an average of 68.2 dBA
- Future 2030 noise levels at residences were predicted to be:
 - L_{dn} ranging from 52.5 to 77.3 dBA, with an average 68.3 dBA
 - L_n ranging from 42.9 to 70.1 dBA, with an average of 60.2 dBA
- Future 2030 noise levels within passive parks were predicted to be:
 - L_d ranging from 49.5 to 61.7, with an average of 55 dBA
- Future 2030 noise level at the school, daycares and, worship facilities were predicted to be:
 - L_d ranging from 65.3 to 75.2, with an average of 71.7 dBA
- Maximal construction noise levels at residences were estimated to be:
 - L_{dn} ranging from 39 to 84 dBA, with an average of 75 dBA (non-pile driving)
 - L_d ranging from 52 to 86 dBA, with an average of 70 dBA (pile driving)

The BAM assessments conducted within the mainline segments of Highway 99 contained within segments A, B, D, E and F (**Table 2**) revealed relatively small Project-related increases in L_{dn} to 2030. This is because the alignment of Highway 99 will generally not be significantly altered within these segments. Therefore, while the baseline noise levels at residences closest to the Project are typically quite high due to the high traffic volumes and relatively high vehicle speeds, the effects of the Project (largely due to volume growth and some anticipated speed increases) within these segments are not numerically large.

The TNM approach generated two key findings for the segment of Highway 99 that would include the new bridge and approaches (segment C in **Table 2**), 10 travel lanes, and a grade on the bridge approaches. For the segment of Highway 99 currently within the Tunnel, to be replaced with the new bridge and its approaches, it is predicted that there will be increased traffic noise levels in the areas (e.g., Deas Island Regional Park) that currently are shielded from much of the Highway 99 traffic noise by the Tunnel. To the south of the Tunnel portal, where Highway 99 is now at or near ground level (Deas Slough Bridge and southern approach), post-Project noise exposures created by traffic on the new bridge are predicted to be similar to, or even slightly lower than, baseline levels. This is because residences adjacent to this segment of Highway 99 currently receive only minimal noise shielding from a concrete roadside barrier, and are hence directly exposed to highway noise. With the Project, these residences will receive substantial noise shielding from the bridge deck parapet, which will largely block line-of-sight to the sources of traffic noise on the bridge and southern approach.

5.2 Reproducibility

The reproducibility (day-to-day variation) in measured baseline noise levels at locations adjacent to Highway 99 was assessed by conducting two consecutive 24-hour noise monitoring sessions at certain sites. At site 9 (residence/daycare at 12431 Blundell Road) the results of consecutive monitoring between October 29 - 30, 2013 and October 30 - 31, 2013 were L_{dn} 72.5 and L_{dn} 70.4 dBA, indicating a variability of approximately 2 dBA. Since this monitoring was conducted over Halloween, much of the variation in L_{dn} is attributable to atypical noise events associated with fireworks during the night⁷ of October 30.

⁷ The nighttime equivalent sound levels for October 30 and October 31, 2013 were L_n 65.9 dBA and L_n 62.8 dBA, respectively, i.e. it was 3.1 dBA noisier on the night of October 30. Fireworks were observed to be in use on both nights.

5.3 Data Gaps and Limitations

The following data gaps and limitations have been identified:

- **Variations in instrument sensitivity and highway traffic noise levels:** the level of accuracy and precision of the baseline measurements performed is ± 0.5 dBA for the instrumentation, and generally between ± 0.5 and ± 2 dBA for day-to-day variation, including meteorological conditions, traffic volume, speed variations and local activities. The day-to-day variation is closer to ± 0.5 dBA in the many situations where Highway 99 traffic is clearly the dominant noise source and setbacks are small. Baseline levels presented in **Table 5**, **Table 6**, and **Table 7** are subject to such variation. However, in the application of the Ministry's 2014 noise policy, it is accepted that there are inherent accuracy limitations to both the measurement and prediction of highway noise levels and the approach taken is to accept the noise levels produced using best practices in measurement and modelling and not to apply error bands or soft boundaries around the policy's mitigation thresholds.
- **Variations in non-highway noise sources:** at a small number of monitoring sites, baseline noise levels are not clearly controlled by Highway 99 traffic. Therefore, to predict the total future (2030) L_{dn} with the Project, it is necessary to establish the individual noise contributions from both the highway and any prominent non-highway sources. If the noise from the non-highway source(s) is not expected to vary over time (e.g., from an industry), its level may be added to the future Highway 99 noise level to obtain the total 2030 L_{dn} at a given site. If the non-highway noise is expected to vary over time, then ideally its anticipated future level should be established and combined with the future Highway 99 noise level to obtain the total 2030 L_{dn} . In most cases, the primary source of non-highway noise was traffic on other highways (Westminster and Steveston) and arterial roads. However, it was not possible to obtain projections of traffic growth on these other routes to 2030 with the Project, and the effects of any such increases in non-Highway 99 noise have therefore not been qualitatively accounted for herein. However, it is not expected that this limitation has influenced the magnitudes of forecast Project-related L_{dn} to any significant degree.
- Other non-Highway 99 noise sources that made non-trivial contributions to overall daily noise exposures at a few sites included industrial and shipping noise along the Fraser River, local traffic and activities, aircraft flyovers, and heavy rail movements. On October 31, 2013 (Halloween) in particular, atypical noise interference occurred at suburban noise monitoring sites. In some cases it was possible to extract the more prominent atypical noise events to adjust the measured L_{dn} . In other cases, this was not possible; therefore, some uncertainty was introduced as to how much of the baseline L_{dn} was due to Highway 99 and how much was due to other sources.

- **Uncertainty associated with baseline estimates at short-term site:** short-term monitoring sites situated on the opposite side of Highway 99 from their control sites, particularly in the vicinity of the Tunnel, potentially increase the uncertainty of the short-term sites' baseline L_{dn} estimates. Since traffic noise levels increase with average vehicle speed, and since traffic flow speeds tend not to be symmetrical (due to the counter-flow lane) in the congested areas around the Tunnel approaches, L_{dn} at short-term sites on the more free-flowing side of the highway could be slightly underestimated when based on an L_d obtained at control sites on the more congested side. An example of where this is expected to have occurred is in the vicinity of the Deas Slough and south Tunnel portal, where a slowdown occurs in the northbound lanes during the morning peak traffic period.
- **Limitations associated with speed profile data:** speed profiles provide hourly average traffic speeds at a given point along the highway and, as such, are useful for the analysis and interpretation of noise monitoring results, particularly where speed regimes are expected to change as a result of a project. However, only two speed profile stations, at Westminster Highway and Steveston Highway, were available from the Ministry. No speed profile was available near Blundell Road, for example. To resolve this data gap in the BAM, it was necessary to interpolate between the Westminster Highway and Steveston Highway speed profiles to make adjustments for traffic congestion near Blundell Road. This increased the uncertainty of the BAM estimates of the 2030 L_{dn} s at the Blundell Road sites.
- **Uncertainty associated with model calibrations:** The TNM model was calibrated by inputting the existing (2013) traffic volume and speed profiles into the model and adjusting the rate at which sound levels are attenuated with distance from the highway so as to achieve agreement with measured baseline noise levels. This is standard procedure when developing a TNM for a future highway situation. However, in the case of the new bridge, the noise sources (10 lanes of traffic ascending and descending the structure) are elevated well above the ground, and their noise is shielded to varying degrees (for ground level receptors) by the eastern and western bridge parapets. Because of the need to incorporate these unique features into the TNM for the new bridge, there is some uncertainty associated with use of a model calibration procedure based on sound propagation between sources and receptors located close to the ground.

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ATTACHMENT A
Instrumentation

Noise monitoring was conducted using the instrumentation presented in **Table A1**. Continuous 24-hour noise monitoring was conducted in the fall of 2013 using up to four Larson-Davis (LD) environmental noise monitors (ENM) and in the spring of 2014 using two Larson Davis ENMs, and LD sound level meters (SLM).

Table A1 Atmospheric Noise Measurement Equipment

| Equipment Type | Make | Model | Serial Number |
|-----------------------------------|--------------|--------------------------------|---------------|
| Environmental Noise Monitor (ENM) | Larson-Davis | LD 812 Sound Level Meter (SLM) | S496 |
| Preamp | Larson-Davis | LDPRM828 | 0654 |
| Microphone | Larson-Davis | LD2541 | 4130 |
| ENM | Larson-Davis | LD 812 SLM | S497 |
| Preamp | Larson-Davis | LDPRM828 | 1486 |
| Microphone | Larson-Davis | LD2541 | 5461 |
| ENM | Larson-Davis | LD 820 SLM | S654 |
| Preamp | Larson-Davis | LDPRM828 | 1794 |
| Microphone | Larson-Davis | LD2541 | 3204 |
| ENM | Larson-Davis | LD 820 SLM | S1466 |
| Preamp | Larson-Davis | LDPRM828 | 2165 |
| Microphone | Larson-Davis | LD2541 | 7749 |
| SLM | Larson-Davis | LD SoundTrack LxT® | 0001125 |
| Preamp | Larson-Davis | PRMLxT1 | 0275 |
| Microphone | Larson-Davis | 377A02 | 100090 |
| SLM | Larson-Davis | LD SoundExpert™ LxT | 3708 |
| Preamp | Larson-Davis | PRMLxT1L | 028013 |
| Microphone ¹ | Larson-Davis | 377B020 | 137346 |
| SLM | Larson-Davis | LD SoundExpert™ LxT | 3736 |
| Preamp | Larson-Davis | PRMLxT1L | 028018 |
| Microphone | Larson-Davis | 377B020 | 141221 |
| Calibrator | Larson-Davis | LD CA250 | 2202 |
| Real-Time Analyzer (RTA) | Brüel & Kjær | Type 2250 | 2548151 |
| Preamp | Brüel & Kjær | ZC 0032 | 4875 |

| Equipment Type | Make | Model | Serial Number |
|----------------|--------------|----------|---------------|
| Microphone | Brüel & Kjær | 4189 | 2543198 |
| Calibrator | Brüel & Kjær | 4231 | 2545632 |
| RTA | Larson-Davis | LD 2800 | 0270 |
| Preamp | Larson-Davis | PRM900B | 5018 |
| Microphone | Larson-Davis | LD 2560 | 2130 |
| Calibrator | Larson-Davis | LD CA200 | 2202 |

Notes ¹ Replaced in September 2014 with new microphone Larson-Davis Model 377B02 Serial Number 144273.

ATTACHMENT B

Project Baseline Noise Monitoring Results

Site 2

Address: 22 Capella Garden, 9731 Capella Drive, Richmond, B.C.

Pre-Project Ambient Noise:

Site 2 is representative of fronting residences along Patterson Road, and is typical of residences along the Richmond portion of the Project corridor. Continuous noise monitoring was conducted at Site 2 for 24 hours. The microphone was located at the property line of Capella Garden adjacent residential Unit 22, 52 m south west of the centerline of Highway 99 (**Figure 1**). Site 2 had 180 degree exposure to Highway 99 traffic noise, the dominant noise source in this residential area. Secondary noise sources included YVR flights following the inbound flight path 700 m to the north. **Figure 2** depicts the noise levels in 15 minute intervals over the duration of the monitoring session. The pre-Project average day/night noise exposure to at Site 2 was estimated to be $L_{dn}(24)$ 72.2 dBA.

Proposed Improvements: Improvements along Highway 99 in the vicinity of this location include providing a dedicated transit/HOV lane in each direction and construction of a transit-only ramp at Bridgeport Road.



Figure 1 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

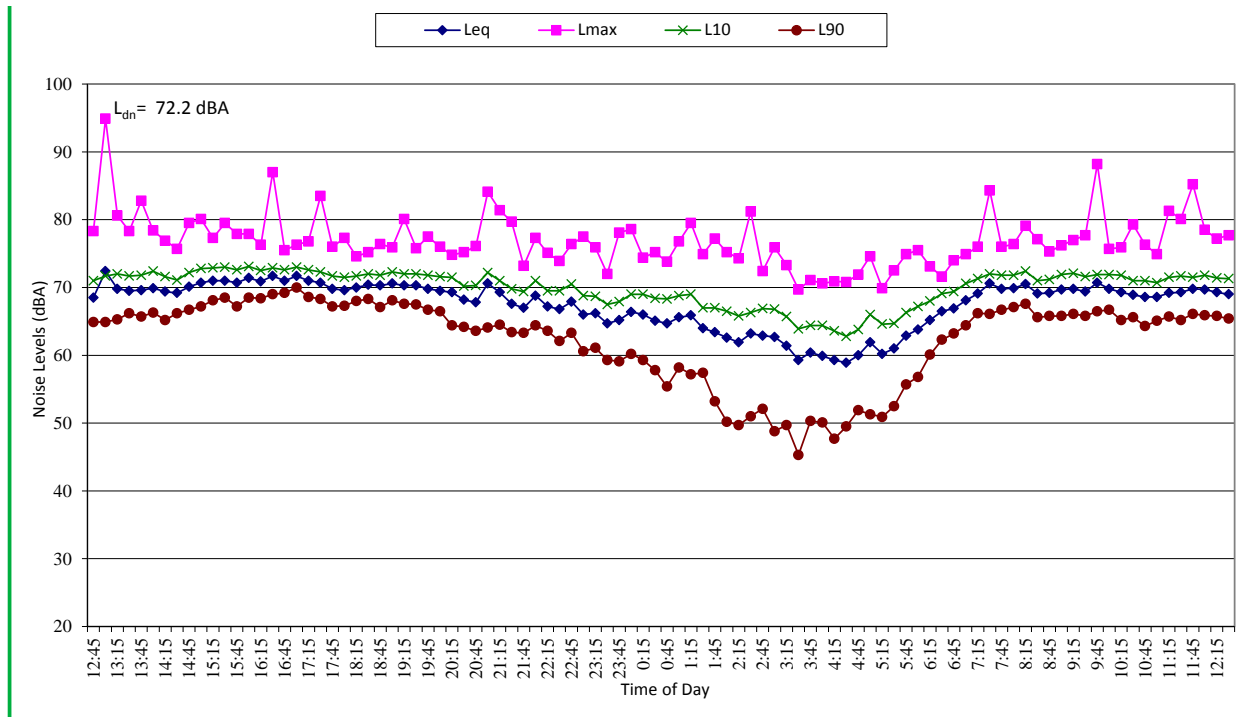


Figure 2 Noise Levels at Site 2 Measured in 15 Minute Intervals

Site 3

Address: 10168 Caithcart Road, Richmond, B.C.

Pre-Project Ambient Noise:

Site 3 is representative of residences along the western portion of the Caithcart Road residential area. Continuous noise monitoring was conducted at Site 3 for 24 hours. The microphone was located slightly above a 1.7 m high wooden fence located along the western property line of a standard sized city lot fronting onto St. Edwards Drive, the northbound offramp, and Highway 99 (**Figure 3**). Site 3 was set back 105 m from the Highway 99. Highway 99 traffic was the dominant noise source. The wooden fence provided noise shielding to the backyard area of 10168 Caithcart Road. However, the shielding was limited by noise scattering from the large evergreen canopy above the fence. Exposure to Highway 99 was slightly reduced by shielding provided by commercial buildings to the south. **Figure 4** depicts the noise levels in 15 minute intervals over the duration of the monitoring session. The pre-Project average day/night noise exposure at Site 3 was $L_{dn}(24)$ 69.7 dBA.

Proposed Improvements: Improvements along Highway 99 in the vicinity of this location include providing a dedicated transit/HOV lane in each direction and construction of a transit-only ramp at Bridgeport Road.

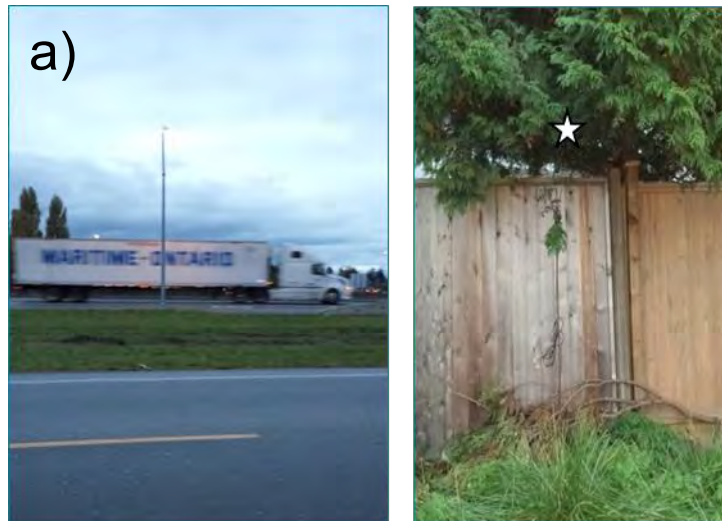




Figure 3 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 November 4 - 5, 2013

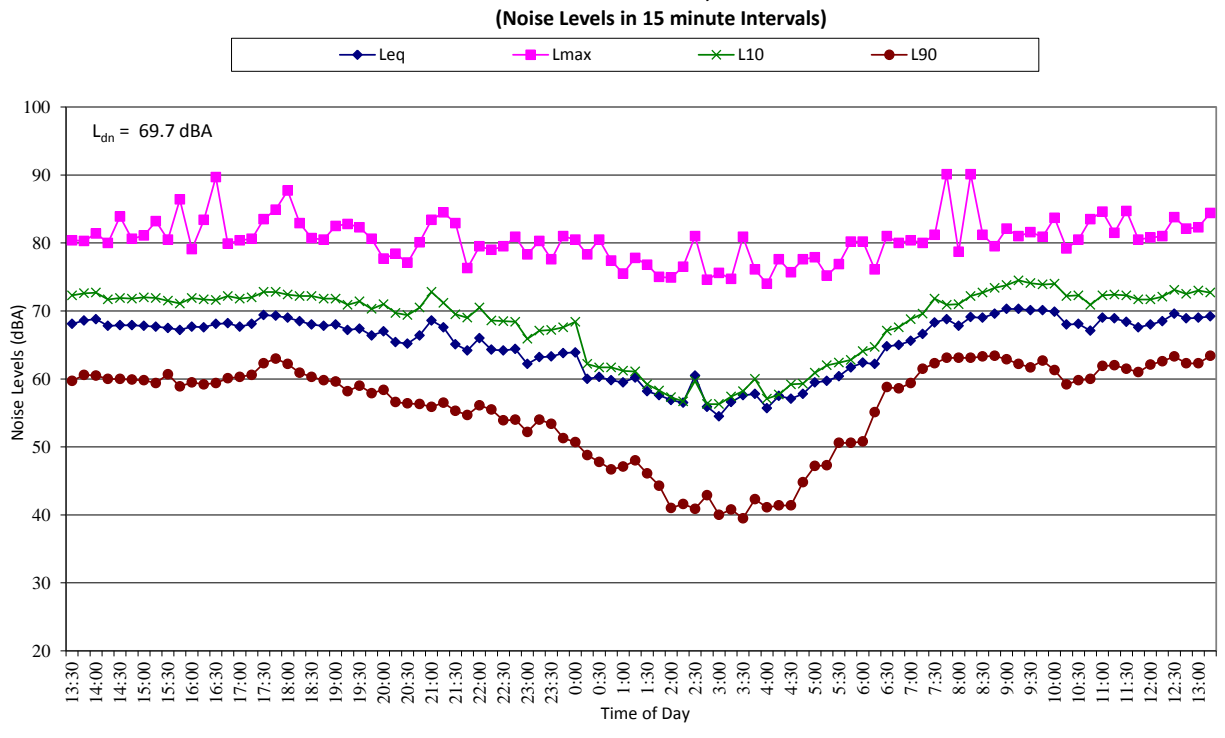


Figure 4 Noise Levels at Site 3 Measured in 15 Minute Intervals

Site 4

Address: 9 Florence Estates, 10411 Hall Avenue, Richmond, B.C.

Pre-Project Ambient Noise:

Site 4 is representative of fronting residences along Hall Avenue. The microphone was located in a high hedge at a setback of 35 m from the centerline of Highway 99 (**Figure 5**). This microphone position was chosen to provide line-of-sight to Highway 99 over a varying height barrier located along the eastern property line. Continuous noise monitoring was conducted at Site 4 for 14-hours. The dominant noise source at Site 4 was Highway 99 traffic noise. **Figure 6** depicts the noise levels in 15 minute intervals in. The pre-Project average day/night noise exposure at Site 4 was estimated to be L_{dn} 72.0 dBA. The noise exposures at Site 2 and Site 4 are similar.

Proposed Improvements: Improvements to this section of Highway 99 including providing a dedicated transit/HOV lane in each direction.





Figure 5 a) Photo of Microphone Site (fence alignment perpendicular to centerline of Highway 99), and b) Aerial View of Noise Sampling Site

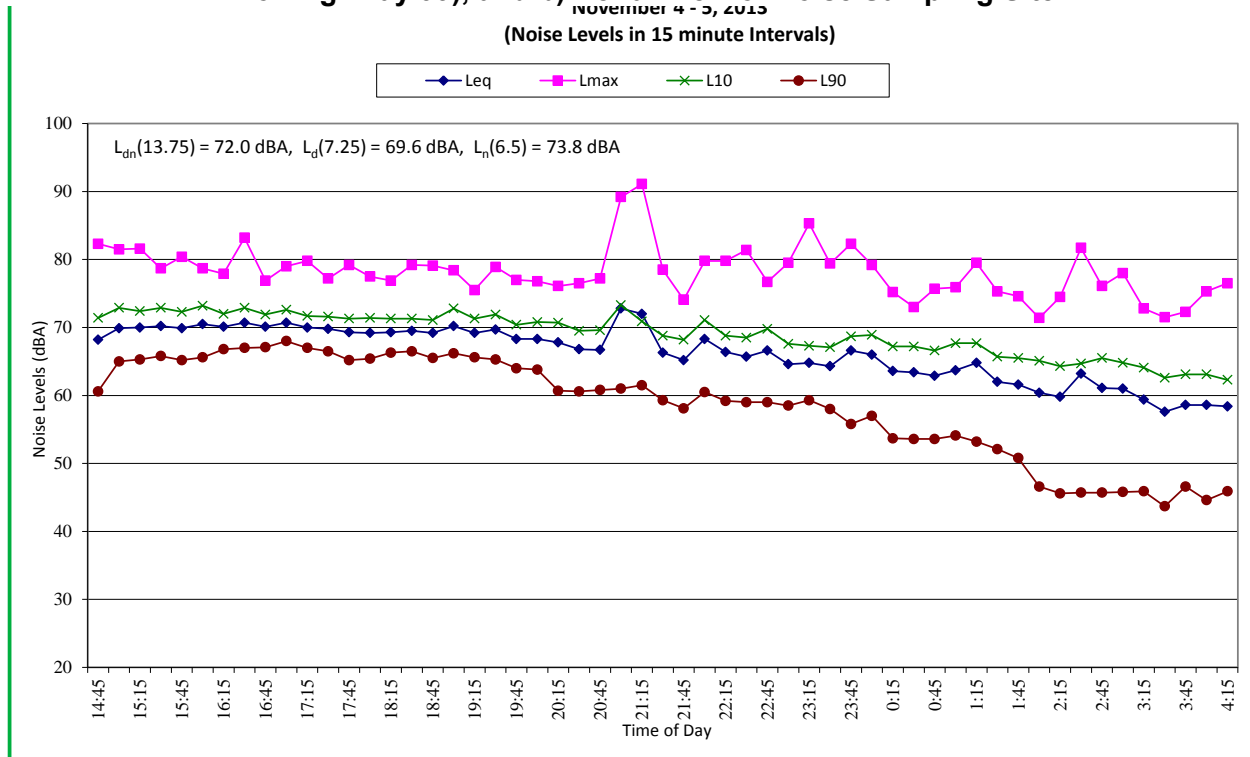


Figure 6 Noise Levels at Site 4 Measured in 15 Minute Intervals

Site 5

Address: 4591 Dallyn Road, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located in a high hedge at a setback of 35 m from the centerline of Highway 99 (**Figure 7**). This microphone position was chosen to provide line-of-sight to Highway 99 over a varying height barrier located along the eastern property line. Continuous noise monitoring was conducted at Site 5 for 14-hours. The dominant noise source at Site 5 was Highway 99 traffic noise. **Figure 8** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 5 was $L_{dn}(22.3)$ 68.7 dBA.

Proposed Improvements: Improvements along Highway 99 in the vicinity of this location include providing a dedicated transit/HOV lane in each direction.

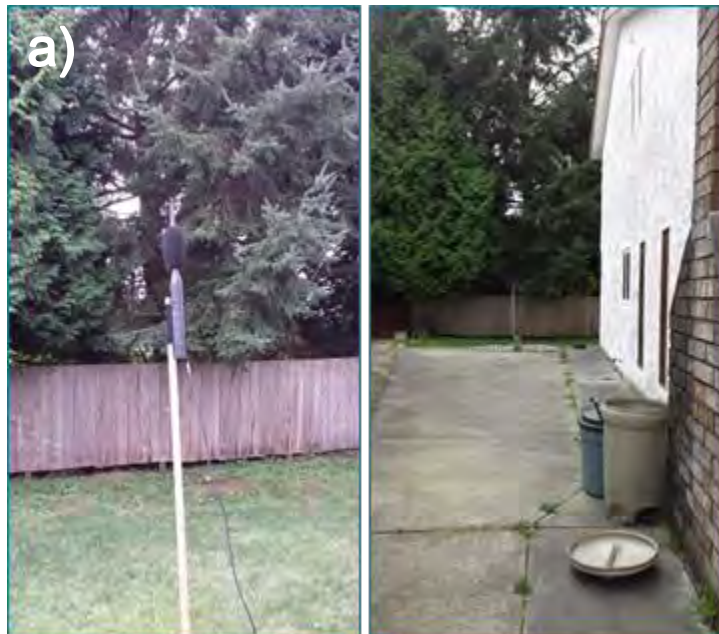




Figure 7 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 November 5 - 6, 2013

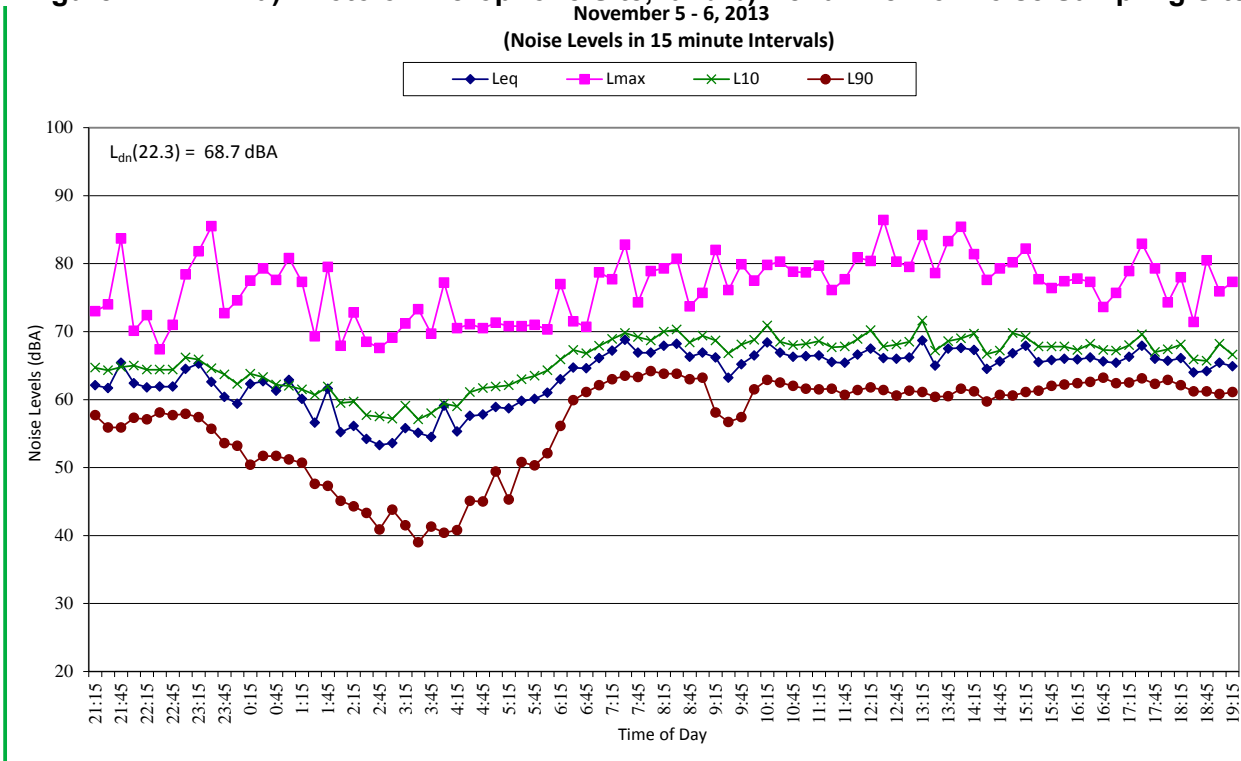


Figure 8 Noise Levels at Site 5 Measured in 15 Minute Intervals

Site 6

Address: 11600 Dewsbury Drive, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located just above the fence at a setback of 62 m from the centerline of Highway 99 (**Figure 9**). This microphone position was chosen to provide line-of-sight to Highway 99 over the fence located along the western property line. Continuous noise monitoring was conducted at Site 6 for 21-hours. The dominant noise source at Site 6 was Highway 99 traffic noise. **Figure 10** depicts the noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 6 was $L_{dn}(21)$ 74.1 dBA.

Proposed Improvements: Improvements along Highway 99 in the vicinity of this location include providing a dedicated transit/HOV lane in each direction.





Figure 9 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 April 7 - 8, 2014

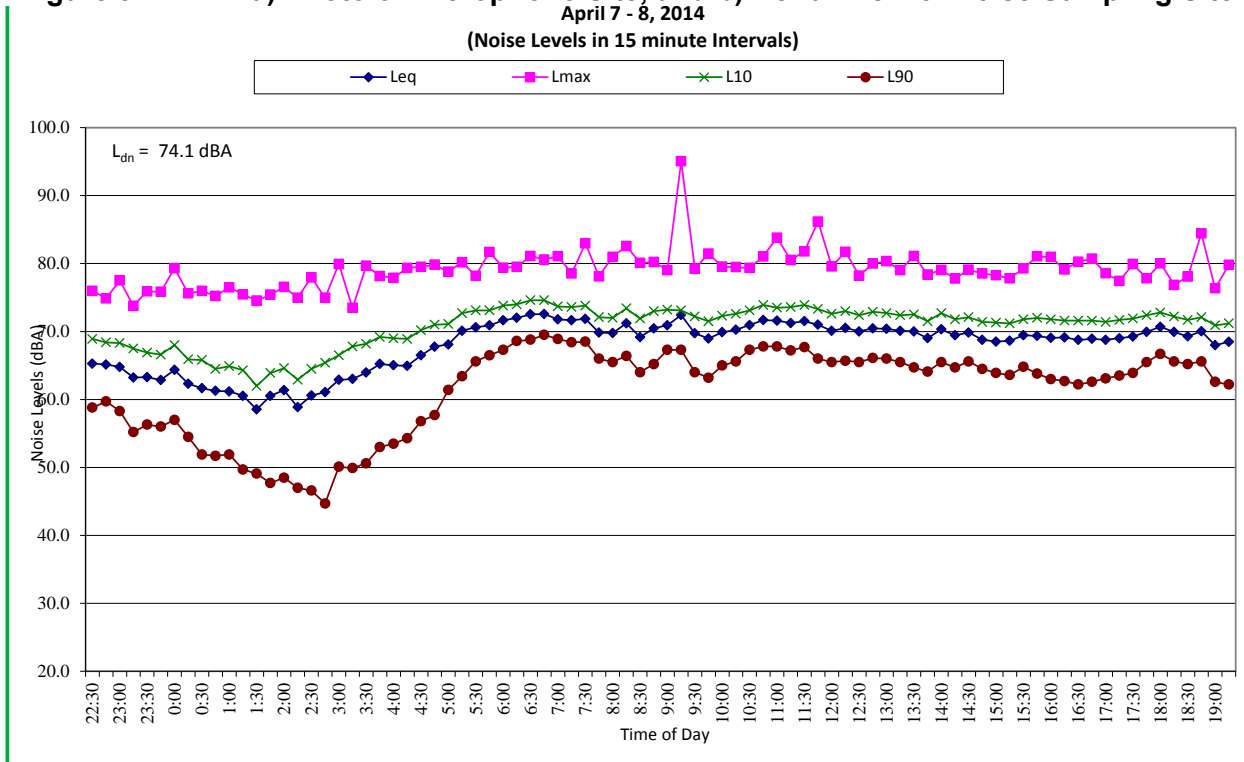


Figure 10 Noise Levels at Site 6 Measured in 15 Minute Intervals

Site 7

Address: 12260 Westminster Highway, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 93 m from the centerline of Highway 99 (**Figure 11**). Site 7 is directly exposed to the Westminster Highway overpass eastbound lanes. Line-of-sight to Highway 99 is broken by the south bound onramp fill section. Continuous noise monitoring was conducted at Site 7 for 20 hours. The dominant noise source at Site 7 was Westminster Highway traffic noise. **Figure 12** depicts the noise levels in 15-minute intervals. The pre-Project average day/night noise exposure at Site 7 was $L_{dn}(21)$ 67.0 dBA.

Proposed Improvements: The existing Westminster Highway interchange will be upgraded.





Figure 11 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 April 9, 2014

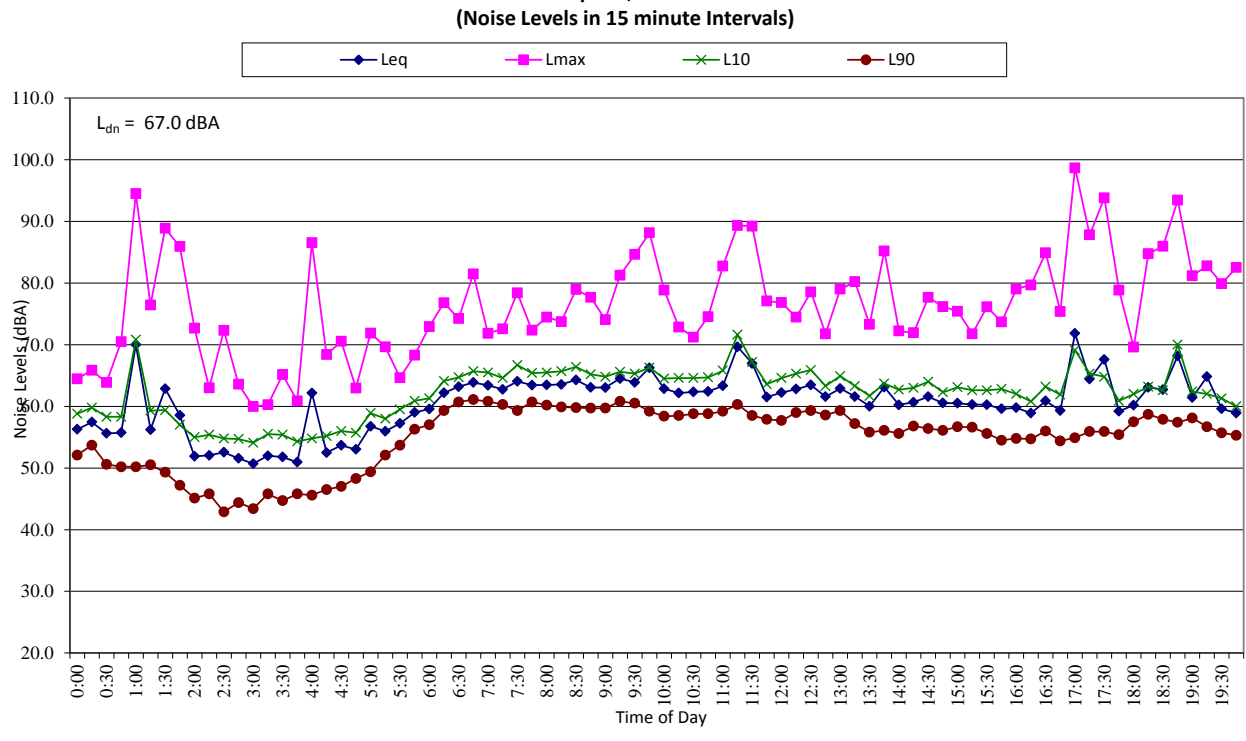


Figure 12 Noise Levels at Site 7 Measured in 15 Minute Intervals

Site 8

Address: 12250 Westminster Highway, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located at the western edge of the property line at a setback of 115 m from the centerline of Highway 99 (**Figure 13**). Continuous noise monitoring was conducted at Site 8 for 24 hours. The dominant noise source at Site 8 was Highway 99 traffic noise. **Figure 14** depicts the noise levels in 15-minute intervals. The pre-Project average day/night noise exposure at Site 8 was L_{dn} 64.2 dBA.

Proposed Improvements: The existing Westminster Highway interchange will be upgraded.



Figure 13 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

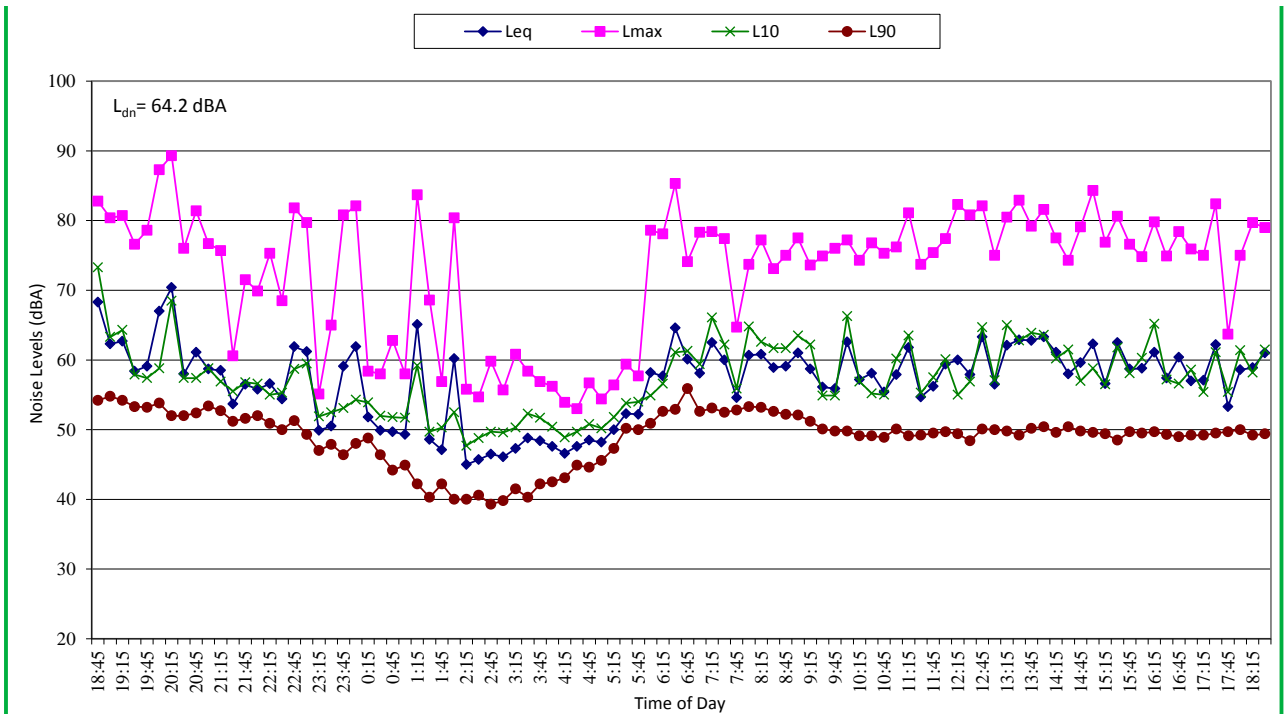


Figure 14 Noise Levels at Site 8 Measured in 15 Minute Intervals

Site 9

Address: 12431 Blundell Road, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located just above the fence with a setback of 73 m from the centerline of Highway 99 (**Figure 15**). Continuous noise monitoring was conducted at Site 9 for a total of 48 hours. The dominant noise source at Site 9 was Highway 99 traffic noise. **Figure 16** depicts the noise levels in 15 minute intervals for 29 to 30 Oct and 30 to 31 Oct, respectively. The pre-Project average day/night noise exposure at Site 9 was L_{dn} 72.5 dBA for October 29 to 30, and 70.4 dBA for October 30 to 31, 2013.

Proposed Improvements: The existing Blundell Road overpass will be upgraded.





Figure 15 a) Photo of Microphone Sites, and b) Aerial View of Noise Sampling Site

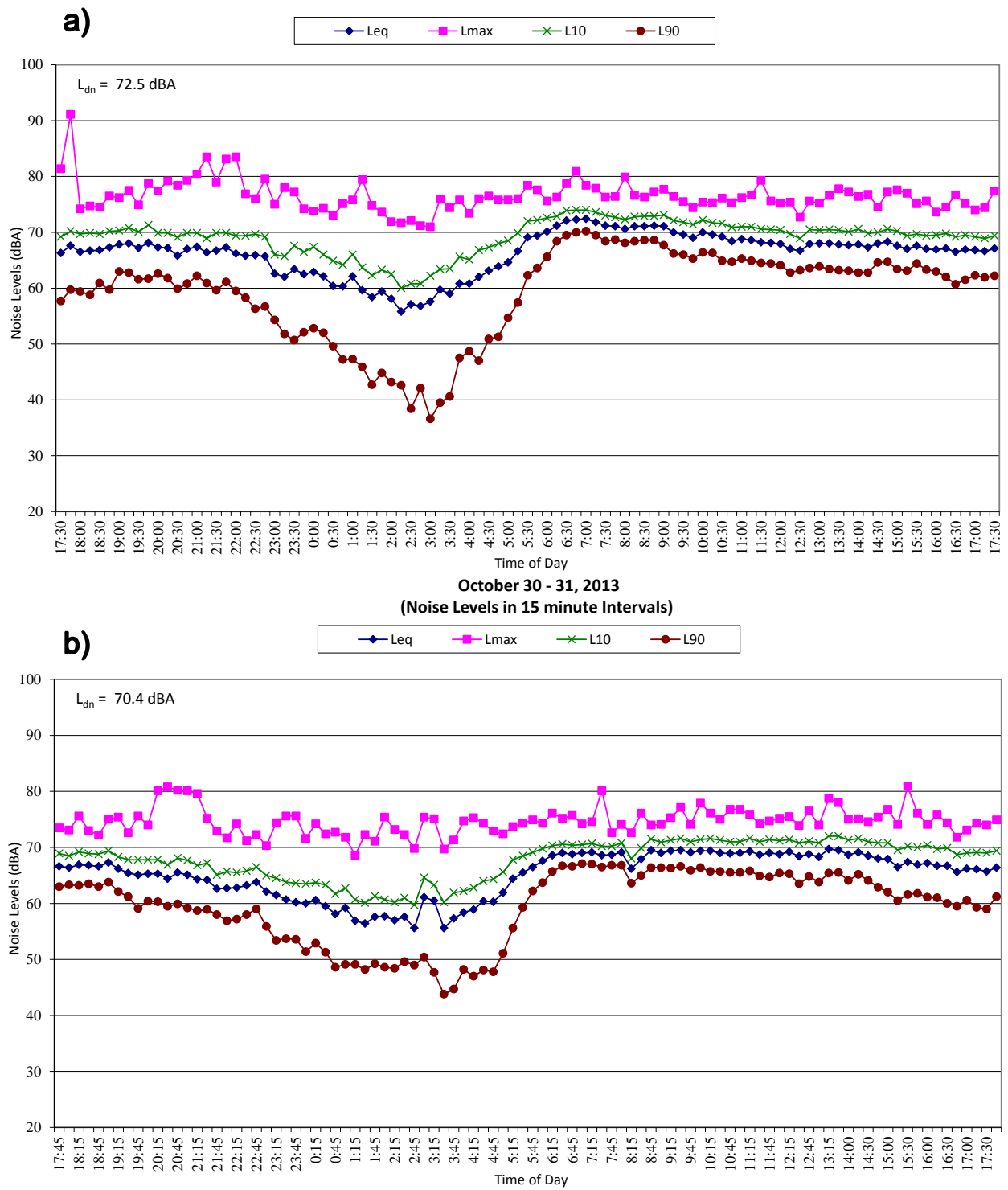


Figure 16 Noise Levels at Site 9 Measured in 15 Minute Intervals for a) 29 to 30 October, and b) 30 to 31 October

Site 10

Address: 12280 Blundell Road, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located just adjacent the fence with a setback of 75 m west of the centerline of Highway 99 (**Figure 17**). Continuous noise monitoring was conducted at Site 10 for 20-hours. The dominant noise source at Site 10 was Highway 99 traffic noise. **Figure 18** depicts noise levels in 15-minute intervals. The pre-Project average day/night noise exposure at Site 10 was $L_{dn}(20)$ 66.3 dBA.

Proposed Improvements: The existing Blundell Road/Highway 99 overpass will be upgraded.





Figure 17 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 October 31 - November 1, 2013
 (Noise Levels in 15 minute Intervals)

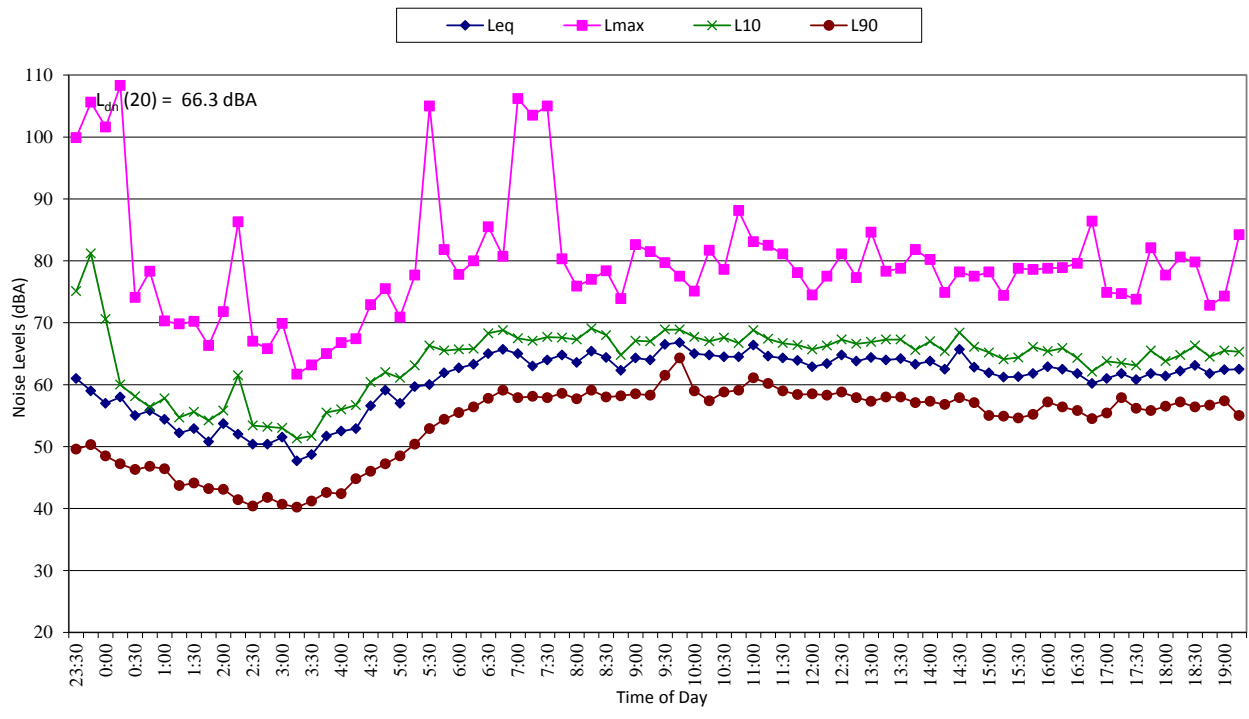


Figure 18 Noise Levels at Site 10 Measured in 15 Minute Intervals

Site 11

Address: 10640 No. 5 Road, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located adjacent the Highway 99 southbound exit to the Steveston Highway, and 100 m to the west of the centerline of Highway 99. This location is representative of the proposed façade of The Gardens - Phase 3 located an additional 15 m to the west (**Figure 19**). Continuous noise monitoring was conducted at Site 11 for 24 hours. The dominant noise source was Highway 99 traffic noise. **Figure 20** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 11 was $L_{dn}(24)$ 65.7 dBA.

Proposed Improvements: This section of Highway 99 includes the northern approach to the proposed new bridge replacing the Tunnel. The Steveston Highway interchange will be upgraded.





Figure 19 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

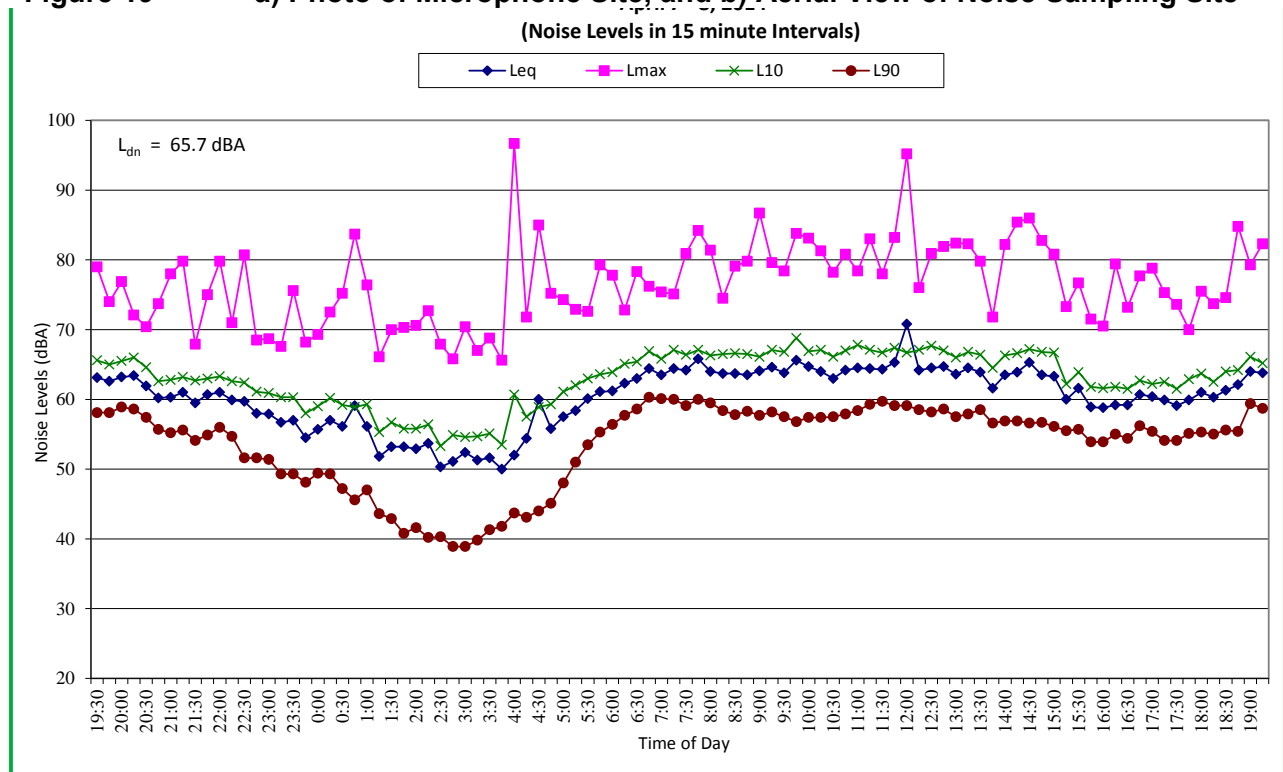


Figure 20 Noise Levels at Site 11 Measured in 15 Minute Intervals

Site 12

Address: 12900 Steveston Highway, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located adjacent the Highway 99 northbound exit to the Steveston Highway. This location is 175 m to the east of the centerline of Highway 99 (**Figure 21**). Continuous noise monitoring was conducted at Site 12 for 24 hours. The dominant noise source at Site 12 was Highway 99 traffic noise. **Figure 22** depicts noise levels in 15-minute intervals. The pre-Project average day/night noise exposure was $L_{dn}(24)$ 69.5 dBA.

Proposed Improvements: This section of Highway 99 includes the northern approach to the proposed new bridge replacing the Tunnel. The Steveston Highway interchange will be upgraded.





Figure 21 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 November 1, 2013

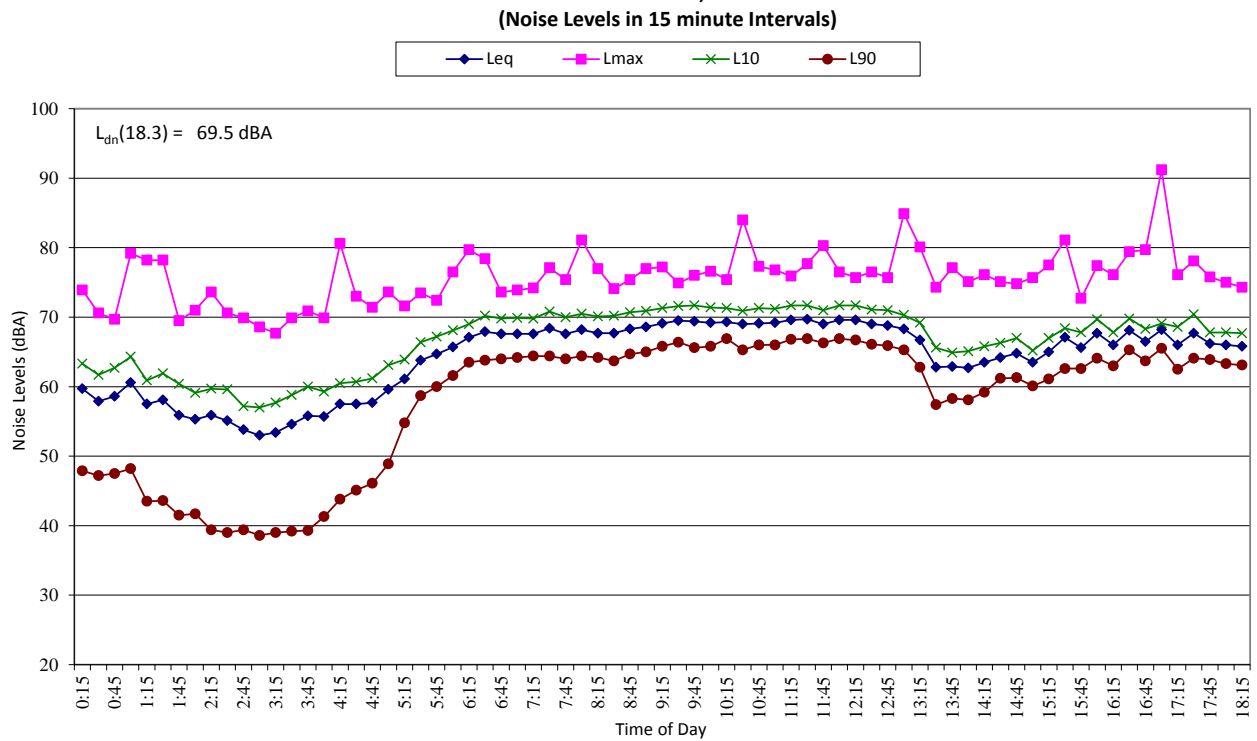


Figure 22 Noise Levels at Site 12 Measured in 15 Minute Intervals

Site 13

Address: 103-14100 Riverport Way, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located in front of the condominium unit 103 facing the Fraser River South Arm with River Road in Delta in the distance. This location is 1700 m to the east of the centerline of the proposed new bridge the Tunnel (**Figure 23**). Continuous noise monitoring was conducted at Site 13 for 24 hours. The dominant noise source at Site 13 was River Road traffic noise. **Figure 24** depicts noise levels in 15-minute intervals. The pre-Project average day/night noise exposure was $L_{dn}(24)$ 69.9 dBA.

Proposed Improvements: This section of Highway 99 includes the proposed new bridge replacing the Tunnel.

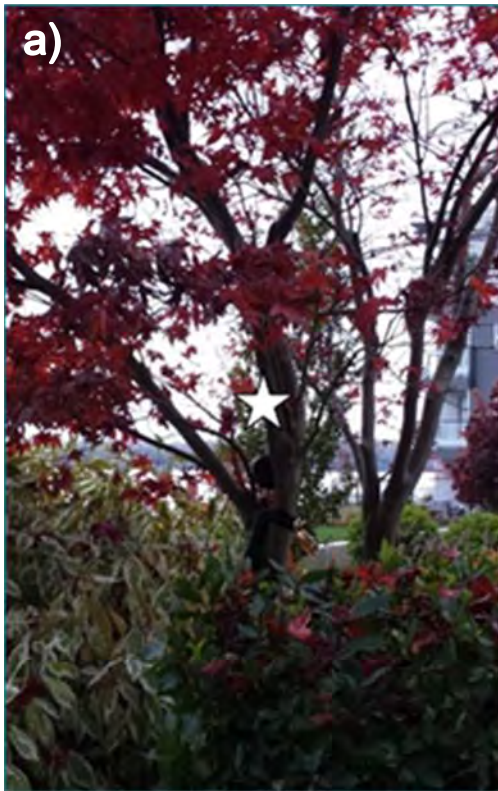




Figure 23 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

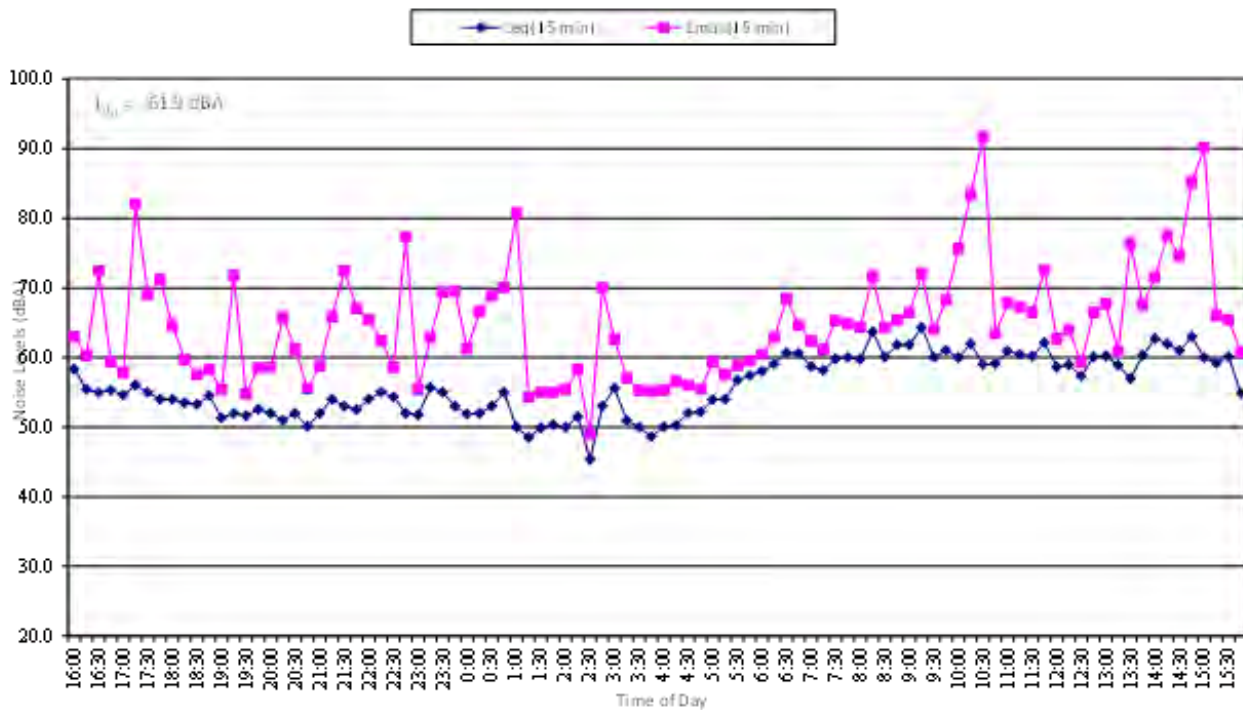


Figure 24 Noise Levels at Site 13 Measured in 15 Minute Intervals

Site 14

Address: 12951 Rice Mill Road, Richmond, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 120 m from the centerline of the Highway 99 at the north portal of the Tunnel (**Figure 25**). Continuous noise monitoring was conducted at Site 14 for 24 hours. The dominant noise source at Site 14 was Highway 99 traffic noise. **Figure 26** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 14 was $L_{dn}(24)$ 63.1 dBA.

Proposed Improvements: This section of Highway 99 includes the proposed new bridge replacing the Tunnel.



Figure 25 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

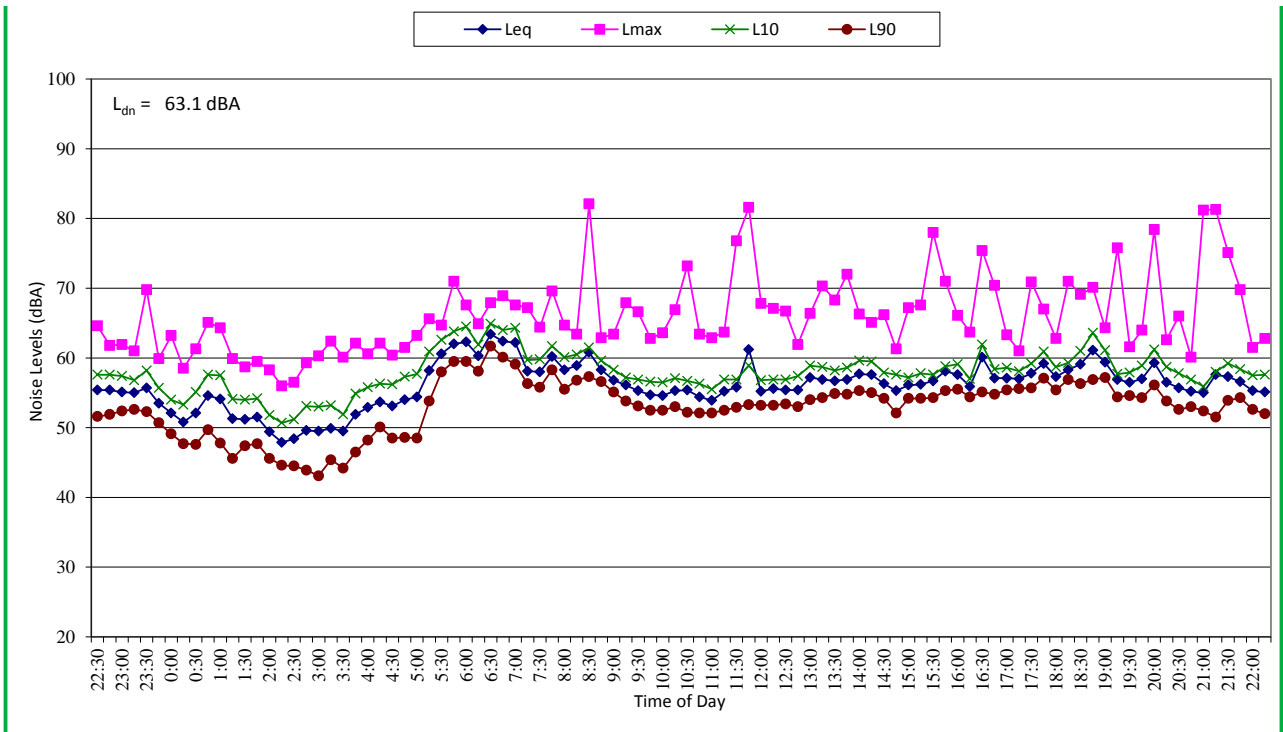


Figure 26 Noise Levels at Site 14 Measured in 15 Minute Intervals

Site 15

Address: 12 Riverwoods, 6105 River Road, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 65 m from the centerline of Highway 99 (**Figure 27**). Site 15 is directly exposed to the northbound lanes of Highway 99. Continuous noise monitoring was conducted at Site 15 for 24 hours. The dominant noise source at Site 15 was Highway 99 traffic noise. **Figure 28** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 15 was $L_{dn}(24)$ 68.4 dBA.

Proposed Improvements: The existing approach to the Deas Slough Bridge and the Tunnel would be replaced by the proposed new bridge.

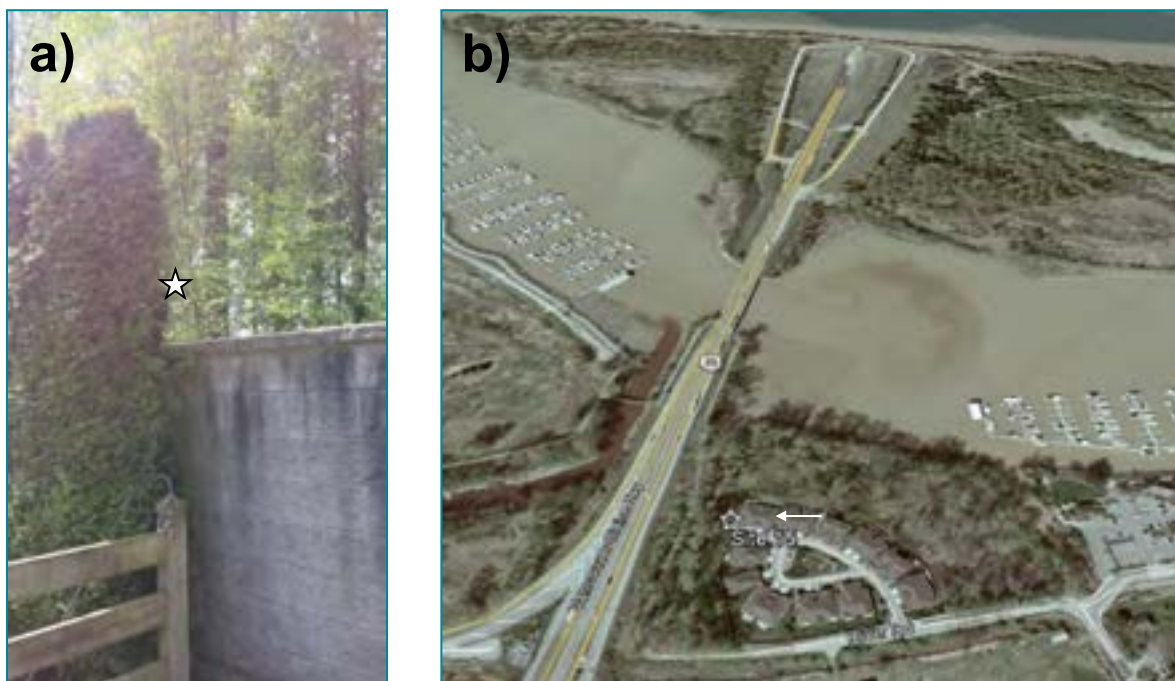


Figure 27 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

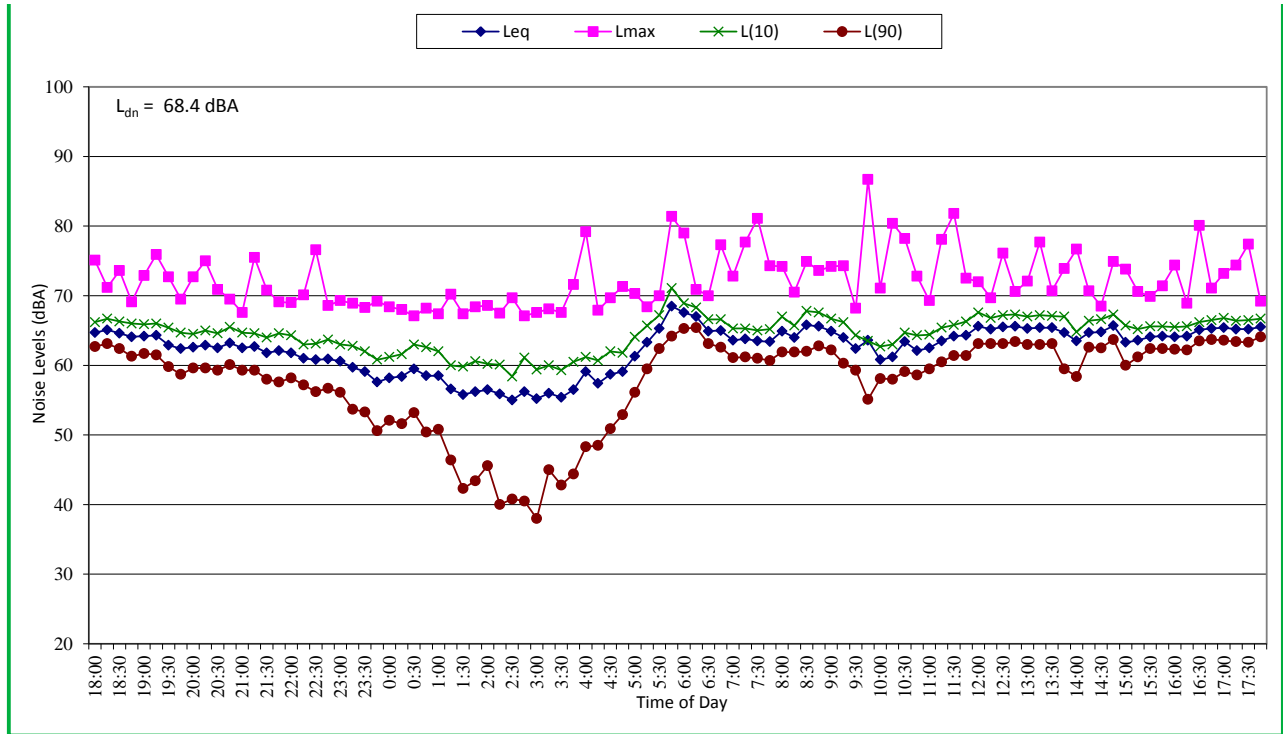


Figure 28 Noise Levels at Site 15 Measured in 15 Minute Intervals

Site 16

Address: 37 Woodward Landing, 5300 Admiral Way, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at the northeast corner of the Woodward Landing community. The setback from the centerline of Highway 99 was 525 m (**Figure 29**). Site 16 is directly exposed to the southbound lanes of the Highway 99 Deas Slough Bridge. The intervening ground types include approximately 250 m of water, and 250 m of grassy soil. Continuous noise monitoring was conducted at Site 16 for 24 hours. The dominant noise source at Site 16 was Highway 99 traffic noise. **Figure 30** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 16 was $L_{dn}(24)$ 57.6 dBA.

Proposed Improvements: The existing approach to the Deas Slough Bridge and the Tunnel would be replaced by the proposed new bridge.



Figure 29 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

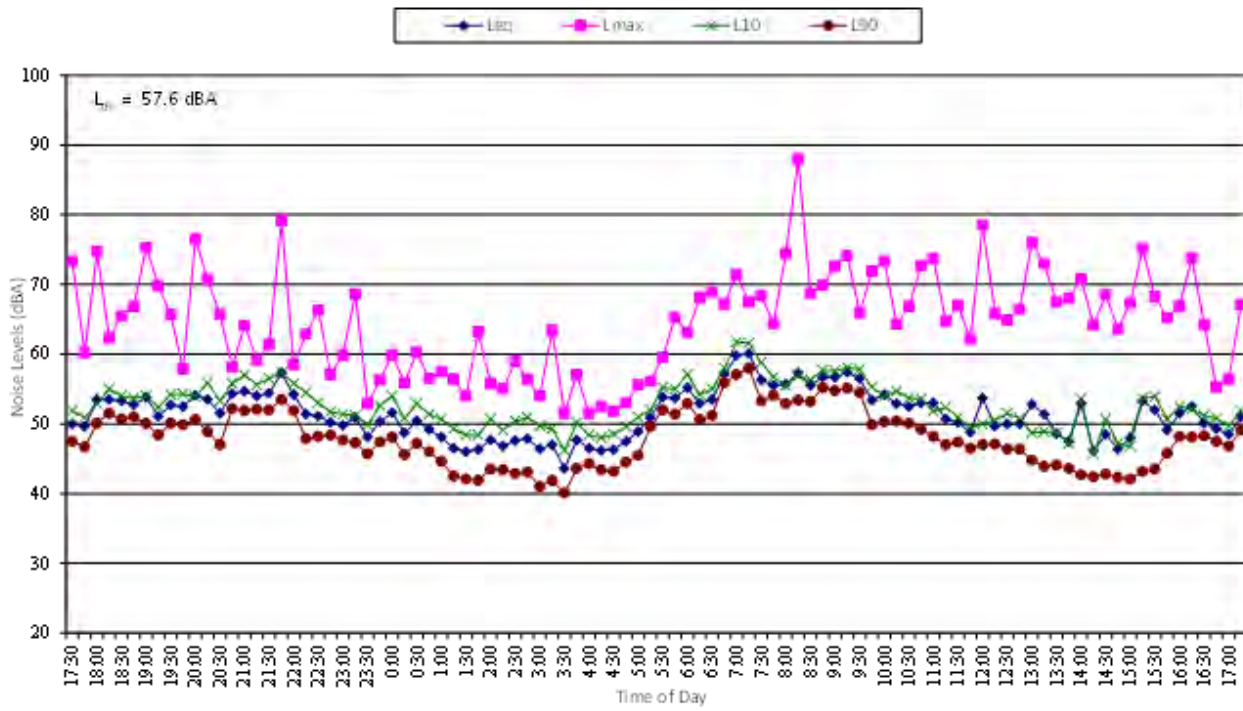


Figure 30 Noise Levels at Site 16 Measured in 15 Minute Intervals

Site 17

Address: 5954 River Road, Ladner, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 115 m from the centerline of Highway 99 (**Figure 31**). The intervening ground between Site 17, and Highway 99 was a grassy field. Continuous noise monitoring was conducted at Site 17 for 24 hours. The dominant noise source at Site 17 was Highway 99 traffic noise. **Figure 32** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 17 was $L_{dn}(24)$ 67.6 dBA.

Proposed Improvements: The existing approach to the Deas Slough Bridge and the Tunnel would be replaced by the proposed new bridge.



Figure 31 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

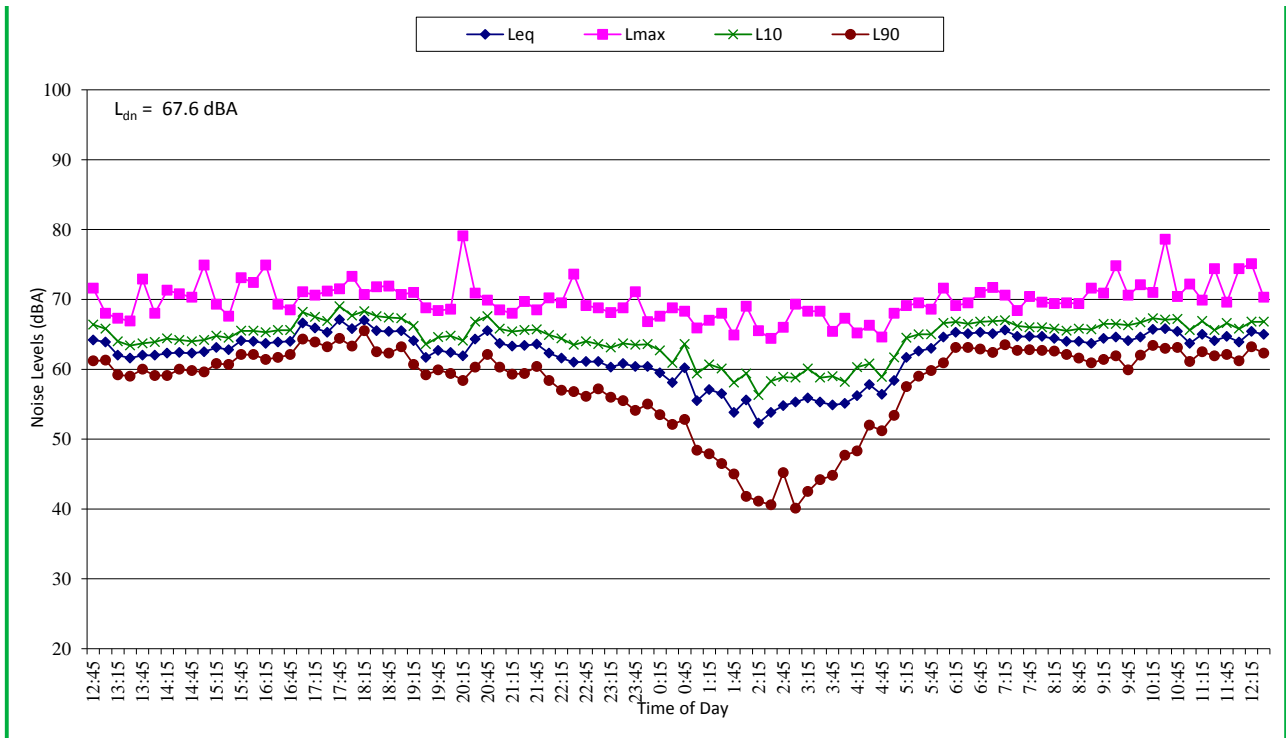


Figure 32 Noise Levels at Site 17 Measured in 15 Minute Intervals

Site 18

Address: 5202 Regatta Way, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 1500 m from the centerline of Highway 99 (**Figure 33**). Continuous noise monitoring was conducted at Site 18 for 24 hours. The dominant noise source at Site 18 was light local traffic. **Figure 34** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 18 was $L_{dn}(24)$ 51.5 dBA.

Proposed Improvements: The approach to the Deas Slough Bridge the Tunnel would be replaced by the proposed new bridge.



Figure 33 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

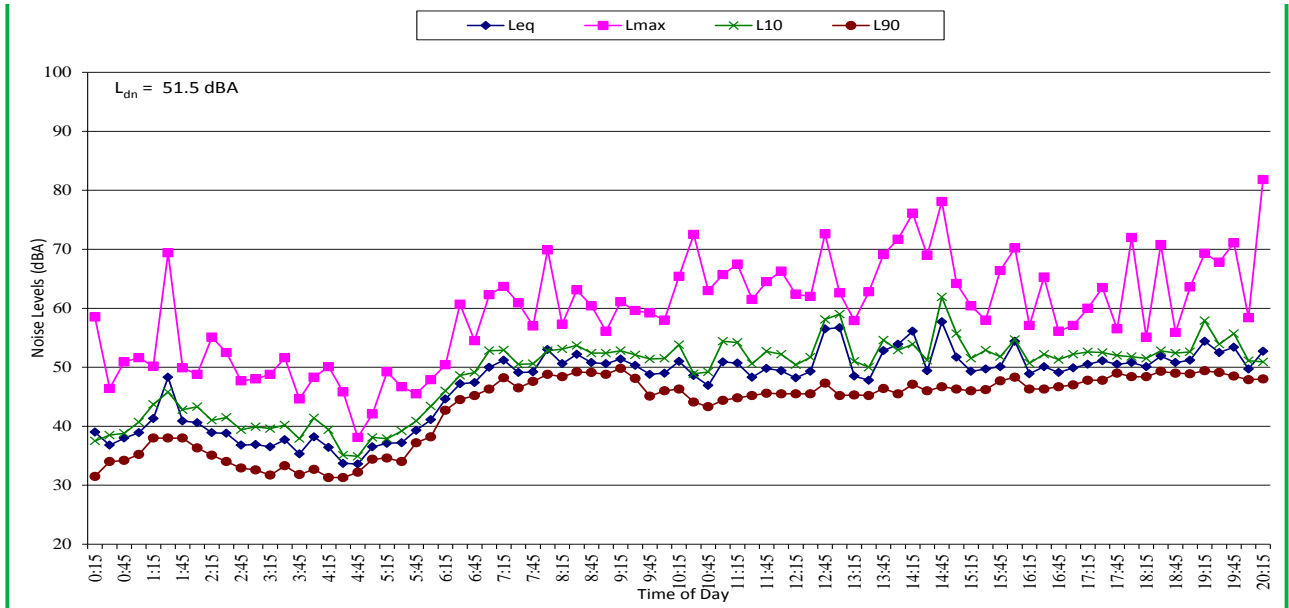


Figure 34 Noise Levels at Site 18 Measured in 15 Minute Intervals

Site 19

Address: 5631 64th Street, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 135 m from the centerline of Highway 99 (**Figure 35**). Line-of-sight to Highway 99 is broken by new residential buildings replacing the original barn. Continuous noise monitoring was conducted at Site 19 for 24 hours. The dominant noise sources at Site 19 were Highway 99 traffic noise and heavy truck movements along 64th Street/Burns Drive. **Figure 36** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 19 was $L_{dn}(24)$ 57.4 dBA.

Proposed Improvements: The existing Highway 99/Highway 17A interchange will be replaced.



Figure 35 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

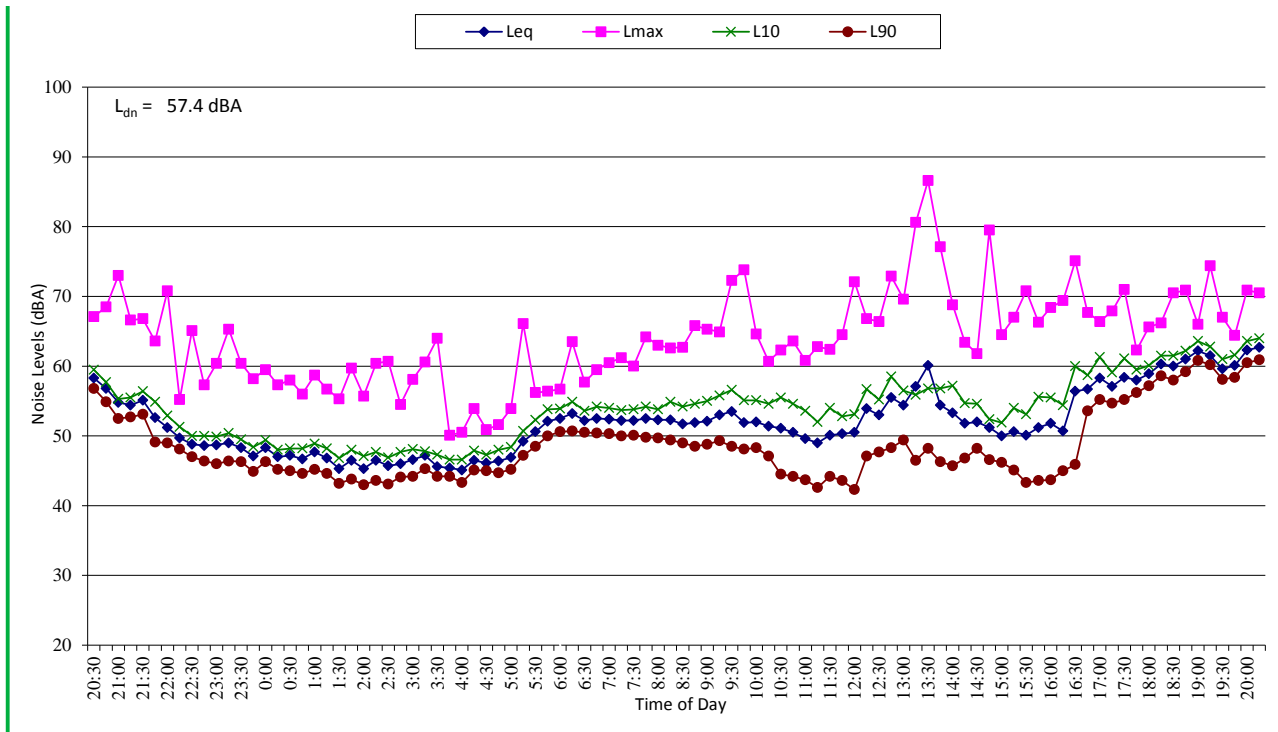


Figure 36 Noise Levels at Site 19 Measured in 15 Minute Intervals

Site 20

Address: 8640 Ladner Trunk Road, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 93 m from the centerline of Highway 99 (**Figure 37**). Site 20 is exposed to Highway 99 noise, and influenced by Ladner Trunk Road noise. Line-of-sight to Highway 99 is unbroken. The dominant noise source at Site 20 was Highway 99 noise. Continuous noise monitoring was conducted at Site 20 for 24 hours. **Figure 38** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 20 was $L_{dn}(24)$ 67.5 dBA.

Proposed Improvements: The existing Highway 99 alignment will remain unchanged. Additional lanes are proposed which could involve widening the section of Highway 99 between the Highway 17 connection, and Ladner Trunk Road and include providing a dedicated transit/HOV lane in each direction



Figure 37 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

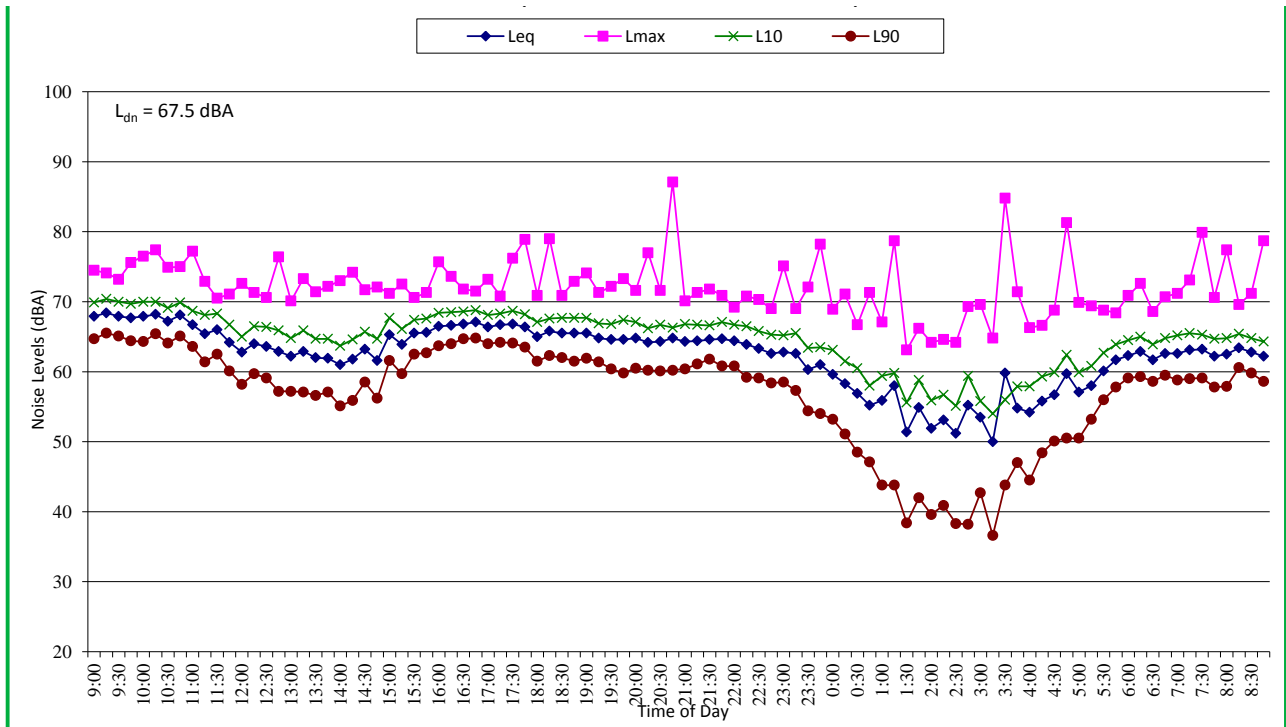


Figure 38 Noise Levels at Site 20 Measured in 15 Minute Intervals

Site 21

Address: 9321 Burns Drive, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 40 m from the centerline of Highway 99 (**Figure 39**). The line-of-sight was unbroken between Site 21, and the entire dominant section of Highway 99. Site 21 was directly exposed to Highway 99 north bound lanes on a 1 m high fill section. The dominant noise source at Site 21 was Highway 99 traffic noise. Recent improvements in the area include the northbound on ramp adjacent to Site 21 which was recently realigned. Continuous noise monitoring was conducted at Site 21 for 24 hours. **Figure 40** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 21 was $L_{dn}(24)$ 75.0 dBA.

Proposed Improvements: Highway improvements along this section of Highway 99 include providing a dedicated transit/HOV lane in each direction.



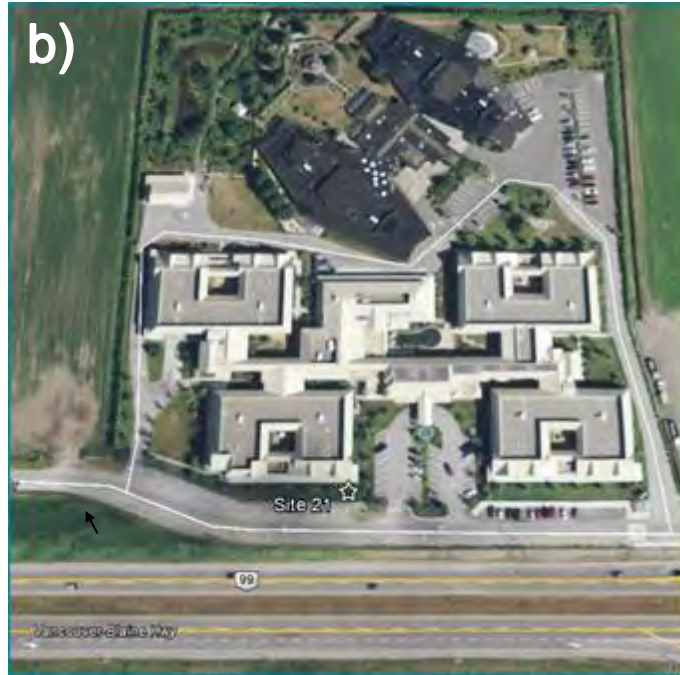


Figure 39 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 September 26 - 27, 2013

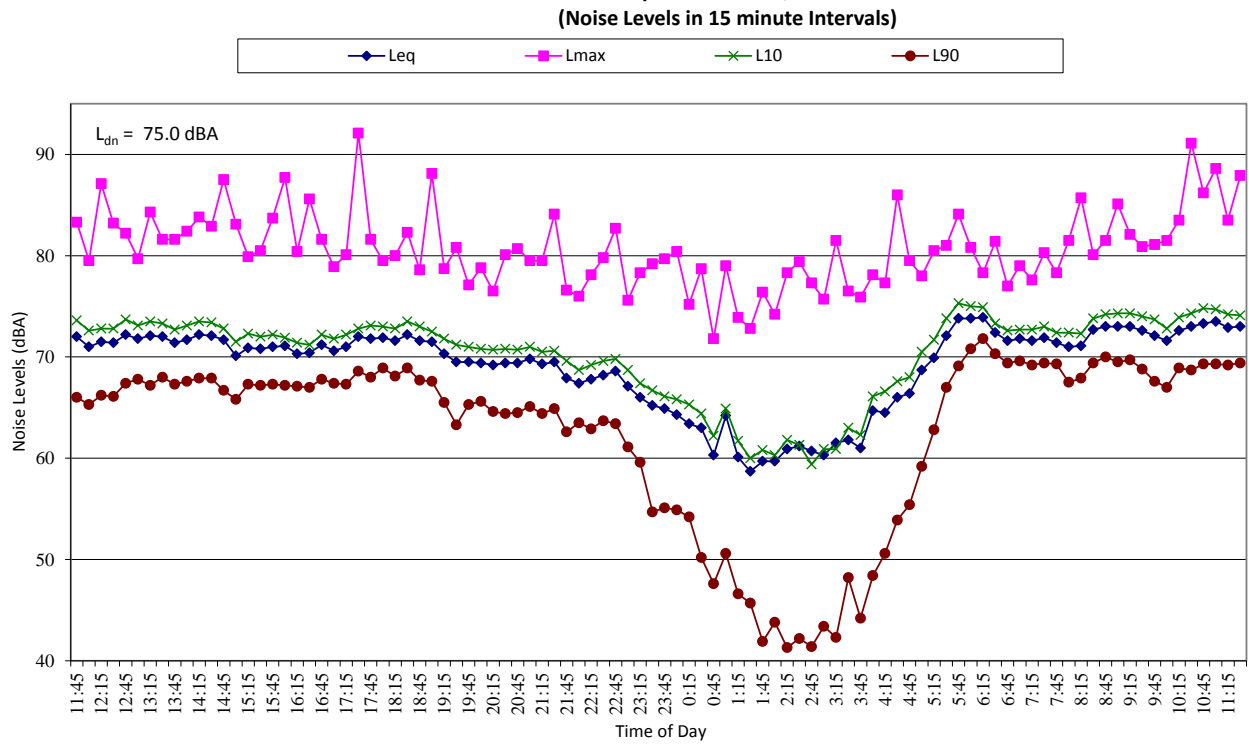


Figure 40 Noise Levels at Site 21 Measured in 15 Minute Intervals

Site 22

Address: 9321 Burns Drive, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 40 m from the centerline of Highway 99 (**Figure 41**). The line-of-sight was unbroken between Site 22, and the entire dominant section of Highway 99. Site 22 was directly exposed to Highway 99 north bound lanes on a 1 m high fill section. The dominant noise source at Site 22 was Highway 99 traffic noise. Recent improvements in the area include the northbound on ramp adjacent to Site 21 which was recently realigned. This site is located 20 m north or south from Site 21.

Continuous noise monitoring was conducted at Site 22 for 24 hours. **Figure 42** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 22 was $L_{dn}(24)$ 74.7 dBA.

Proposed Improvements: Highway improvements along this section of Highway 99 include providing a dedicated transit/HOV lane in each direction.



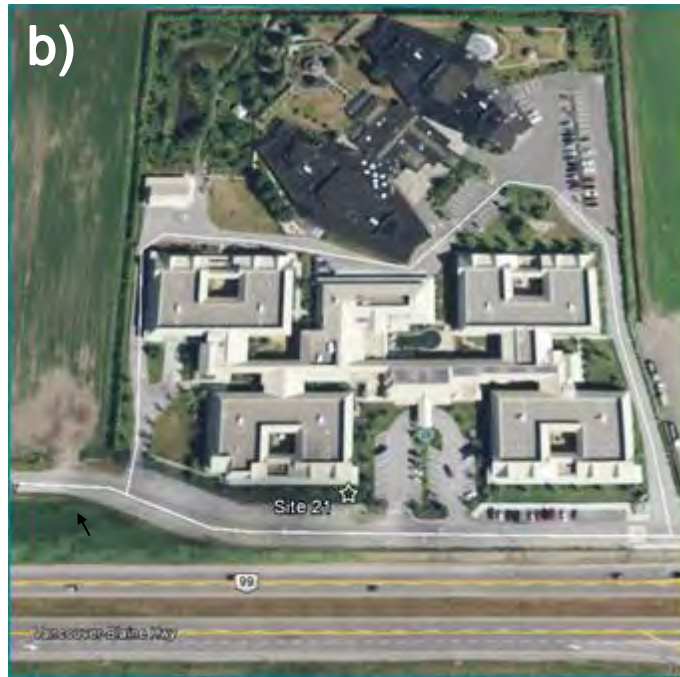


Figure 41 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site
 September 26 - 27, 2013

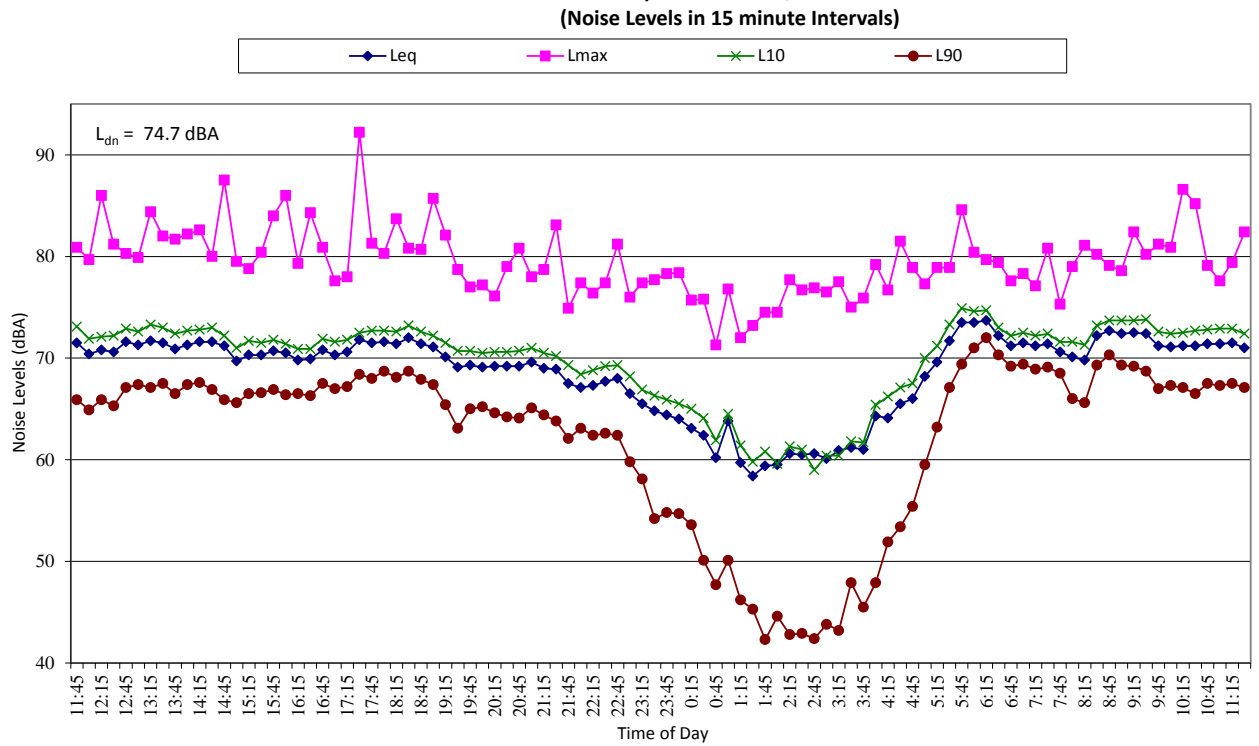


Figure 42 Noise Levels at Site 22 Measured in 15 Minute Intervals

Site 23

Address: 4779 104th Street, Delta B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 67 m from the centerline of Highway 99 (**Figure 43**). Site 23 is directly exposed to the Highway 99 south bound lanes. Line-of-sight to Highway 99 is unbroken. Continuous noise monitoring was conducted at Site 23 for 48 hours. The dominant noise source at Site 23 was Highway 99 traffic noise. The contribution of local traffic on Hornby Drive was negligible. **Figure 44** depict noise levels in 15-minute intervals for October 30 to 31 and October 31 to November 1, 2013 respectively. The pre-Project average day/night noise exposures at Site 23 were $L_{dn}(24)$ 69.0 dBA from October 30 to 31 and $L_{dn}(24)$ 69.5 dBA from October 31 to November 1, 2013.

Proposed Improvements: Highway improvements along this section of Highway 99 include providing a dedicated transit/HOV lane in each direction.



Figure 43 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

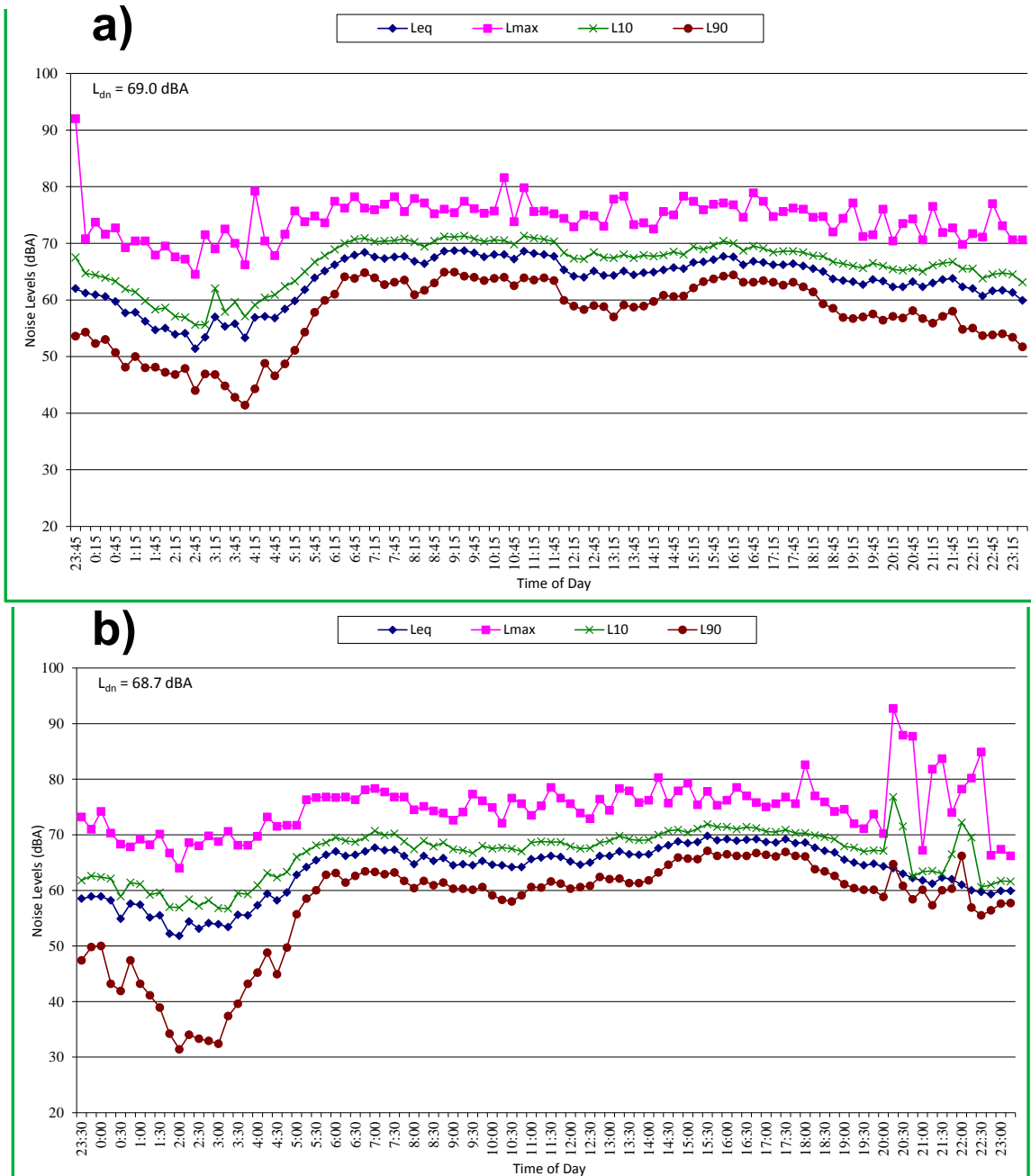


Figure 44 Noise Levels at Site 23 Measured in 15 Minute Intervals on a) October 30 to 31 and, b) October 31 to November 1, 2013.

Site 24

Address: 4949 112th Street, Delta, B.C.

Pre-Project Ambient Noise:

The microphone was located at a setback of 115 m from the centerline of Highway 99 (**Figure 45**). Site 24 is directly exposed to the Highway 99 northbound lanes. Line-of-sight to Highway 99 is unbroken. Continuous noise monitoring was conducted at Site 24 for 23 hours. The dominant noise sources at Site 24 were Highway 99 traffic noise and rail noise. **Figure 46** depicts noise levels in 15 minute intervals. The pre-Project average day/night noise exposure at Site 24 was $L_{dn}(23)$ 73.7 dBA.

Proposed Improvements: Highway improvements along this section of Highway 99 include providing a dedicated transit/HOV lane in each direction and replacing the 112th Street overpass.





Figure 45 a) Photo of Microphone Site, and b) Aerial View of Noise Sampling Site

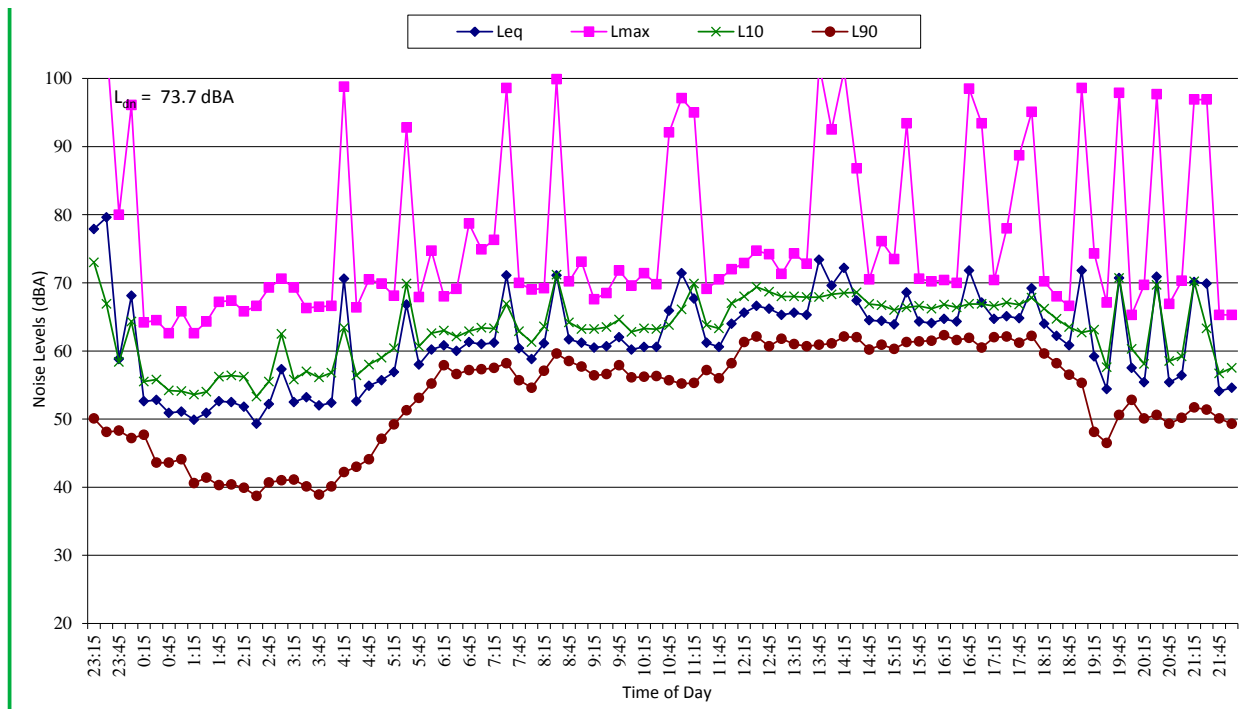


Figure 46 Noise Levels at Site 24 Measured in 15 Minute Intervals

ATTACHMENT C

Traffic Noise Prediction Methods

Prediction of the 2030 L_{dn} , L_d , and L_n

The relevant noise metrics for the atmospheric noise study include L_{dn} , L_d , and L_n . These three metrics were measured at all long-term monitoring noise sites and were estimated at short-term monitoring sites.

The forecast noise levels with Project for the year 2030 were predicted using either a baseline adjustment method or highway noise modelling software.

Baseline Adjustment Method for Estimating the 2030 L_{dn} , L_d , and L_n

The baseline adjustment method (BAM) is suitable for predicting future noise levels in situations where the highway geometry, existing and with Project, is simple. The BAM has been used to estimate effects of the Project on receptor exposures to operational (traffic) noise throughout most of the study area with the exception of the segment including the new bridge and its approaches. The BAM was then employed for all sites between Westminster Highway and Steveston Highway; between Highway 17A and Highway 17; and between Highway 17 and Highway 91.

The BAM is based largely on *Road and Rail Noise: Effects on Housing* (CMHC 1981), which provides a manual procedure for forecasting highway noise levels. This methodology can also be used to estimate project-related changes in noise levels by adjusting baseline noise levels to reflect future traffic growth and foreseeable changes in other highway parameters, as listed below. The procedure permits 24-hour average highway noise exposures to be predicted based on the following pre-Project and post-Project traffic parameters:

- Average daily traffic volume
- Heavy truck mix
- Posted speed
- Level-of-service
- Noise sensitive receptor setback distance from highway centreline
- Elevations of both highway and receptor relative to the surrounding ground surface
- Nature of the intervening ground surface – acoustically hard or soft

Using these input parameters, the 2030 24-hour equivalent sound level ($L_{eq}(24)$) at the receptor location may be estimated. Similarly, if one or more of these parameters is to be changed as a result of a proposed highway improvement project, then the effect(s) of the change(s) on a measured baseline $L_{eq}(24)$ can be predicted. Assuming the proportioning of traffic between the 15 daytime and nine nighttime hours does not change, the change in L_{dn} will be the same as the change in $L_{eq}(24)$.

As an example of the CMHC procedure, consider the hypothetical case in which a new lane is to be added on each side of an existing four-lane highway around a fixed centreline and, as a result, the total traffic volume will increase by 30%, heavy truck mix will increase from 5% to 8%, and the posted speed will increase from 80 km/h to 100 km/h. The $L_{eq}(24)$ at residences set back more than about 30 m from the highway would then be expected to increase by approximately 4.0 dBA (1.0 dBA from volume growth, 1 dBA from heavy truck mix growth, and 2 dBA from speed increase¹). Therefore, if the pre-Project noise level was, for example, L_{dn} 63 dBA, the post-Project level would be approximately L_{dn} 67 dBA.

Noise Modelling Software for Predicting the 2030 L_{dn} , L_d , and L_n

The new bridge that will replace the Tunnel involves a complex change from the existing horizontal and vertical alignment of Highway 99. The BAM approach is not capable of accurately predicting the effects of these changes on noise levels at the baseline noise monitoring sites. Therefore, for the extent of the new bridge and its approaches (i.e., from the Steveston Highway Interchange to the Highway 17A Interchange), the U.S. Federal Highway Administration (FHWA) Traffic Noise Model (TNM) Version 2.5 was used instead, and was run within DataKustiks' CadnaA Version 4.3.143 noise prediction software. The input parameters required for TNM are as follows:

- Proposed horizontal and vertical alignments of Highway 99
- 2030 annual average daily traffic volumes (AADT), and day/night traffic split
- Proposed posted speed (km/h) (light vehicles are assumed to run at posted speeds; heavy trucks are assumed to run at posted speeds on flat but at reduced speeds on grades)
- Anticipated distribution of traffic across the new 10-lane bridge

¹ These adjustments come from CMHC (Canadian Mortgage and Housing Corporation 1981. Road and Rail Noise: Effects on Housing, ISBN 0-662-11021-0.ftp://ftp.cmhc-schl.gc.ca/chic-ccdh/Research_Reports-Rapports_de_recherche/Older13/CA1%20MH110%2081R56_w.pdf)

- Proposed pavement type
- Setback distances from the new Bridge and approaches to noise receptors
- Nature of intervening ground (acoustically hard versus soft)
- Presence of noise-shielding elements, such as concrete roadside barrier (CRB) or bridge parapet
- TNM default weather conditions; calm winds and neutral atmosphere

The FHWA's TNM contains vehicle noise source reference data developed from North American vehicles, including heavy trucks with elevated exhaust stacks, as well as algorithms for generating the appropriate noise emissions from each highway segment based on volume, truck mix, speed, and grade. The noise emission data for heavy trucks are partitioned into two source zones — a lower zone that represents engine, drive train and tires; and a higher zone that represents exhaust stacks. This partitioning of noise source zones for heavy trucks is particularly important in terms of noise prediction accuracy when noise-shielding elements will be involved, such as the CRB and parapet that will run along outer edges of both the northbound and southbound lanes on the new Bridge and approaches. The TNM's split source height has the additional advantage of accurately representing truck noise emissions in evaluating the effectiveness of any roadside noise barriers that might be considered, should predicted noise levels due to the Project warrant mitigation consideration.

The TNM of the new bridge and its approaches is a three-dimensional model that incorporates the horizontal and vertical alignments, and the distribution of the forecast 2030 traffic flows across the five southbound and five northbound lanes. Each lane is assigned the appropriate daytime/nighttime traffic volumes and daytime/nighttime heavy truck mix. The noise emissions from the various traffic lanes are then propagated outward from the highway, over the edge of the bridge parapet, down to the quite widely distributed noise-sensitive receptors below, both to the east and west of the alignment.

Sound is only partially blocked when the line of sight between the source and the receptor is interrupted by a solid object such as a bridge parapet. Sound, particularly lower-frequency sound, diffracts around such objects and is attenuated (reduced in level) in the process, but not eliminated. The bridge parapet, enhanced by the 0.8 m high CRB located along the outer edge of the bridge deck, acts to reduce the levels of traffic noise reaching receptors near ground level, particularly for traffic in the centre lanes, well away from the bridge parapet. Modelling has shown that noise levels at these ground-level receptors would, in fact, be expected to be higher if the Project was not located on a high bridge, but rather was essentially at grade or on a causeway similar to the existing low bridge spanning Deas Slough. This is because,

in the ground level highway case, only a small amount of shielding would be provided by the 0.8 m CRB as it would shield tire noise only. Heavy truck engine and exhaust noise would receive little or no shielding in this situation.

A baseline (pre-Project) noise model can be calibrated against the traffic noise levels measured at certain locations. For this purpose, a baseline noise model was developed of the existing Highway 99 traffic over a limited portion of the study area. Calibration of the TNM then involved the comparison of predicted baseline noise levels at a suitable location with the baseline noise level measured at the same location. A suitable location is one that is fairly close to the highway (so that highway noise dominates overall noise levels), and has level ground conditions between it and the highway.

The traffic data used in the baseline model calibration are provided in **Table C2** to **Table C5**. 2013 AADT and heavy truck mix for Highway 99 was used, based on count station data and/or Equilibrie Intermodal; Modal Equilibrium 2 (EMME2), model projections. The intervening terrain between Highway 99 and residences was modelled using existing ground elevation contours.

Site 15 (12 River Woods, 6105 River Road, Delta; **Figures 27** and **28**, **Appendix B**) was chosen for model calibration since it is set back 70 m over flat terrain from the centerline of Highway 99, and its noise environment is dominated by highway traffic. The baseline traffic noise level was predicted at this site using 2013 traffic volumes and assuming a posted speed of 80 km/h.

The calibration was also sensitive to ground type. The default ground for TNM is grass. CadnaA provides a selectable ground absorption coefficient in the range of 0 (hard) to 1 (soft). A ground absorption coefficient of 0.5 was assumed representing medium ground (meadow grasses) over a propagation path length of typically 50 to 500 m.

The L_{dn} measured at site 15 in April 2014 was 68.4 dBA. The TNM baseline model of Highway 99, using the input parameters listed above, yielded L_{dn} 69.0 dBA. The resulting 0.5 dBA difference between measured and predicted baseline noise levels at site 15 is considered to represent acceptable agreement for purposes of the subsequent modelling of traffic noise levels with the Project. This minor deviation between the measured and modelled baseline L_{dn} is considered to be attributable, in part, to the effects of the traffic congestion that occurs in the northbound lanes during peak traffic periods.

The 2030 L_{dn} , L_d , and L_n

The BAM and TNM were used to forecast the 2030 L_{dn} , L_d , and L_n at the noise-sensitive locations (baseline monitoring sites) listed in **Table 8** and **Table 9** of the technical volume report. These forecasts accounted for anticipated traffic volume growth, heavy truck mix increases, alignment modifications, and other changes over the decade following Project completion, in accordance with the 2014 MOTI noise policy.

The Highway 99 alignment within the study area features five interchanges, or nodes, and six mainline segments (see **Table C1**). The traffic parameters (2013 and 2030 AADT, lane distribution, heavy truck mix, day/night split, posted speed, and level of service) can vary from one segment to the next.

Table C1 Highway 99 Segments for Assessment of Operational Noise

| Mainline Segments | Station Numbers |
|--|--|
| A - Bridgeport Road to Westminster Highway | 1a, 1, 2, 3, 4a, 4b, 4, 5, 6, and 7a |
| B - Westminster Highway to Steveston Highway | 7, 8, 9, 10, 10a, 10b, 10c, 11, and 13 |
| C - Steveston Highway to Highway 17A | 11a, 12, 12a, 14, 15, 15a, 15b, 15c, 16a, 16b, 17, 17a, 17b, 17c, and 18 |
| D - Highway 17A to Highway 17 | 19 |
| E - Highway 17 to Ladner Trunk Road | 20, 21, 22 |
| F – Ladner Trunk Road to Highway 91 | 20a, 23, 24, 24a |

The relevant traffic data for each of the six mainline segments of Highway 99 shown in **Table C1** are provided in **Tables C2 to C5**. The Ministry provided existing 2013 AADT and heavy truck mix. However, the 2013 volumes do not reflect the opening of Highway 17, which occurred in December, 2013. The future 2030 traffic data were provided by the Ministry Project team and are based on the EMME2 traffic volume model. The EMME2 2030 forecast provided the following for the mainline and on/off-ramps:

- AADT
- Lane distribution
- Heavy truck mix
- Day/night traffic split

The Ministry provided the 2013 posted and 2030 design speeds. The Project team provided the relevant future alignment information, namely, horizontal and vertical alignments and grades of the mainline and on/off-ramps. The pavement was assumed to be the average pavement type specified in the TNM. The intervening terrain between these roadway segments and residences was modelled using a composite digital terrain model which, within the Project footprint, superimposed the design ground on the existing ground.

Table C2 Existing and Future Traffic Data for Highway 99 (Segment A)

| Location | | Average Daily Traffic Volume AADT ¹ (vpd) | | Heavy Truck Mix | | Speeds (km/h) | |
|---|------------------|--|-----------------|-----------------|-----------------|-----------------|---------------------|
| Interchange /Segment ¹ | Lanes | Existing (2014) | Forecast (2030) | Existing (2014) | Forecast (2030) | Existing (2014) | Post-Project (2030) |
| Hwy 99/ Bridgeport Road (Sea Island Way) | NB Off | 10,000 | 17,000 | 3.5% | 7% | 50 ⁴ | 50 ⁴ |
| | NB On | 12,000 | 12,000 | 1% | 1.5% | | |
| | SB Off | 11,500 | 13,500 | 1% | 1% | | |
| | SB On | 10,500 | 16,500 | 4% | 6.5% | | |
| Hwy 99 / No. 4 Road | SB Off | 4,500 | 4,000 | 0% | 2.5% | | |
| Hwy 99/Main | NBC ² | 36,500 | 48,000 | 3.5% | 4.5% | 60 | 60 |
| | NBF ² | | | | | | |
| | SBF ³ | 33,500 | 42,000 | 2% | 4% | | |
| | SBC ³ | | | | | | |
| Hwy 99 / Shell Road | NB On | 8,000 | 10,000 | 0% | 1% | 50 ⁴ | 50 ⁴ |
| | SB Off | 4,000 | 2,000 | 0% | 0% | | |
| Hwy 99/Main | NBC ² | 36,500 | 48,000 | 3.5% | 4.5% | 90 | 90 |
| | NBF ² | | | | | | |
| | SBF ³ | 33,500 | 42,000 | 2% | 4% | | |
| | SBC ³ | | | | | | |
| Hwy 99 / Highway 91 | NB Off | 10,000 | 12,500 | 6% | 20% | 50 ⁴ | 50 ⁴ |
| | NB On | 12,500 | 13,000 | 1.5% | 5.5% | | |
| | SB Off | 13,000 | 14,000 | 0% | 3.5% | | |
| | SB On | 9,500 | 13,000 | 10% | 17.5% | | |

Notes

- ¹ Interchanges and overpass/underpass structure are shown in **bold text**
- ² NBC and NBF denote northbound curb, and northbound fast lanes, respectively.
- ³ SBF and SBC denote southbound fast, and southbound curb lanes, respectively.
- ⁴ Ramp speed is taken to be the average of the maximum ramp speed of 100 km/h, and the minimum of 0 km/h.

Table C3 Existing and Future Traffic Data for Highway 99 (Segment B)

| Location | | Annual Average Daily Traffic Volume (vehicles per day) | | Heavy Truck Mix | | Speeds (km/h) | |
|--|------------------|--|-----------------|-----------------|-----------------|-----------------|---------------------|
| Interchange / Segment ¹ | Lanes | Existing (2014) | Forecast (2030) | Existing (2014) | Forecast (2030) | Existing (2014) | Post-Project (2030) |
| Hwy 99 / Westminster Hwy | NB Off | 10,000 | 14,500 | 1% | 1% | 50 ⁴ | 50 ⁴ |
| | SB On | 8,000 | 16,000 | 1% | 1% | | |
| Hwy 99 / Westminster Hwy to Hwy 99 / Steveston Hwy | NBC ² | 36,000 | 52,000 | 5% | 8% | 90 | 100 |
| | NBF ² | | | | | | |
| | SBF ³ | 34,000 | 55,000 | 5% | 6.5% | | |
| | SBC ³ | | | | | | |
| Hwy 99 / Steveston Hwy | NB Off | 11,000 | 11,500 | 2% | 7% | 50 ⁴ | 50 ⁴ |
| | NB On | 7,000 | 10,000 | 3% | 4% | | |
| | SB Off | 6,500 | 10,000 | 6% | 4% | | |
| | SB On | 12,500 | 16,000 | 3% | 4% | | |

Notes

- ¹ Interchanges and overpass/underpass structure are shown in **bold text**
- ² NBC and NBF denote northbound curb, and northbound fast lanes, respectively.
- ³ SBF and SBC denote southbound fast, and southbound curb lanes, respectively.
- ⁴ Ramp speed is taken to be the average of the maximum ramp speed of 100 km/h, and the minimum of 0 km/h.

Table C4 Existing and Future Traffic for Highway 99 Tunnel and New Bridge (Segment C)

| Location | | Annual Average Daily Traffic Volume (vehicles per day) | | Heavy Truck Mix | | Speeds (km/h) | |
|---|------------------|--|-----------------|-----------------|-----------------|-----------------|---------------------|
| Interchange/ Segment ¹ | Lanes | Existing (2014) | Forecast (2030) | Existing (2014) | Forecast (2030) | Existing (2014) | Post-Project (2030) |
| Hwy 99/ Steveston Hwy | NB Off | 11,000 | 11,500 | 2% | 7% | 50 ⁴ | 50 ⁴ |
| | NB On | 7,000 | 10,000 | 3% | 4% | | |
| | SB Off | 6,500 | 10,000 | 6% | 4% | | |
| | SB On | 12,500 | 16,000 | 3% | 4% | | |
| Hwy 99/Steveston Hwy to Hwy 99/Hwy 17A | NBC ² | 20,000 | - | 4.5% | 8% | 80 | 100 |
| | NBF ² | 20,000 | - | | | | |
| | NBext1 | - | 53,500 | | | | |
| | NBext2 | - | | | | | |
| | NBexp1 | - | | | | | |
| | NBexp2 | - | | | | | |
| | NB HOV | - | | | | | |
| | SBF ³ | 20,000 | | - | 5% | | |
| | SBC ³ | 20,000 | - | | | | |
| | SBext1 | - | 61,000 | | | | |
| | SBext2 | - | | | | | |
| | SBexp1 | - | | | | | |
| | SBexp2 | - | | | | | |
| | SB HOV | - | | | | | |
| Hwy 99/Hwy 17A | NB Off | 4,000 | | 5,000 | | 5% | 8% |
| | NB On | 18,000 | 25,500 | 2% | 4% | | |
| | SB Off | 18,500 | 23,000 | 1% | 0.5% | | |
| | SB On | 6,000 | 5,000 | 5% | 14% | | |

Notes

Cells containing a dash “-” are not part of the current design or are not relevant.

¹ Interchanges and overpass/underpass structure are shown in **bold text**

² NBC and NBF denote northbound curb, and northbound fast lanes, respectively.

³ SBF and SBC denote southbound fast, and southbound curb lanes, respectively.

⁴ Ramp speed is taken to be the average of the maximum ramp speed of 100 km/h, and the minimum of 0 km/h.

Table C5 Existing and Future Traffic Data for Highway 99 (Segment D)

| Location | | Annual Average Daily Traffic Volume (vehicles per day) | | Heavy Truck Mix | | Speeds (km/h) | |
|-----------------------------------|------------------|--|-----------------|-----------------|-----------------|-----------------|---------------------|
| Interchange /Segment ¹ | Lanes | Existing (2014) | Forecast (2030) | Existing (2014) | Forecast (2030) | Existing (2014) | Post-Project (2030) |
| Hwy 99/Hwy 17A | NB Off | 4,000 | 5,000 | 5% | 8% | 50 ⁴ | 50 ⁴ |
| | NB On | 18,000 | 25,500 | 2% | 4% | | |
| | SB Off | 18,500 | 23,000 | 1% | 0.5% | | |
| | SB On | 6,000 | 5,000 | 5% | 14% | | |
| Hwy 99/Hwy 17A to Hwy 99/Hwy 17 | NBC ² | 26,000 | 33,000 | 6.5% | 11.5% | 100 | 100 |
| | NBF ² | | | | | | |
| | SBF ³ | 27,500 | 43,000 | 8% | 10% | | |
| | SBC ³ | | | | | | |
| Hwy 99/Hwy17 | NB Off | 3,500 | 5,000 | 3% | 6% | 50 ⁴ | 50 ⁴ |
| | NB On | 7,000 | 6,500 | 15% | 41.5% | | |
| | SB Off | 8,000 | 7,000 | 20% | 38.5% | | |
| | SB On | 3,500 | 4,500 | 8.5% | 9% | | |

Notes

Cells containing a dash “-“ are not part of the current design or are not relevant.

¹ Interchanges and overpass/ underpass structure are shown in **bold** text

² NBC and NBF denote northbound curb, and northbound fast lanes, respectively.

³ SBF and SBC denote southbound fast, and southbound curb lanes, respectively.

⁴ Ramp speed is taken to be the average of the maximum ramp speed of 100 km/, and the minimum of 0 km/h.

Table C6 Existing- and Future Traffic Data for Highway 99 (Segment E)

| Location | | Annual Average Daily Traffic Volume (vehicles per day) | | Heavy Truck Mix | | Speeds (km/h) | |
|---|------------------|--|-----------------|-----------------|-----------------|-----------------|---------------------|
| Interchange/ Segment ¹ | Lanes | Existing (2014) | Forecast (2030) | Existing (2014) | Forecast (2030) | Existing (2014) | Post-Project (2030) |
| Hwy 99/Hwy17 | NB Off | 3,500 | 5,000 | 3% | 6% | 50 ⁴ | 50 ⁴ |
| | NB On | 7,000 | 6,500 | 15% | 41.5% | | |
| | SB Off | 8,000 | 7,000 | 20% | 38.5% | | |
| | SB On | 3,500 | 4,500 | 8.5% | 9% | | |
| Hwy 99/Hwy 17 to Hwy 99/Ladner Trunk Road | NBC ² | 22,500 | 31,500 | 3.5% | 4.5% | 100 | 100 |
| | NBF ² | | | | | | |
| | SBF ³ | 23,000 | 40,500 | 3.5% | 5% | | |
| | SBC ³ | | | | | | |
| Hwy 99/Ladner Trunk Road | NB Off | 2,500 | 2,000 | 0% | 0% | 50 ⁴ | 50 ⁴ |
| | NB On | 4,000 | 7,500 | 2.5% | 5% | | |
| | SB Off | 2,500 | 4,500 | 0% | 2% | | |
| | SB On | 1,500 | 1,500 | 0% | 0% | | |

Notes

Cells containing a dash "-" are not part of the current design or are not relevant.

¹ Interchanges and overpass/ underpass structure are shown in **bold text**

² NBC and NBF denote northbound curb, and northbound fast lanes, respectively.

³ SBF and SBC denote southbound fast, and southbound curb lanes, respectively.

⁴ Ramp speed is taken to be the average of the maximum ramp speed of 100 km/h, and the minimum of 0 km/h.

Table C7 Existing and Future Traffic Data for Highway 99 (Segment F)

| Location | | Annual Average Daily Traffic Volume (vehicles per day) | | Heavy Truck Mix | | Speeds (km/h) | |
|-----------------------------------|------------------|--|-----------------|-----------------|-----------------|-----------------|---------------------|
| Interchange/ Segment ¹ | Lanes | Existing (2014) | Forecast (2030) | Existing (2014) | Forecast (2030) | Existing (2014) | Post-Project (2030) |
| Hwy 99/Ladner Trunk Road | NB Off | 2,500 | 2,000 | 0% | 0% | 50 ⁴ | 50 ⁴ |
| | NB On | 4,000 | 7,500 | 2.5% | 5% | | |
| | SB Off | 2,500 | 4,500 | 0% | 2% | | |
| | SB On | 1,500 | 1,500 | 0% | 0% | | |
| Hwy 99/Main | NBC ² | 21,000 | 26,000 | 3% | 4% | 100 | 100 |
| | NBF ² | | | | | | |
| | SBF ³ | 22,000 | 37,500 | 3.5% | 5% | | |
| | SBC ³ | | | | | | |
| Hwy 99/Hwy 91 | NB Off | 11,500 | 15,500 | - | 9% | 50 ⁴ | 50 ⁴ |
| | NB On | 4,000 | 4,000 | - | 0% | | |
| | SB Off | 5,500 | 6,500 | - | 7.5% | | |
| | SB On | 11,500 | 11,000 | - | 6.5% | | |

Notes

- Cells containing a dash “-” are not part of the current design or are not relevant.
- ¹ Interchanges and overpass/ underpass structure are shown in **bold** text
- ² NBC and NBF denote northbound curb, and northbound fast lanes, respectively.
- ³ SBF and SBC denote southbound fast, and southbound curb lanes, respectively.
- ⁴ Ramp speed is taken to be the average of the maximum ramp speed of 100 km/h, and the minimum of 0 km/h.

Estimating Effects of Level of Service Improvement on Noise Levels

One of the objectives of the Project is improving the level of service provided to drivers. Currently, there is substantial congestion at the northbound and southbound Tunnel portals. The resulting reduced average vehicle speeds result in reduced overall traffic noise emissions. At speeds above about 30 km/h, overall traffic noise emissions decrease steadily with decreasing average vehicle speed by approximately 1.5 dBA per 10 km/h (US FHWA 2004).

Information on the existing level of service was available from three Ministry permanent count stations — one at each of the north and south Tunnel portals, and one just north of Westminster Highway. The data provided included the hourly traffic volumes and hourly speed profiles at Westminster Highway, Steveston Highway, and Highway 17A. This information characterized the diurnal traffic patterns around the Tunnel and permitted the hourly correction to the L_{eq} for traffic volume and speed. In some locations, and for some times of day, the congestion-related reductions in average vehicle speed are as much as 70 to 80 km/h (e.g., existing speeds of 20 to 30 km/h, and posted or free-flowing speeds of 90 to 100 km/h). For a traffic stream containing five per cent heavy trucks ², TNM predicts that traffic noise levels are minimized when average vehicle speed falls into the 30 to 35 km/h range. When speeds drop below 30 km/h, however, TNM predicts that overall noise emissions begin to increase again. The associated increases in noise levels due to the elimination of congestion may, for certain traffic movements at certain hours of the day, be as much as 8 dBA. This assumes that in the assessment horizon year 2030, Highway 99 traffic will be free-flowing and at or near posted speeds throughout the study area.

For noise-sensitive receptors in the vicinity of the new bridge, and for which TNM has been used to predict noise changes related to the Project (see technical volume, **Table 9**), there is no need to correct for the speed-related traffic noise effects described above, since they are addressed directly in the modelling process. Where changes related to the Project have been predicted using the BAM, however, it has been necessary to apply speed-related adjustments to account for the fact that, in the BAM, both existing and future traffic regimes are considered free-flowing, with average vehicle speeds equaling the posted speeds, as indicated in **Tables C2** through **C7**.

To quantify these adjustments, the Ministry's hourly speed profiles were combined with the 24-hour baseline hourly noise levels measured at the noise-sensitive receptor closest to each of the count stations. This process was executed separately for northbound and southbound lanes since the speed profiles for the two travel directions are not symmetrical. This process took into account a 10 dBA penalty for traffic noise between 22:00 and 07:00 hours (defined as nighttime in the 2014 MOTI noise policy) and yielded daily average baseline noise levels (L_{dn}) without the effects of traffic congestion. The BAM was then applied to these adjusted levels to forecast effects of the Project and arrive at the 2030 noise levels in terms of L_{dn} at the representative receptor locations.

² The Project team provided the truck mix data throughout the study area as derived from EMM2 modelling. Existing (2013 with SFPR) truck mixes range from approximately 3.5% to 5%.

ATTACHMENT D

Project Construction Noise

Scope and Description of Project Construction

The construction zone includes sections of the Project that reside within the Ministry right-of-way as summarized in **Table D1**. The scope of construction for the Project includes the components presented in **Table D2**.

Table D1 Project Segments for Construction Noise Modelling

| Project Segments | Station Numbers |
|--|---|
| A - Bridgeport Road to Westminster Highway | 1a, 1, 2, 3, 4a, 4b, 4, 5, 6, and 7a |
| B - Westminster Highway to Steveston Highway | 7, 8, 9, 10, 10a, 10b, 10c, 11, and 13 |
| C -Steveston Highway to Highway 17A | 11a,12, 12a, 14, 15, 15a, 15b, 15c, 16a, 16b, 17, 17a, 17b, 17c, and 18 |
| D - Highway 17A to Highway 17 | 19 |
| E - Highway 17 to Ladner Trunk Road | 20, 21, 22 |
| F – Ladner Trunk Roadto Highway 91 | 20a, 23, 24, 24a |

Table D2 Project Works and Activities that May Generate Atmospheric Noise

| Works | Activities |
|--|---|
| Westminster Highway interchange | Ramp relocation, interchange reconstruction |
| Overpass construction/replacement | Reconstruction |
| Steveston Highway interchange | Ramp relocation, interchange reconstruction |
| North approach ramp (Richmond) to new bridge | Hauling, grading, compacting, paving |
| New bridge | Pile driving, tower construction, deck replacement |
| Tunnel decommissioning | Sediment removal, diesel-powered pumps |
| S. bridge approach/River Road ramp (Delta) | Hauling, grading, compacting, paving |
| Highway 17A interchange | Ramp relocation, interchange reconstruction |
| Highway 99 mainline | Hauling, grading, compacting, paving, line painting |
| Highway 17 interchange | Ramp configuration |

The anticipated conceptual design construction elements and activities include the following:

- New bridge - Fraser River crossing
 - Clear-span bridge – no piers in river
 - Sections of bridge lifted into place from barge
 - Ground improvements required to address soft soils

- Traffic management during construction
- Deas Slough crossing
 - Sections of bridge deck lifted into place - no piers in Deas Slough
 - Ground improvements required to address soft soils
 - Ground improvements on edge of the slough
 - Traffic management during construction
- Tunnel decommissioning once the new bridge is operating
 - Remove sediment, sand and riprap protection layer above the six elements of the Tunnel
 - Remove concrete apron along submerged Tunnel sections
 - Remove sediment beneath the Tunnel elements to install cables
 - Lift the Tunnel elements with pontoons

Other construction activities in proximity to noise-sensitive receptors would occur at the eastward displacement of Highway 99 at Blundell Road, the Steveston Highway overpass and laydown area, and potentially at the Deas Slough barge access.

Construction Noise Model

Since the details of construction schedules and equipment lists will not be available until later in the design process, it has not been possible to conduct a specific assessment of the noise emissions to be expected during the construction phase of the Project. Therefore, in estimating potential construction noise exposures for the Project, a generic construction noise analysis has been adopted that was originally developed for the Sea-to-Sky Highway Improvement Project (STS project) and subsequently employed during the environmental impact assessment phases of the Port Mann Highway 1 and SFPR projects. Estimates based on the STS project have been adjusted according to anticipated construction activities that would apply to this Project.

In estimating potential outdoor noise exposures from major construction activities at noise-sensitive locations, the following factors were taken into account within the generic construction noise model:

- The distance from the construction noise source area to noise-sensitive receptors
- The various major roadway and/or structure construction activities that are expected to take place within each segment of the Project
- The time of day or night and duration (hours per day) of the major activities

- Types and numbers of pieces of heavy equipment anticipated in each major construction activity
- Rated or typical full-power noise emissions for each equipment type (noise level in dBA at a standard reference distance of 15 m)
- Representative usage factors for each equipment type (i.e. proportion of time operating at or near full power)
- Attenuation of construction noise levels with increasing setback distance from the roadway due to several effects (geometric spreading, atmospheric absorption and ground effect attenuation)

The overall equivalent sound levels (L_{eq}) predicted to be generated during active construction periods on the STS project are shown in **Table D3**. Note that the values shown are the average noise levels that would be expected to be produced at various setback distances from an active, 200 m-long construction zone due to the cumulative noise output of all active heavy construction equipment. The levels presented are those that would be expected if the intervening ground was acoustically soft (e.g., grass). **Table D3** may then be used to estimate the ranges of average unmitigated construction noise levels that may be experienced during active construction periods at various noise-sensitive locations within the Project.

The entries in **Table D3** represent the average noise levels that would be measured at the given distances from an active construction zone. These levels would then exist only as long as the construction activities continues. To express potential Project construction noise exposures in terms of daily average levels, such as $L_{eq}(24)$ and L_{dn} , it is necessary to know or assume the normal hours of work. It is assumed that the construction work will be primarily conducted during daytime working hours and that a double day-shift schedule would be followed (i.e., within the hours of 07:00 to 22:00). This would result in, at most, about 14 hours of active construction per day, assuming 0.5 hour per shift for breaks. It has been assumed that there will be a night shift with seven active hours of construction and one hour for breaks. The L_d would then be obtained by adjusting the entries by a factor of -0.3 dBA to account for the lack of any construction noise for one hour of the 15 hours of nominal daytime (i.e., the energy ratio, $10 \cdot \log(15/14) = 0.3$ dBA). The L_n would be obtained by adjusting the entries by a factor of -1.0 dBA to account for the lack of any construction noise for two hours per night (i.e., the energy ratio, $10 \cdot \log(9/7) = 1.0$ dB). The L_{dn} would be calculated by combining the following:

- $L_d - 0.3$ dBA.
- Nighttime $L_{eq}(7 \text{ hours}) + 10$ dBA during active construction.
- Nighttime $L_{eq}(2 \text{ hours}) + 10$ dBA during inactivity.

Table D3 Average (equivalent) construction noise levels outdoors at various setback distances from an active, 200 m-long, construction zone, over soft ground

| Major construction activity | Equivalent Noise Levels (dBA) at Various Setback Distances | | | | | | |
|-----------------------------|--|------|------|-------|-------|-------|-------|
| | 15 m | 30 m | 50 m | 100 m | 200 m | 400 m | 800 m |
| Clearing and grubbing | 82.5 | 78.0 | 74.5 | 69.0 | 60.5 | 51.0 | 39.5 |
| Excavation and hauling | 84.0 | 79.5 | 76.0 | 70.5 | 62.0 | 52.5 | 41.0 |
| Pile-driving | 83.0 | 78.5 | 75.0 | 69.5 | 61.0 | 51.5 | 40.0 |
| Retaining walls/Structures | 80.0 | 75.5 | 72.0 | 66.5 | 58.0 | 48.5 | 37.0 |
| Grading | 82.0 | 77.5 | 74.0 | 68.5 | 60.0 | 50.5 | 39.0 |
| Asphalt paving | 79.0 | 74.5 | 71.0 | 65.5 | 57.0 | 47.5 | 36.0 |

The average construction noise exposures presented in **Table D3** are considered somewhat conservative since they assume construction activities are essentially continuous throughout the working hours. In reality, slowdowns and stoppages in construction activity are likely to occur from time to time. The duration of the various phases of construction will also vary considerably, from a few weeks for clearing, to a few months for grading, to three or four weeks for paving, and approximately two years for the new bridge.

Potential Noise Effects Associated with Interchange Upgrades

The Project will include the general construction activities provided in **Table D3** that would be associated with the upgrading of interchanges in the following locations:

- Blundell Road (Segment B)
- Highway 99/Steveston Highway Interchange (Segment C)

These locations are indicated by a construction zone polygon for the relevant noise sensitive receptor(s).

In addition, at this preliminary stage of the Project, construction sequencing details and optimal routes for the detouring of local traffic around active construction zones have not yet been developed. However, most detouring is expected to occur away from residential areas or be contained within the highway right-of-way.

Pile-driving Noise

During construction of the new bridge, residences within the study area Segment C may be exposed to noise in addition to the levels summarized in **Table D3**. These noise exposures will be associated with bridge foundation and structural activities which, with the exception of for pile

driving, can not be estimated until the construction methods to be employed and construction sequencing details are known.

Pile driving will be carried out in the Bridge construction zone and along the north and south bridge approaches in the following locations:

- North and south of Rice Mill Road
- South shore of Fraser River
- South abutment of the Deas Slough Bridge
- Near the River Woods residential community
- South bound off-ramp at River Road

Where appropriate, these locations are indicated by a construction zone polygon for the relevant noise sensitive receptor(s).

A model was created to predict noise levels (equivalent sound levels during active piling) at noise-sensitive receptors from pile driving impacts. Pile-driving activities were modelled as point sources of sound, and the propagation of pile-driving noise into the community was modelled using the *International Standards Organization 1996, ISO-9613(2), Acoustics - Attenuation of sound during propagation outdoors* (ISO 1996). Pile-driving on the Project is anticipated to involve steel pipe piles driven by a diesel hammer. The sound emission of L_w 132 dBA to be expected from such activities were provided by *Technical Memorandum on the Noise from Percussive Piling*, Hong Kong (EPD 1997). The pile-driving noise source was positioned at the various pile driving sites within the noise model, and the average pile driving noise levels at the relevant noise-sensitive receptors were calculated.

Construction Noise Model Results

The results from the construction noise estimation throughout the entire study area and the pile-driving noise and vibration predictions for the relevant receptor locations adjacent the Tunnel, north approach, and south approach are summarized in **Table D4**. For a given receptor, the ranges of levels correspond to the lowest noise level from the most distant piling site to the highest levels from the closest piling site to the relevant receptor site.

Table D4 Baseline Noise Levels and Construction Noise Levels Estimated at Noise Receptor Sites

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | |
|------------------|---|----------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max |
| | | | | | | min | max | min | max | min | max | | |
| 2 | 22 Capella Garden, 9731 Capella Drive, Richmond, B.C. | Residential | 72.2 | - | 64.5 | 76 | 81 | 71 | 76 | 70 | 75 | - | - |
| 3 | 10168 Caithcart Road, Richmond, B.C. | Residential | 69.7 | - | 61.4 | 70 | 75 | 64 | 69 | 63 | 68 | - | - |
| 4 | 9 Florence Estates, 10411 Hall Avenue, Richmond, B.C. | Residential | 72 | - | 63.8 | 78 | 83 | 72 | 77 | 72 | 77 | - | - |
| 4a | Richmond Estates, 10511, Kilby Drive, Richmond, B.C. | Residential | 70.1 | - | 63 | 77 | 82 | 72 | 77 | 71 | 76 | - | - |
| 4b | 10333 Bryson Drive, Richmond, B.C. | Residential | 68.8 | - | 58.1 | 79 | 84 | 74 | 79 | 73 | 78 | - | - |
| 5 | 4591 Dallyn Road, Richmond, B.C. | Residential | 68.7 | - | 60.8 | 74 | 79 | 68 | 73 | 68 | 73 | - | - |
| 6 | 11600 Dewsbury Drive, Richmond, B.C. | Residential | 74.1 | - | 67.1 | 75 | 80 | 69 | 74 | 69 | 74 | - | - |
| 7 | 12260 Old Westminster Highway, Richmond, B.C. | Residential | 67.0 | 63.7 | 59.9 | 71 | 76 | 66 | 71 | 65 | 70 | - | - |
| 7a | Richmond Nature Park, 11851 Westminster Highway, Richmond, B.C. | Municipal-park | - | 58.0 | - | - | - | 51 | 56 | - | - | - | - |
| 8 | 12250 Old Westminster Highway, Richmond, B.C. | Residential | 64.2 | 61.1 | 56.9 | 69 | 74 | 63 | 68 | 62 | 67 | - | - |
| 9 | 12431 Blundell Road, Richmond, B.C. | Daycare | 72.5 | 66.9 | 65.9 | 74 | 79 | 68 | 73 | 68 | 73 | - | - |
| 9 | 12431 Blundell Road, Richmond, B.C. | Daycare | 70.4 | 67.8 | 62.8 | 74 | 79 | 68 | 73 | 68 | 73 | - | - |
| 10 | 12280 Blundell Road, Richmond, B.C. | Daycare | 67.3 | 64.5 | 59.9 | 73 | 78 | 68 | 73 | 67 | 72 | - | - |
| 10a | Mosque, 12300 Blundell Road, Richmond, B.C. | Worship | - | 71.8 | - | - | - | 71 | 76 | - | - | - | - |
| 10b | School, 12300 Blundell Road Richmond, B.C. | School | - | 71.0 | - | - | - | 69 | 74 | - | - | - | - |
| 10c | Ling Yen Mountain Temple, 10060 No. 5 Road, Richmond, B.C. | Worship | - | 61.7 | - | - | - | 57 | 62 | - | - | - | - |
| 11 | 10640 No. 5 Road, Richmond, B.C. | Residential | 65.7 | 62.6 | 58.3 | 71 | 76 | 65 | 70 | 65 | 70 | - | - |
| 11a | 11551 Dyke Road, Richmond, B.C. | Municipal-park | - | 46.4 | - | - | - | 32 | 37 | - | - | - | - |
| 12 | 12900 Steveston Highway, Richmond, B.C. | Commercial | - | 67.7 | - | - | - | 58 | 63 | - | - | - | - |
| 12a | 13060 Steveston Highway, Richmond, B.C. | Residential | 59.3 | 59.2 | 49.4 | 52 | 57 | 46 | 51 | 46 | 51 | - | - |
| 13 | 103-14100 Riverport Way, Richmond, B.C. | Multi-family | 61.9 | 58.4 | 54.5 | 34 | 39 | 28 | 33 | 28 | 33 | 48 | 52 |
| 14 | 12951 Rice Mill Road, Richmond, B.C. | Residential | 63.1 | 57.5 | 56.5 | 69 | 74 | 63 | 68 | 62 | 67 | 50 | 78 |
| 15 | 12 River Woods, 6105 River Road, Delta, B.C. | Multi-family | 68.4 | 64.2 | 61.5 | 75 | 80 | 69 | 74 | 68 | 73 | 47 | 86 |
| 15a ¹ | Central, Deas Island Regional Park Delta, B.C. | Reg. Park | - | 53.9 | - | - | - | 64 | 69 | - | - | - | - |
| 15b | River Watch, 6251 River Road Delta, B.C. | Multi-family | 59.7 | 56.7 | 52.3 | 59 | 64 | 53 | 58 | 52 | 57 | 52 | 72 |

| Site # | Noise-Sensitive Receptor Location | Land Use | Baseline (2013 - 2014) Noise Levels (dBA) | | | Construction Noise Levels (dBA) | | | | | | Active Pile Driving Noise Level, L_{eq} (dBA) | |
|--------|---|--------------|---|-------|-------|---------------------------------|-----|-------|-----|-------|-----|---|-----|
| | | | L_{dn} | L_d | L_n | L_{dn} | | L_d | | L_n | | min | max |
| | | | | | | min | max | min | max | min | max | | |
| 15c | Town & Country Inn, 6005 Highway 17A, Delta, B.C. | Hotel | 70.1 | 65.6 | 63.2 | 74 | 79 | 68 | 73 | 67 | 72 | 49 | 86 |
| 16 | 37 Woodwards Landing, 5300 Admiral Way, Delta, B.C. | Multi-family | 57.6 | 53.6 | 50.6 | 50 | 55 | 44 | 49 | 43 | 48 | 47 | 61 |
| 17 | 5954 River Road, Delta B.C. | Residential | 67.6 | 64.4 | 60.3 | 70 | 75 | 64 | 69 | 63 | 68 | 52 | 78 |
| 17a | Burr House, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 46.7 | - | - | - | 32 | 37 | - | - | 49 | 52 |
| 16a | East of Parking, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 46.4 | - | - | - | 37 | 42 | - | - | 52 | 57 |
| 17b | First Fork, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 45.9 | - | - | - | 49 | 54 | - | - | 54 | 65 |
| 17c | Second Fork, Deas Island Regional Park, Delta, B.C. | Reg. Park | - | 46.0 | - | - | - | 48 | 53 | - | - | - | - |
| 16b | Captain's Cove Marina, 6100 Ferry Road, Delta, B.C. | Multi-family | 66.8 | 61.8 | 60.1 | 75 | 80 | 69 | 74 | 69 | 74 | 45 | 77 |
| 18 | Ernie Burnett Park, 5400 Ferry Road, Delta, B.C. | Residential | 51.5 | 51.7 | 41.3 | 36 | 41 | 31 | 36 | 30 | 35 | - | - |
| 19 | 5631 64th Street, Delta, B.C. | Residential | 57.4 | 56.3 | 48.7 | 68 | 73 | 62 | 67 | 62 | 67 | - | - |
| 20 | 8640 Ladner Trunk Road, Delta, B.C. | Residential | 67.5 | 65.2 | 59.8 | 71 | 76 | 65 | 70 | 64 | 69 | - | - |
| 20a | 4714 96 Street, Delta, B.C. | Residential | 53.6 | 52.8 | 44.6 | 62 | 67 | 57 | 62 | 56 | 61 | - | - |
| 21 | Delta View Life Enrichment Centre, Delta, B.C. | Multi-family | 75.0 | 71.8 | 67.8 | 78 | 83 | 72 | 77 | 71 | 76 | - | - |
| 22 | Delta View Life Enrichment Centre, Delta, B.C. | Multi-family | 74.5 | 70.4 | 67.4 | 78 | 83 | 72 | 77 | 71 | 76 | - | - |
| 23 | 4779 104th Street, Delta, B.C. | Residential | 69.1 | - | 61.7 | 75 | 80 | 69 | 74 | 69 | 74 | - | - |
| 24 | 4949 112th Street, Delta, B.C. | Residential | 73.7 | - | 67.3 | 70 | 75 | 64 | 69 | 63 | 68 | - | - |
| 24a | 5054 112th Street, Delta, B.C. | Residential | 75.5 | - | 69.7 | 55 | 60 | 49 | 54 | 48 | 53 | - | - |

¹Limited access to the public during construction phase.

**George Massey Tunnel
Replacement Project**



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Ministry of
Transportation
and Infrastructure

Section 16.7

FRASER RIVER SALT WEDGE MODELLING

Technical Volume

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FILE: V13203162

George Massey Tunnel Replacement Project

This report has been produced for the Ministry of Transportation and Infrastructure regarding the George Massey Tunnel Replacement Project.

Subject: Modelling Study to Investigate the Impact of Removal of the George Massey Tunnel on the Salt Wedge [ISSUED FOR USE]

1.0 INTRODUCTION

The potential effect of the proposed removal of the George Massey Tunnel (Tunnel) on the hydrodynamics and the behaviour of the salt wedge in the Fraser River was evaluated using the proprietary three-dimensional hydrodynamic model, H3D.

Two cases were examined in this study: 1) the existing case with the Tunnel in place, and 2) the case without the Tunnel. The top of the Tunnel is at a depth approximately 12-13 m below geodetic datum and is slightly proud of the surrounding river bottom in the deepest part of the channel (Figure 1.1). For these simulations, it is assumed that after the Tunnel is removed or decommissioned, the river bathymetry will return to its natural configuration. Figure 1.2 shows the smoothed bathymetry in the river without the Tunnel, used as the initial case for modelling.

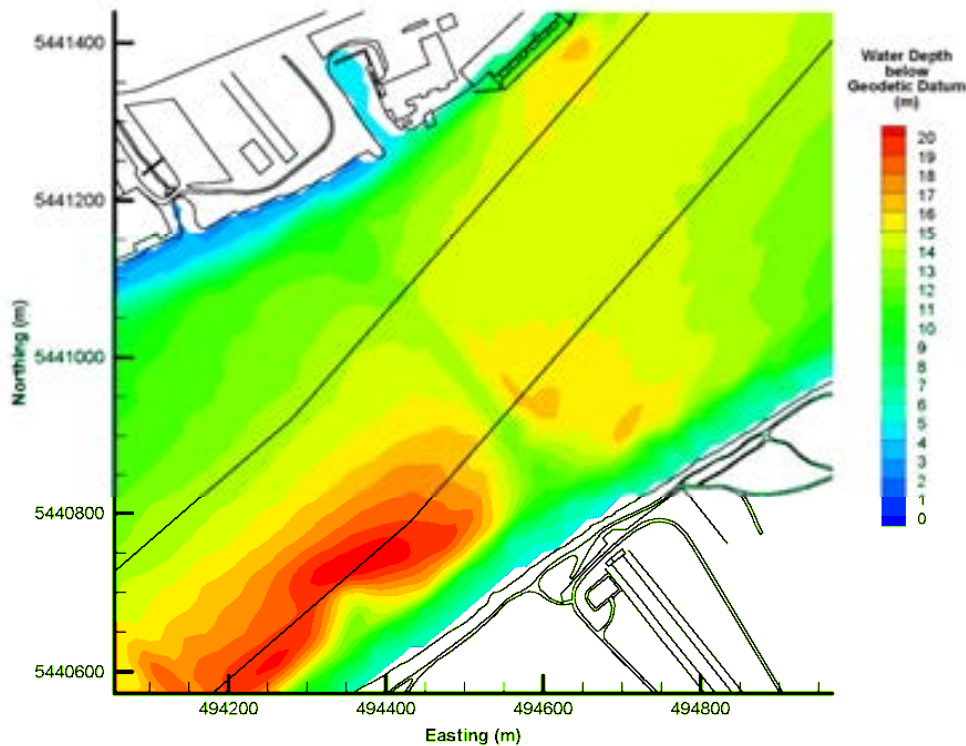


Figure 1.1: Existing Bathymetry near the George Massey Tunnel

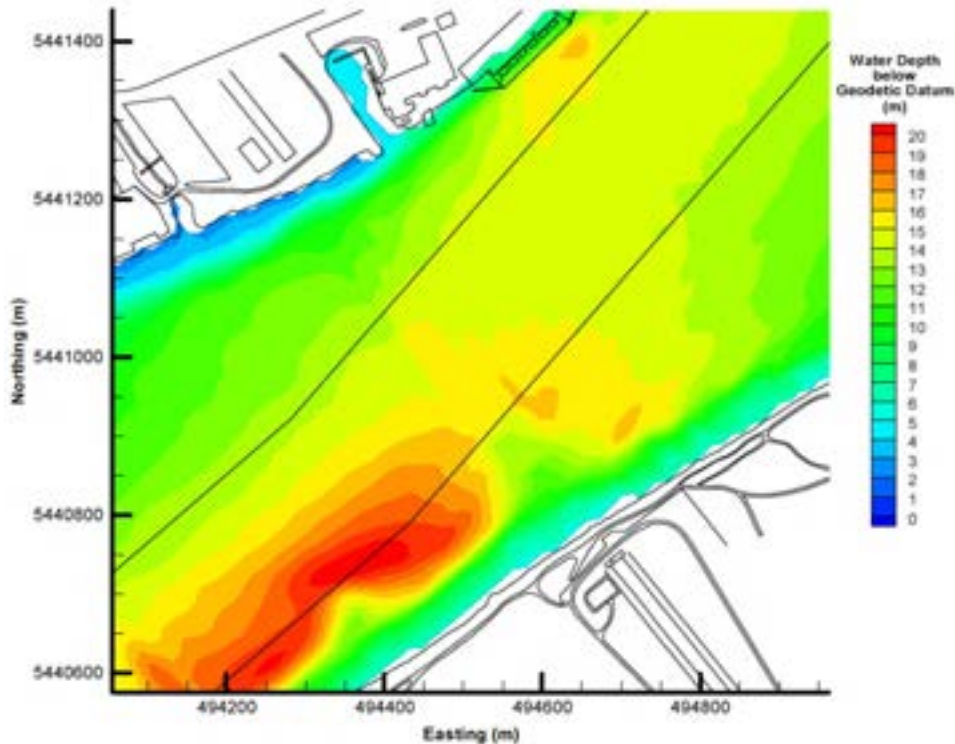


Figure 1.2: “Smoothed” Bathymetry without the Massey Tunnel

The lower reach of the Fraser River is an estuary with outflowing fresh river water on top of the saltier water intruding from the Strait of Georgia at the bottom, thereby forming a salt wedge. The behaviour of the salt wedge strongly depends on the tide and river flow: the salt wedge advances and retreats daily in accordance with the daily tidal pattern, while the seasonally-varying upstream extent of the salt wedge excursion depends on the flow rate in the Fraser River. Tidal characteristics in the river are that at high water, currents in the river are generally small, and become directed in the downstream direction as the water level falls, forming an ebb tide condition. Outflow velocities reach their peak values somewhat before low water, then start to decrease and then change to an up-river, flooding state on the rising tide.

During an ebbing tide, velocities in the river increases until about the time of low water, pushing the salt wedge downstream, and out of the river during high flows. On the other hand, during a flood tide the velocity changes to an upstream flow, offering less resistance to the upstream advancement the salt wedge, thereby allowing the salt wedge to migrate upstream. During the freshet period, the salt wedge retreats offshore of Sand Heads on the ebb tide and advances just past Steveston Island on the flood tide; whereas in the low flow period, it retreats to Steveston Island on the ebb tide, but can advance as far as Annacis Island (Thomson, 1981) on the flood tide.

The main interest regarding the salt wedge as identified by stakeholders is that removal of the Tunnel and the subsequent change of the bathymetry in the vicinity of the Tunnel alignment could provide an easier pathway for the salt wedge to migrate upstream, especially during low flow periods, and thereby reduce the period of time when low-salinity water is available for irrigation purposes. At present, the water intake of greatest interest, located just upstream of Tilbury Island, withdraws water from the Fraser River to supply nearby farmlands for agriculture and harvesting purposes, but only operates in the time windows during which the salt wedge is located sufficiently downstream from the intake location that the water being withdrawn meets an appropriate salinity criterion. Salinity

sensitivity in crops, expressed in terms of conductivity, starts at approximately 700 microsiemens per centimeter, or 700 $\mu\text{S}/\text{cm}$ and the salinity sensor at the No.6 Road pump station was set at 500 $\mu\text{S}/\text{cm}$ (from an article by Matthew Burrows). Water with salinity higher than the criterion value has the potential to cause damage to agricultural products and soil where it is applicable. In this study, the conductivity criterion value of 400 $\mu\text{S}/\text{cm}$ (0.34 parts per thousand (ppt) salinity) is used which is the threshold value for cranberry irrigation.

This report first presents the numerical model, and then provides validation data, based on a comparison of computed salinities versus those collected by a sensor at the intake.

Then key salinity parameters, include salinity levels, location of the salt wedge toe, and daily periods of water suitable for irrigation, with and without the Tunnel in place, are then extracted from model output and compared, in order to quantify the effect of removal of the Tunnel.

2.0 HYDRODYNAMIC MODELLING

2.1 Hydrodynamic Circulation Model

A detailed technical description of H3D is attached in Appendix A. The following is a brief summary.

H3D is a three-dimensional time-stepping numerical model which computes the three components of velocity (u, v, w) on a regular grid in three dimensions (x, y, z), as well as scalar fields such as salinity, temperature and contaminant concentrations. The model uses the Arakawa C-grid (Arakawa and Lamb, 1977) in space, and uses a two level semi-implicit scheme in the time domain.

H3D is an implementation of the numerical model developed by Backhaus (1983; 1985) which has had numerous applications to the European continental shelf, (Duwe et al., 1983; Backhaus and Meir Reimer, 1983), Arctic waters (Kampf and Backhaus, 1999; Backhaus and Kampf, 1999) and deep estuarine waters, (Stronach et al., 1993). Locally, H3D has been used to model the temperature structure of Okanagan Lake (Stronach et al., 2002), the transport of scalar contaminants in Okanagan Lake, (Wang and Stronach, 2005), sediment movement and scour / deposition in the Fraser River (published document), circulation and wave propagation in Seymour and Capilano dams, and salinity movement in the lower Fraser River. H3D forms the basis of the model developed by Saucier and co-workers for the Gulf of St. Lawrence (Saucier et al., 2003), and has been applied to the Gulf of Mexico (Rego et al., 2010).

2.2 Model Implementation

Study of the details of the hydrodynamics requires model nesting to better resolve small scale processes at and near the location of interest. The model used for this study operates in a double-nested configuration, shown in Figure 2.1.

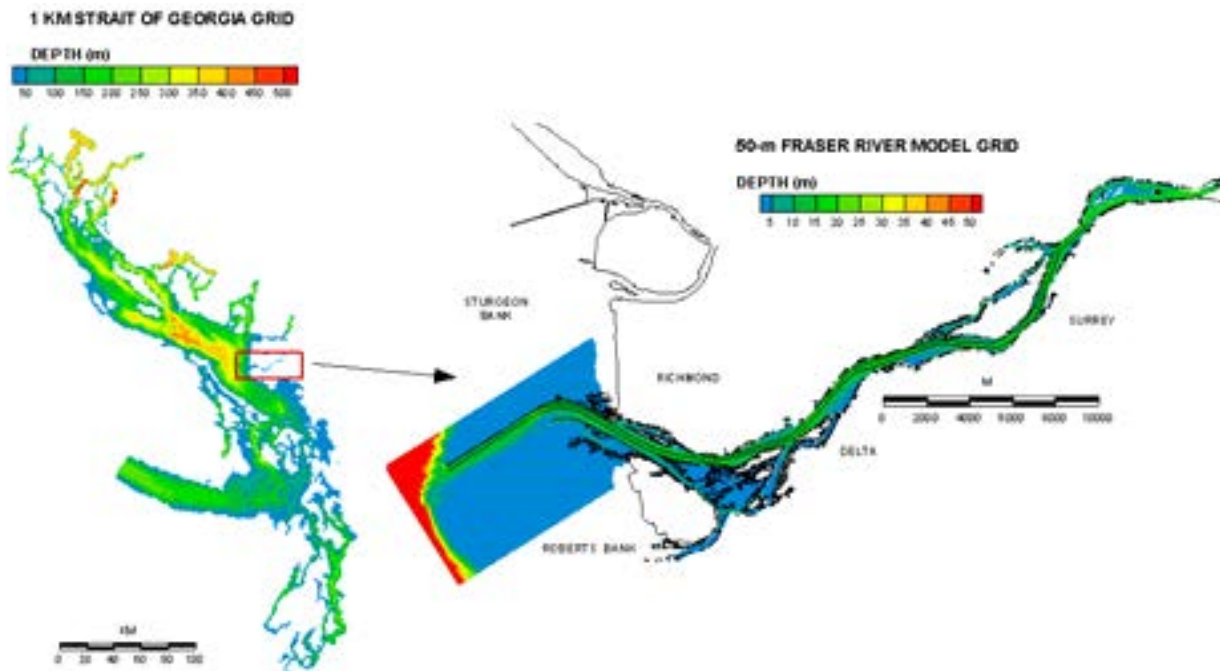


Figure 2.1: Model Nesting of Strait of Georgia and Fraser River Grids

The investigation of the behaviour of the salt wedge is done with a nominally 50-m resolution curvilinear model that spans the lower 41 km of the Fraser River, from Sand Heads to Port Mann Bridge. The model uses 50 m resolution in the along-channel direction, and 20 m in the cross-channel direction. This 50-m resolution model is in turn embedded within a nominally 1-km resolution model of the entire Strait of Georgia (SOG).

Both models simulate tidal, wind-driven and density-driven currents. Water level, velocity components and any scalar quantities output from the coarse grid model are passed on along the boundaries of the fine grid model and used to drive the finer-scale implementation of H3D. The fine-grid implementation provides the details of the effect of small-scale spatial variability in shorelines, depths and structures such as the tunnel cover.

The 1-km SOG model, driven by wind and density as well as tidal conditions along its open boundaries bordering the northern entrance to the Strait of Georgia and the western entrances to Juan de Fuca Strait includes a coarse representation of the Fraser River, extending upstream to km 41, with separate channels for the North Arm, the South Arm and Canoe Pass. At km 41, upstream of all salt wedge penetration, the model is dynamically coupled to a one-dimensional model of the Fraser River, extending to Hope. Tidal conditions are specified along the open boundaries of the 1-km SOG model.

The 50-m lower Fraser River model is driven at its upstream end by a flow boundary condition provided by the same dynamically-coupled one-dimensional model of the Fraser River that was also used for the 1-km model. At the downstream end, water levels and density profiles are obtained from the 1-km grid model, spatially interpolated from those cells of the 1-km grid model that correspond to the boundaries of the lower Fraser model.

The year 2011 was chosen for the modelling study as this is the year when bathymetry data collected from a bank-to-bank survey, from which the 50-m Fraser River model grid was constructed, is available; thus, the Fraser River flow rate in 2011 was used to drive the upstream boundary of the river model. The flow rate at the upstream boundary of the model is the combination of the flow rate at Hope and the estimated runoffs that report to the river downstream of Hope and upstream of Port Mann Bridge. Figure 2.2 shows the river flow rate at Hope in the year 2011. The model was run through the latter part of the fall season and beginning of winter season, from

November to January, when the flow rate at the Fraser River is low and the ability to withdraw freshwater from the river for harvesting is critical.

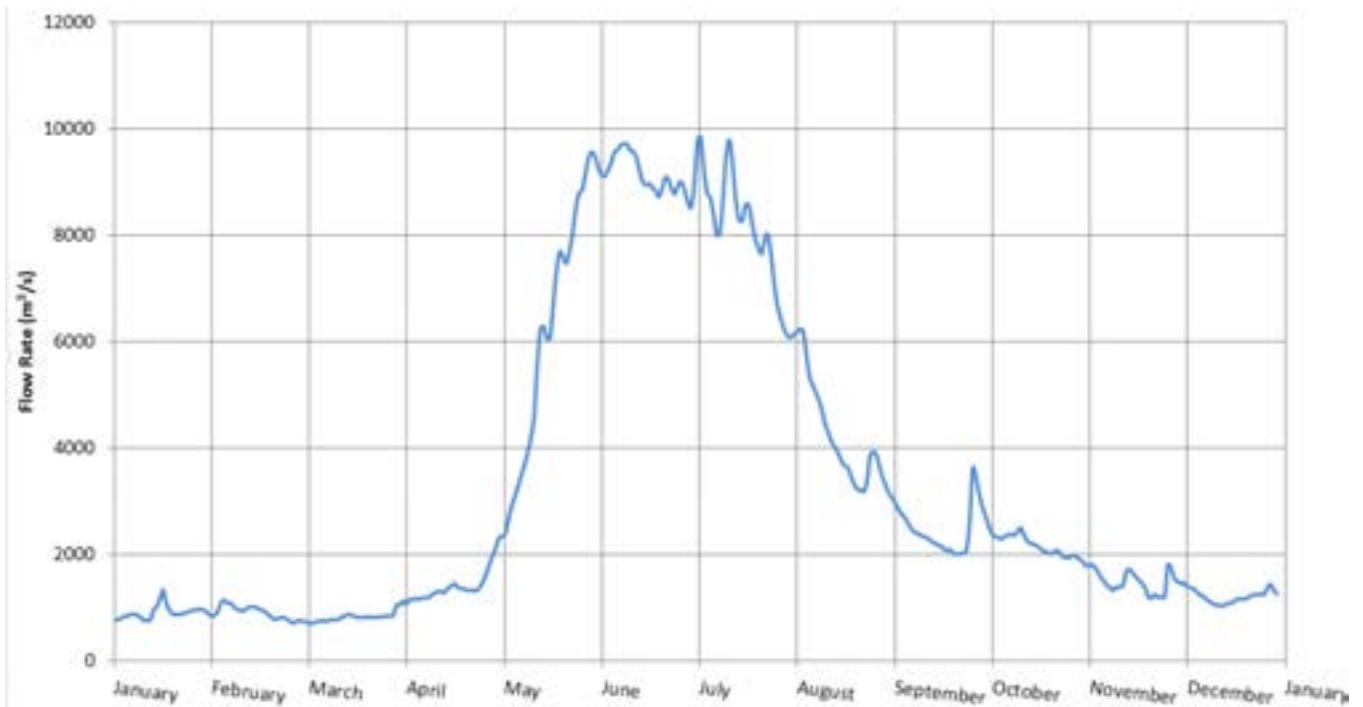


Figure 2.2: Fraser River Flow Rate at Hope in 2011

2.3 Model Validation

The model is validated against water level recorded at New Westminster, and against salinity data collected by a sensor installed at the intake near 8081 River Road, Delta. Data from a sensor that was mounted at 2 m depth from a floating platform is used for the comparison. Figure 2.3 shows comparison of salinity between observed and modelled values from November 3rd to 23rd. Also included in the figure are observed and modelled water levels for the same time period. Black lines show modelled values and red lines show observed values. Since the conductivity sensor cuts off at 5,500 $\mu\text{S}/\text{cm}$, the model results were similarly cut-off to facilitate comparison.

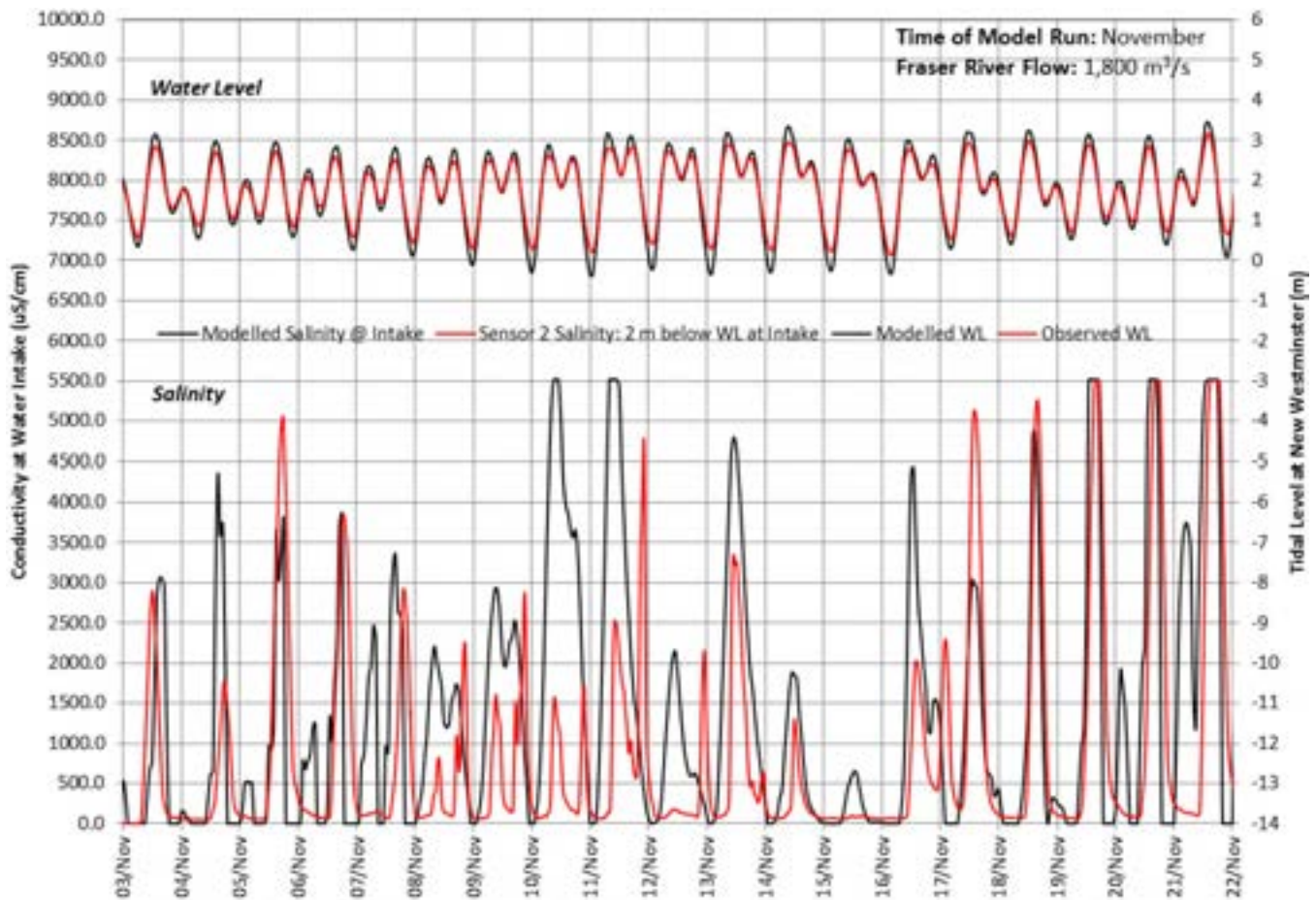


Figure 2.3: Comparison of Observed and Modelled Water Level and Salinity in the Fraser River

The model generally performs well predicting the trend of salinity and its variability on a daily time scale. In fact, the modelled salinities are frequently higher than observed, indicating that the model is conservative: it will under-predict the availability of water suitable for irrigation. However, the water intake is situated in a shallow area where complex processes controlling the movement of stratified flow might have contributed to the observed high variability and, sometimes, unpredictability in salinity at the intake. For example, the model almost always predicts an elevation of salinity during high tides when river flow is comparatively slower and water level in the river higher (for example, on November 7th); however, the sensor at the intake did not always detect such a salinity signal.

This behaviour can be partly understood by considering Figure 2.4, showing the map of salinity at the 2-m depth, on Nov 11 at 7 am, where the modelled result appears to deviate the most from the observed value. It can be seen that there is a high degree of spatial variability in the salinity field (at 2 m depth) in the vicinity of the intake. Salinity can vary from 3.5 ppt (4,500 $\mu\text{S/cm}$) to more than 5.0 ppt (6,500 $\mu\text{S/cm}$) near the intake in a matter of metres. Further analysis of model output demonstrates that there are two mechanisms for saline water to intrude onto the relatively shallow shelf on which the intake is located: either a selective withdrawal process, whereby saltier water is drawn up onto the bench from the adjacent deeper water (on both ebb and flood), or a process whereby the toe of the salt wedge rises to the surface upstream of the bench and then falls back partially onto the bench on the ebb tide.

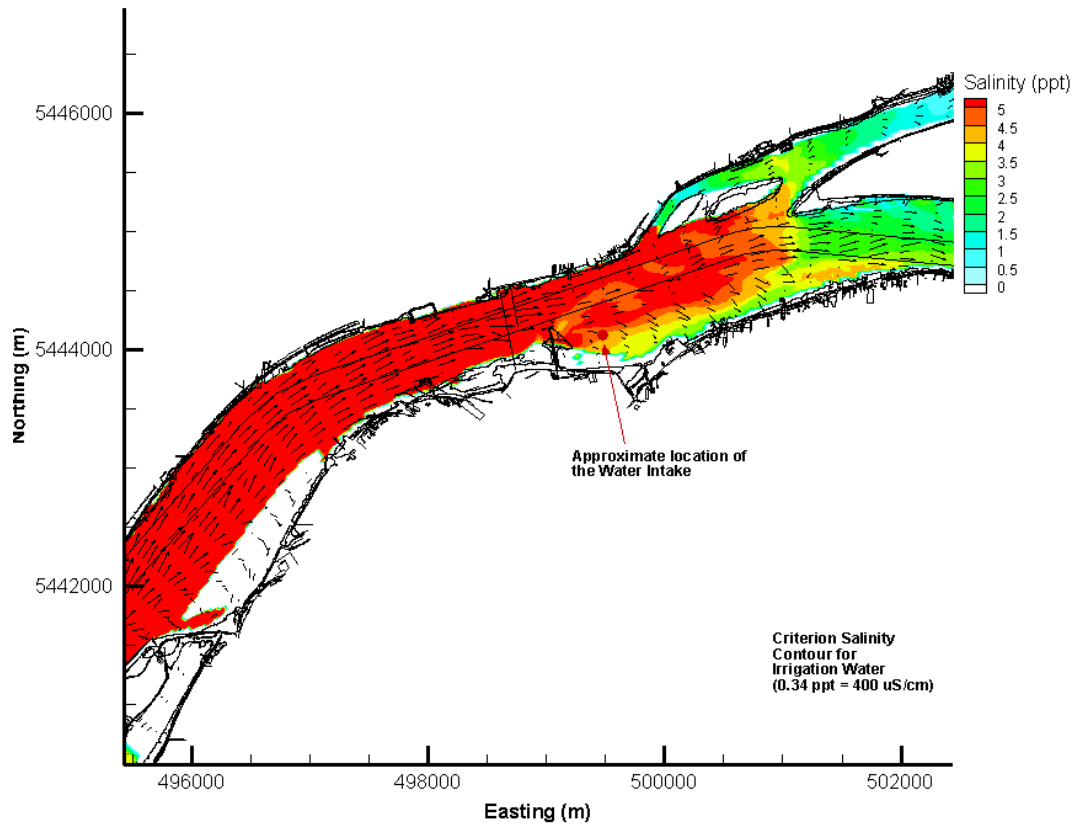


Figure 2.4: Snapshot of Salinity Contour at Intake Depth of 2m on November 11 at 7 am

Beside direct comparison of observed and modelled salinity, model validation can be considered from the perspective of water availability, which describes the onset and offset of salinity intrusion at the water intake and the time window within which river water can be safely withdrawn under the criterion salinity value of 0.35 ppt or 400 $\mu\text{S}/\text{cm}$. Figure 2.5 below compares the observed and modelled number of available hours per running 24 hours. The red line represents the observation and the black line represents the model results. The model, even though more conservative in general, was able to predict the overall trend in availability. Only a short period of record is presented, to facilitate visual comparison.

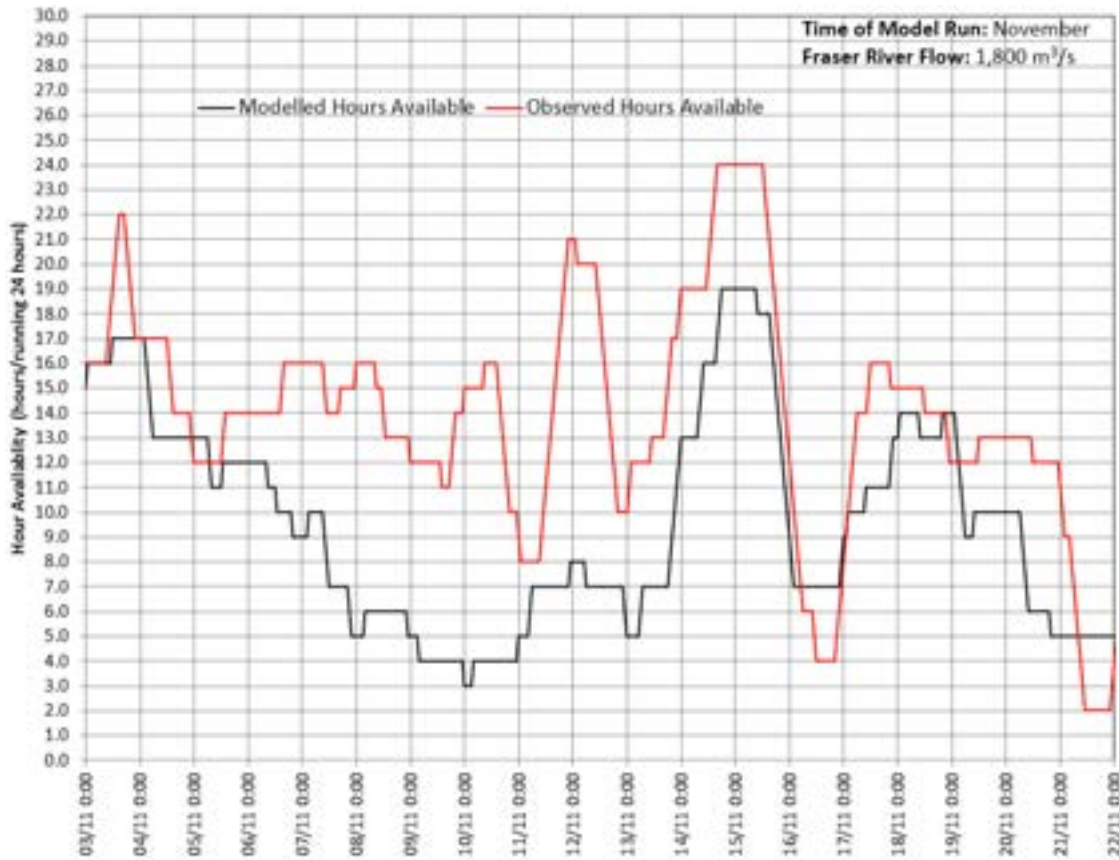


Figure 2.4: Comparison of Modelled and Observed Available Water Withdrawal Hours in November

The model, even though more conservative in general, was able to predict the overall trend in availability. The average number of hours available for water withdrawal in November is 14 hours per day based on observed salinity data, and 10 hours per day for the modelled case.

3.0 IMPACT OF TUNNEL REMOVAL

The hydrodynamic model simulations were run for the cases with and without the Tunnel. Although the model simulations presented in Section 2 did not always agree in detail with observations, the general characteristics are well-reproduced, and it is assumed that the differences in river hydrodynamics, with and without the Tunnel, will be captured by the model.

The effects of the absence of the Tunnel on the advancement of the salt wedge and on the salinity of the river water at the intake were assessed by comparing time-series of the salinity values at the water intake, as well as by comparing maps of salinity contours near the project location in the Fraser River. In this study, the focus is on the salt wedge behaviour during high tide periods, when the salt wedge migrates the furthest upstream.

This study focuses on the period between November and January during which the river flow decreases to a point where the salt wedge begins to exert effects on salinity in the water at the intake. The salt wedge remains mostly downstream of the Tunnel until November when the flow rate in the Fraser River drops to below 2,000 m³/s. The effects of the salt wedge become apparent during flood tide when the water level in the river is increasing and the flow speed is decreasing. Figure 3.1 shows the model results in terms of a time-series of salinity in mid-November at the intake. The black line represents the salinity at the intake for the case with Tunnel, and the green line

represents the case without the Tunnel, while the dotted blue line represents the salinity criterion for irrigation at 0.34 ppt(400 μ S/cm). Note the salinity difference between the two cases ranges between -0.1 ppt and 0.38 ppt, and, for most of the time, the absolute difference is less than 0.15 ppt.

The model was run continuously from November to January. Model results over only several tidal cycles were shown in the figures, however, to better illustrate visually the minute difference in the modelled salinity between the cases with and without the tunnel during the time of interest.

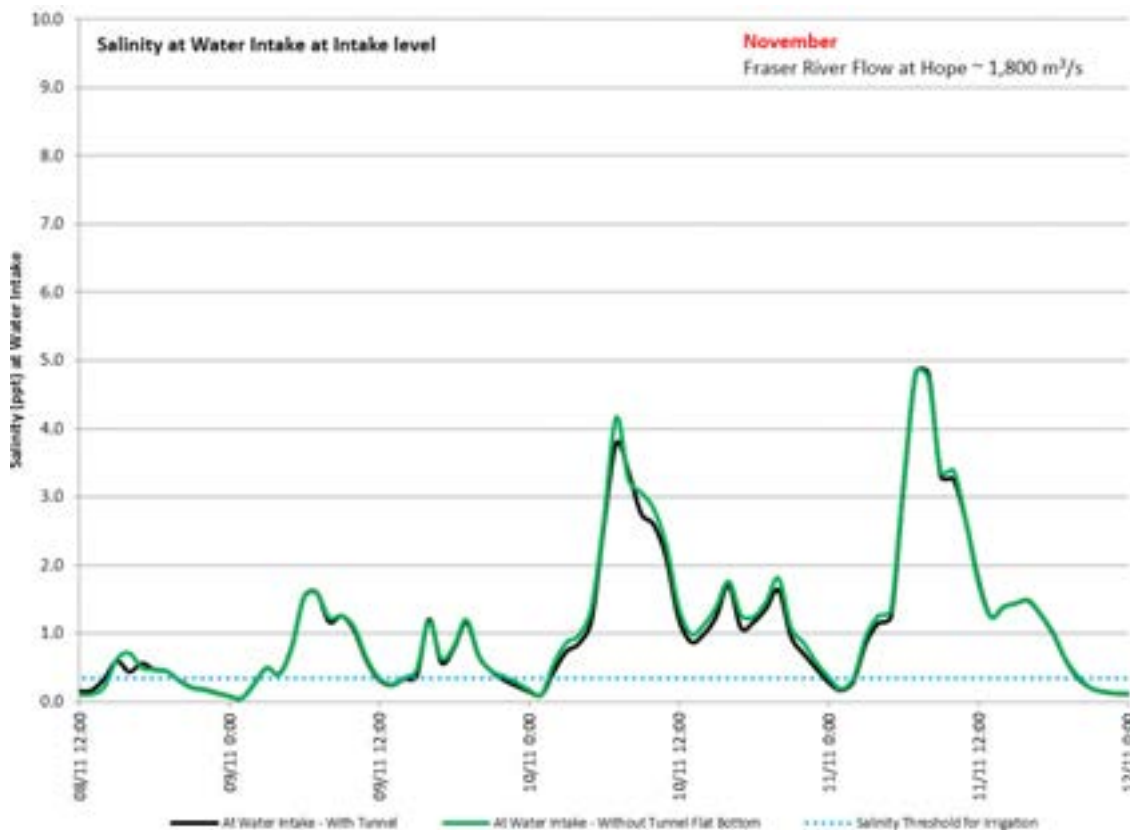


Figure 3.1: Modelled Intake Level Salinity at the Water Intake – November

Importantly, the modelling shows that at the location of the water intake, there is small difference between the salinity behaviour, in relative to the total salinity signal, with or without the Tunnel. The Root Mean Square (RMS) for the salinity signal is 1.36 ppt(1,760 μ S/cm), while the RMS of the salinity difference between the two cases is 0.11 ppt(143 μ S/cm), representing approximate 8% of the total salinity signal. The difference in salinity is greatest when salinities are high, and the water is unsuitable for irrigation.

Figure 3.2 shows, for the with-Tunnel case, a contour map of the salinity at the depth of the intake in the reach from the Tunnel to the water intake on November 13, 10 am during a high tide. Also included in the figure is an inset graph with the predicted (green line) and observed (black line) water levels at New Westminster; the blue and red lines represent the record high (4.66 m above CD) and low (0.42 m below CD) water levels measured at the location. Figure 3.3 shows the corresponding longitudinal sectional plot of salinity from Sand Heads (Km 0) to Annacis Island (Km 28). Figure 3.3 illustrates the upstream advance of the saline water, and that, consistent with Figure 3.2, surface salinities are around 2-3 ppt at the intake. Similarly, Figures 3.4 and 3.5 show the salinity contours for the without-Tunnel case. Figure 3.6 illustrates the two sets of plan view contours overlaid on one another to better illustrate the effect of the Tunnel removal on the salt wedge.

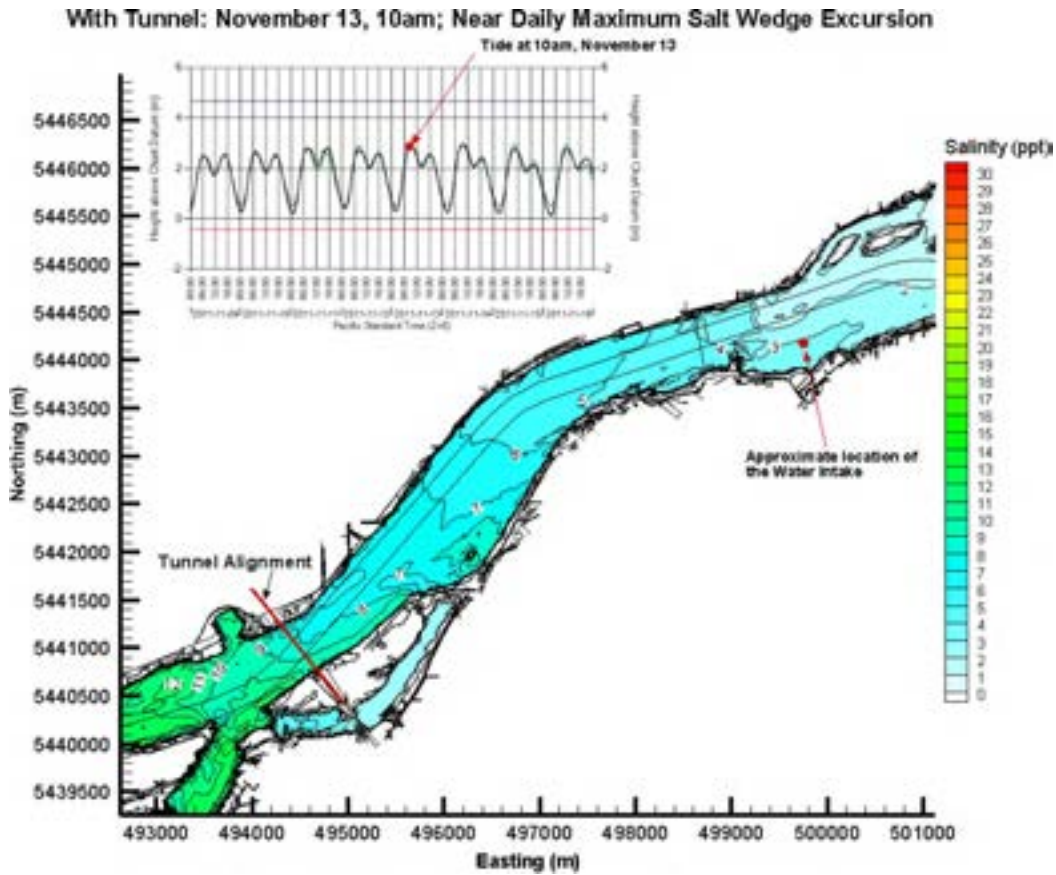


Figure 3.2: With Tunnel: Salinity Contour at Intake Level at High Tide, Nov 13, 2011 10:00 am

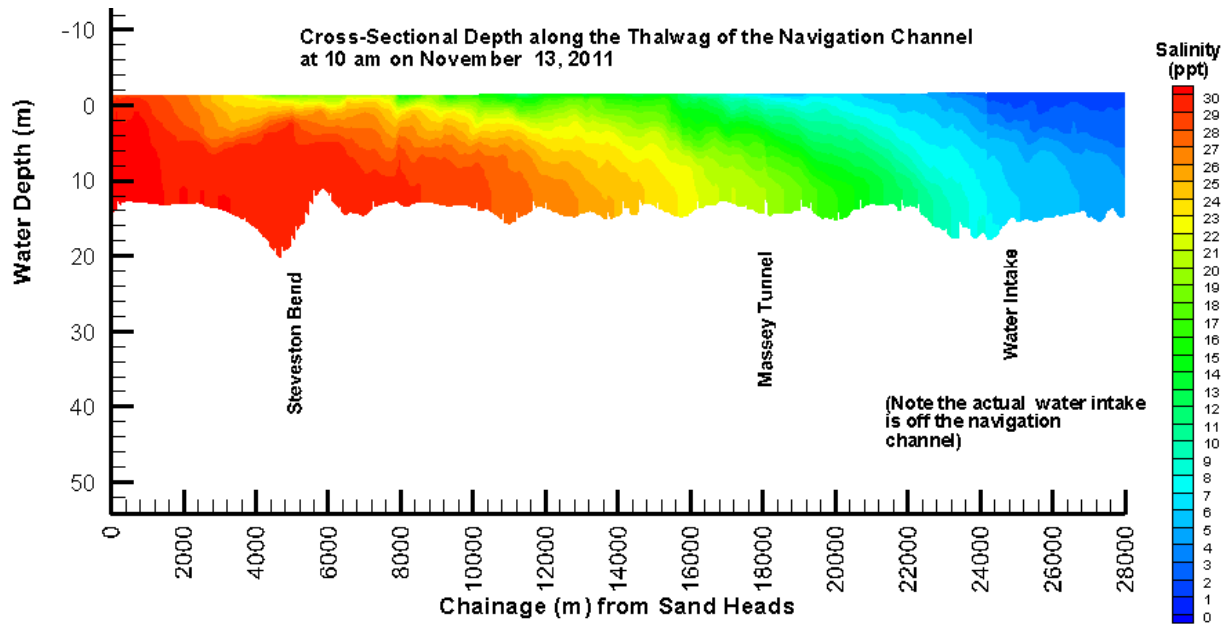


Figure 3.3: With Tunnel: Along-channel Salinity Contour at High Tide, Nov 13, 2011 10:00 am

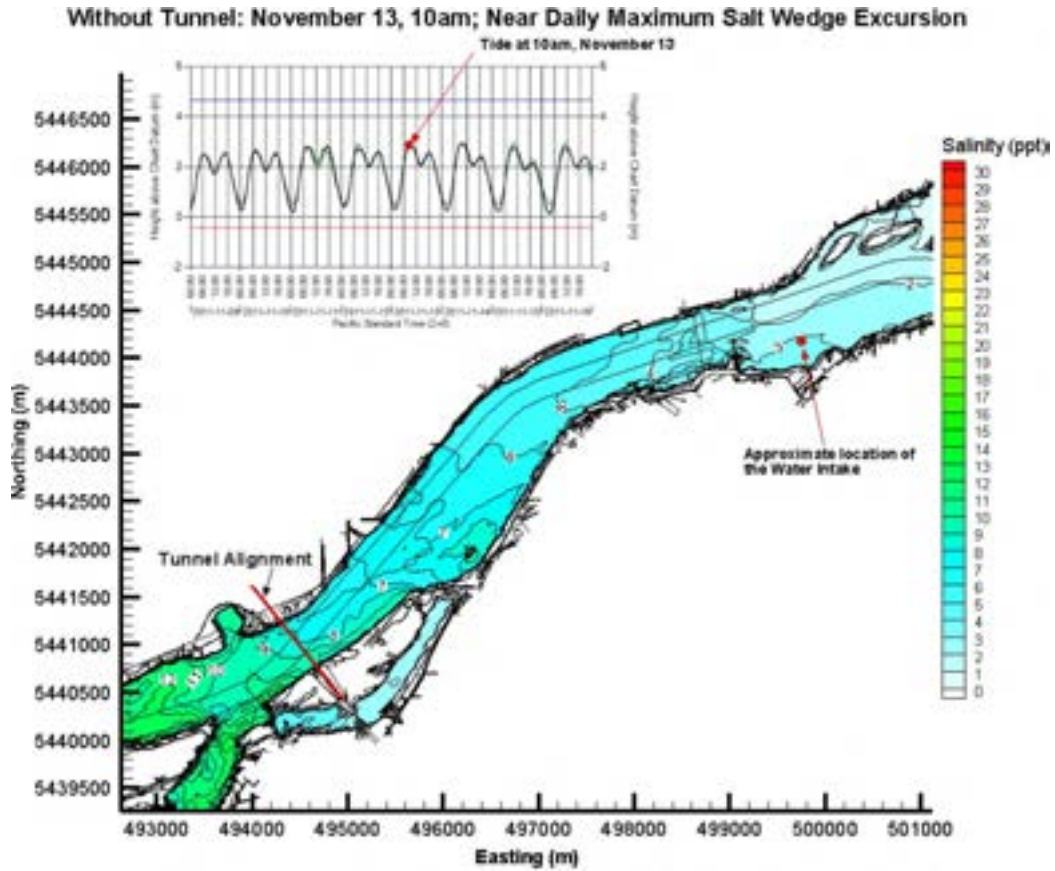


Figure 3.4: Without Tunnel: Salinity Contour at Intake Level at High Tide, Nov 13, 2011 10:00 am

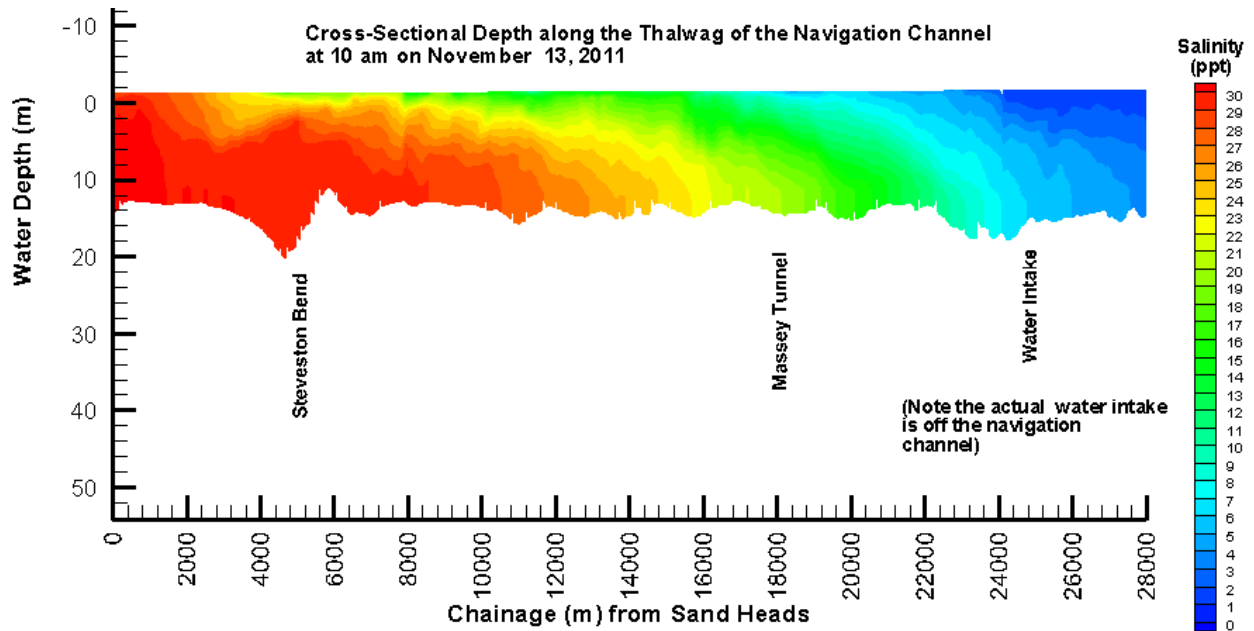


Figure 3.5: Without Tunnel: Along-channel Salinity Contour at High Tide, Nov 13, 2011 10:00 am

November 13, 10am; Near Daily Maximum Salt Wedge Excursion; Flow Rate = 1,800 m³/s

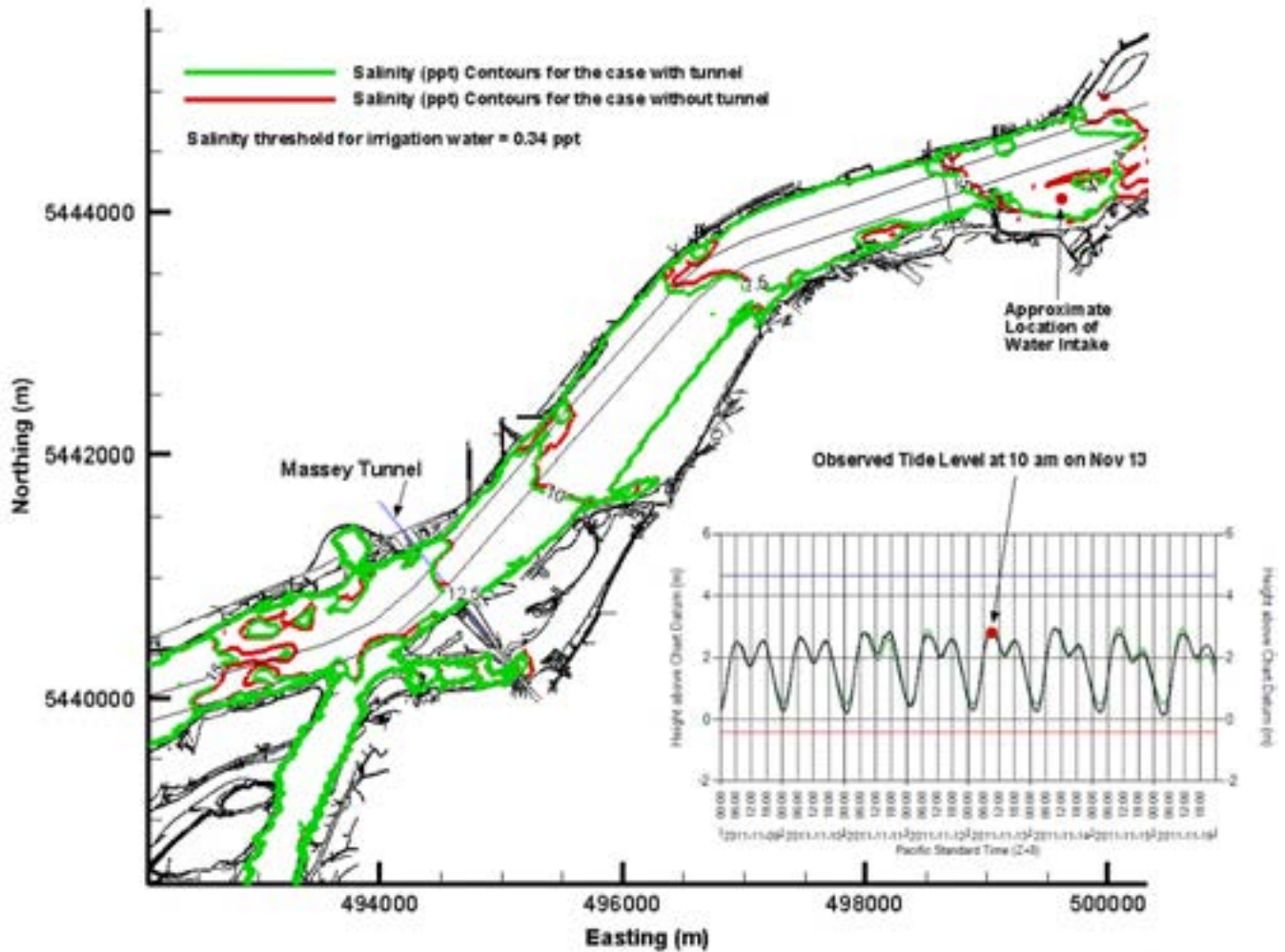


Figure 3.6: Overlaid Salinity Contours at Intake Level at High Tide, Nov 13, 2011 10:00 am

Figure 3.6 clearly indicates that the difference in the salt wedge behaviour between the two cases is generally small. The salt wedge without the Tunnel advances slightly further than in the case when the Tunnel is in place. The difference in salinity diminishes from downstream to upstream and there is only small difference in salinity at the location of the water intake (as illustrated in Figure 3.1).

Figures 3.7 and Figures 3.8 show similar time-series graphs for salinity at the water intake, but in December and January, respectively. Figure 3.9 and Figure 3.10 illustrate the overlaid salinity contour plots for December and January, respectively.

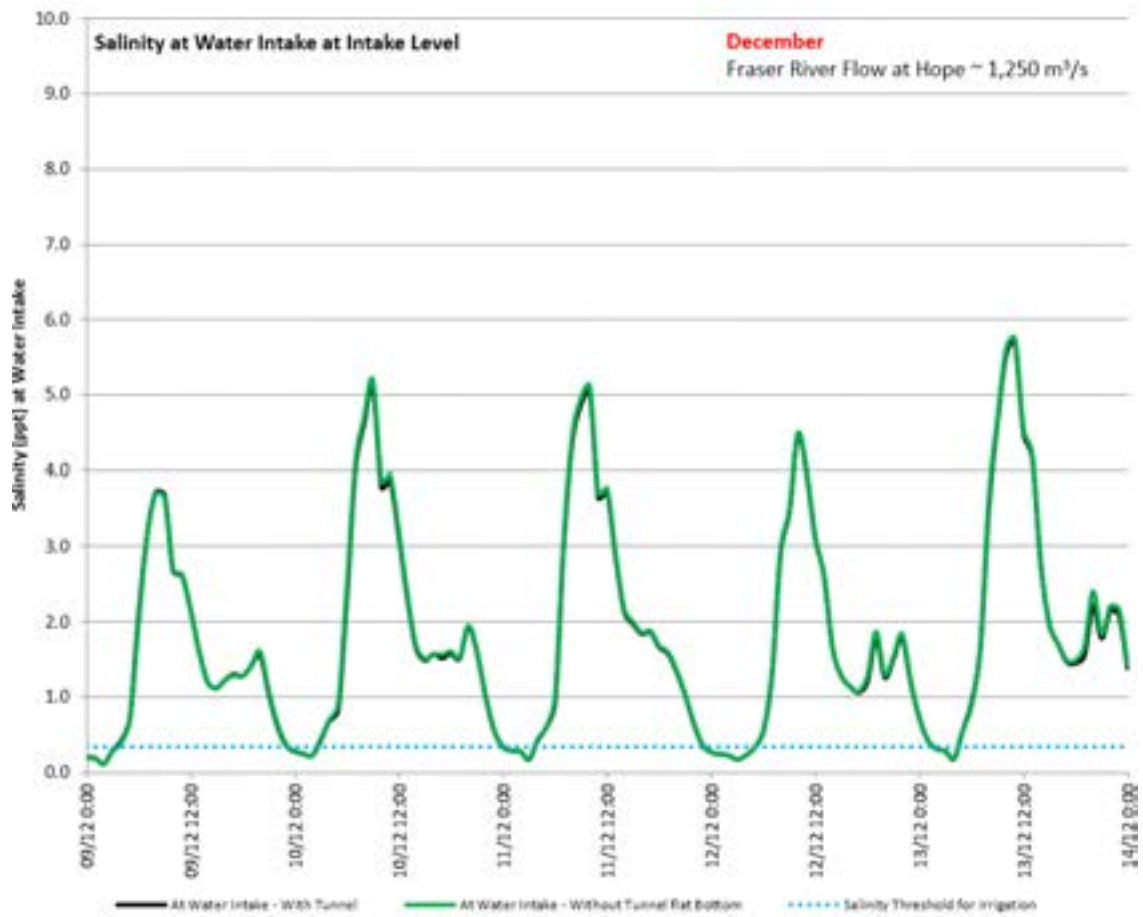


Figure 3.7: Modelled Intake Level Salinity at the Water Intake – December

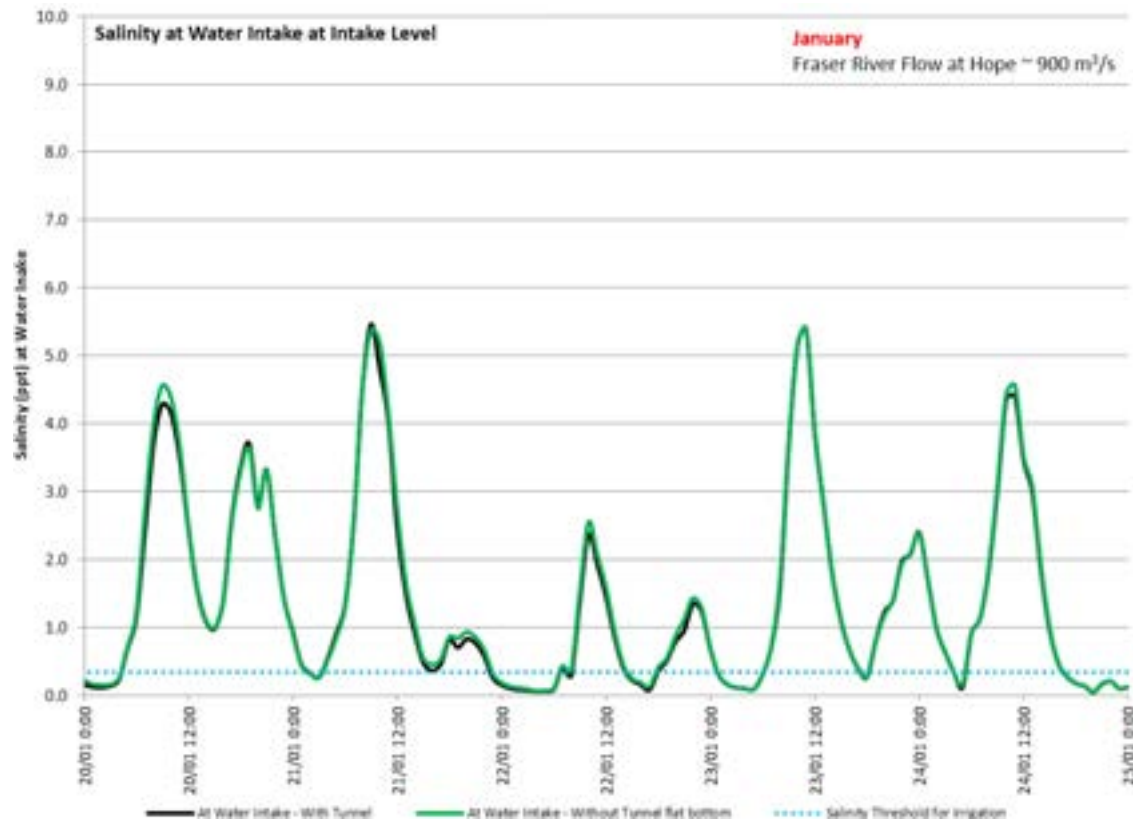


Figure 3.8: Time Series Modelled Salinity at the Water Intake – January

Figures 3.7 and 3.8 indicate that, similar to November, the difference in salinity is insignificant at the intake between the cases with and without the Tunnel. The RMS of the salinity difference is 0.04 ppt (57 $\mu\text{s/cm}$) for December, while the corresponding RMS for the salinity signal is 2.27 ppt (2,930 $\mu\text{s/cm}$), representing less than 2% of the total signal.

For January, the RMS of the salinity difference is 0.20 ppt (259 $\mu\text{S/cm}$), while the corresponding RMS for the salinity signal is 1.70 ppt or 2,200 $\mu\text{s/cm}$, representing approximately 12% of the total signal. The difference in salinity is rather large compared to the total signal; however, the largest salinity difference occurs during high tides when salinity reaches its peak, and the water is unsuitable for irrigation. Salinity, for the most part, remains very similar between the two cases. The difference in peak salinity value and the time window within which the salinity value exceeds the criterion salinity value is also insignificant.

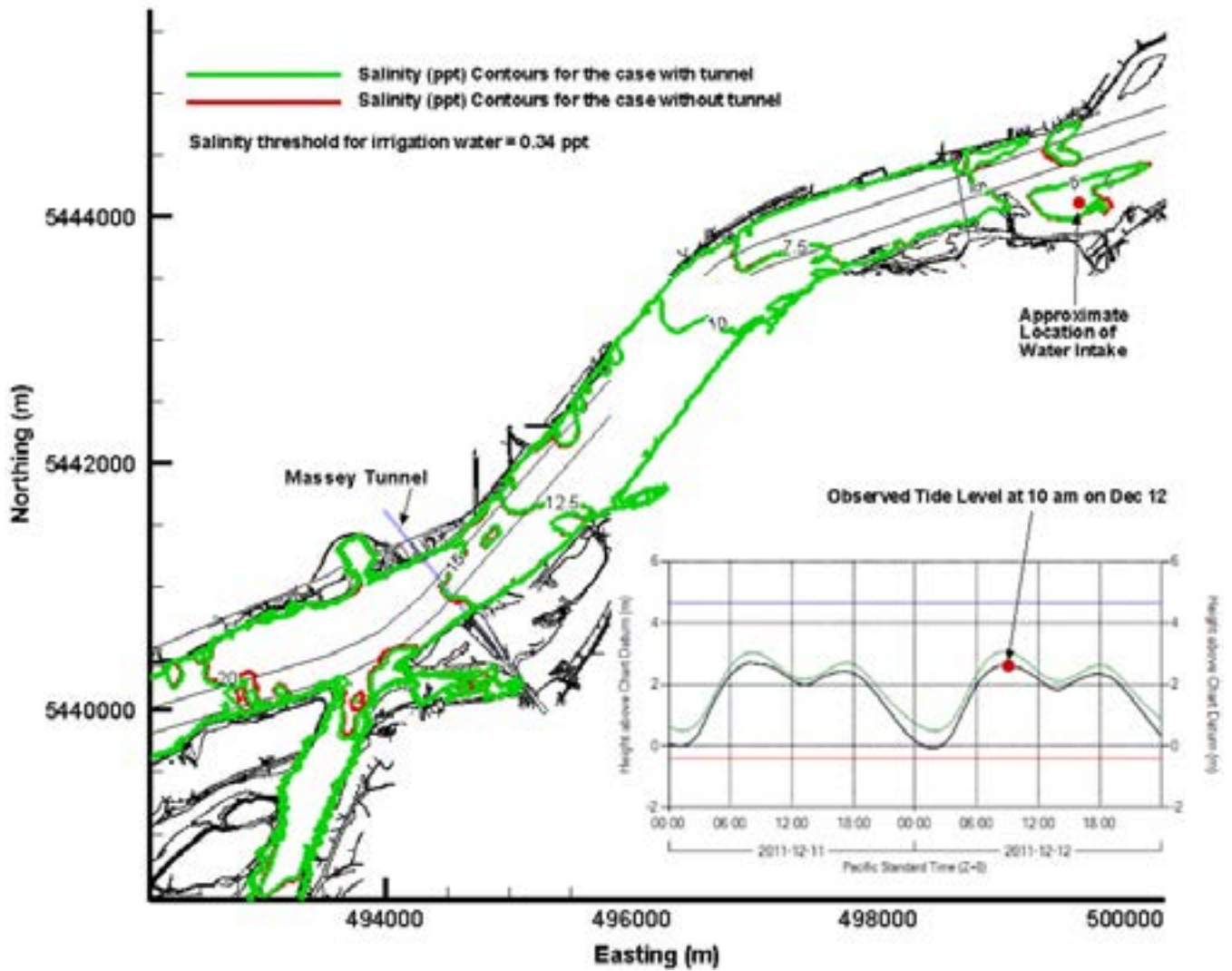


Figure 3.9: Overlaid Salinity Contours at Intake Level High Tide, December 12, 2011 10:00 am

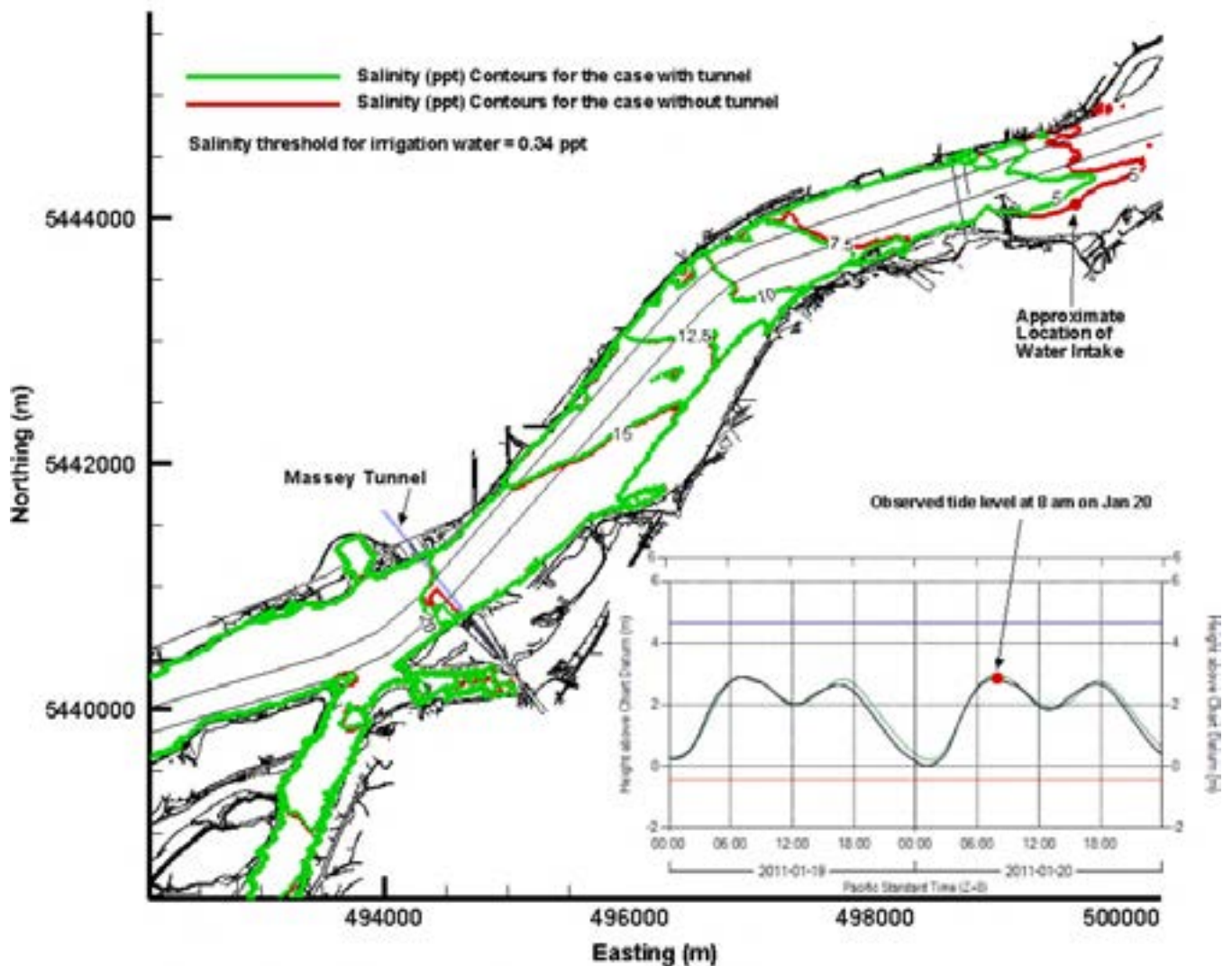


Figure 3.10: Overlaid Salinity Contours at Intake Level at High Tide, January 20, 2011 8:00 am

Figures 3.9 and 3.10 show that the extent of the salt wedge, as in November, behaves similarly between the cases with and without the Tunnel as can be seen by the largely overlapping salinity contours; the model does indicate a further advancement of the salt wedge when the Tunnel is removed as salinity contours can be found at locations mostly less than 50 m upstream in the case without the Tunnel

The small difference in the behaviour of the salt wedge in the pre- and post-removal cases is not unexpected. In the deepest part of the channel in which the salt wedge travels, the cross-channel ridge along the Tunnel alignment bounded by upstream and downstream scour degradation gives the impression that the Tunnel is proud of the surrounding river bottom to a similar height as that of the dynamic sand dunes formed in this part of the river. Figure 3.11 is a graphical excerpt from a 1995 report by Hay & Company (Hayco, 1995), showing the along-channel river bottom from the bathymetry survey in June of 1989 upstream of the tunnel (Massey Tunnel at km 18) and downstream of the intake at 8081 River Road (Intake at km 24). The x-axis is chainage distance measured from Sand Heads and y-axis is water depth. The natural variability of the river bottom in this area is a similar magnitude of, if not bigger than, the bottom associated with the presence of the Tunnel.

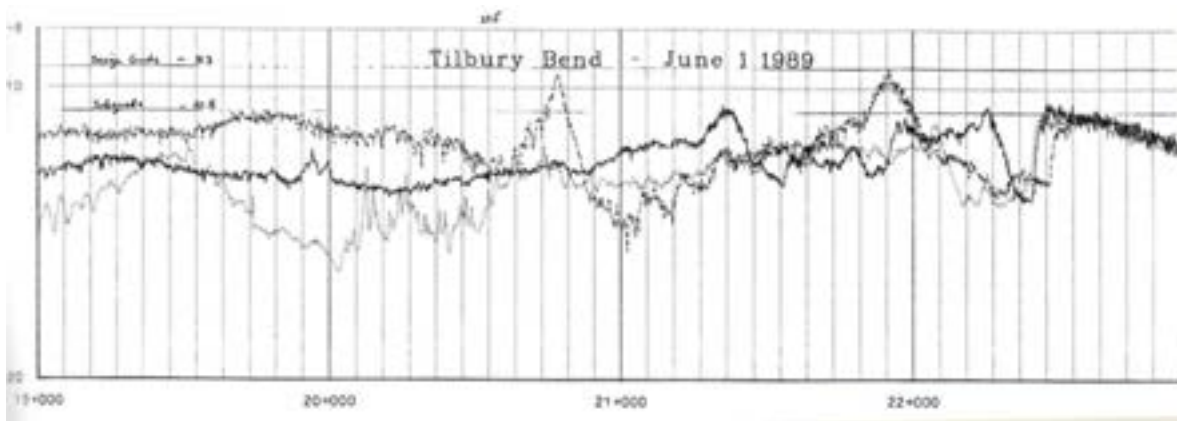


Figure 3.11: Bathymetry of Fraser River at Tilbury Bend upstream of the Tunnel (km 18) and downstream of the Intake (km 24) in June 1989

The river bottom along the Tunnel alignment, although not a migrating feature like dunes on the river bed, can be seen as one of these bottom elements in the river and thus, if considered individually, plays a very minor role in dictating the overall salt wedge behaviour.

4.0 CONCLUSIONS

The effects of the Tunnel removal on the hydrodynamics and salt wedge are summarized as follows:

- The proposed removal of the Tunnel will not affect the behaviour of the salt wedge.
- The effects of the Tunnel removal on the salt wedge diminishes in the upstream direction. While the salinity at the Tunnel alignment, for the case without the Tunnel, is slightly higher than that with the Tunnel, the time window during which the salinity in the water is higher than the criterion value is almost identical for the two cases at the location of the water intake.

The Tunnel does not act like a dam, which would have impeded the motion of water and the salt wedge in the river. The bathymetry footprint of the Tunnel is of no greater height and scale than the existing bathymetry features such as bed waves along other parts of the river.

5.0 CLOSURE

This report will be undertaken subject to the attached General Conditions, which will be incorporated into the report.

We trust this report meets your present requirements. If you have any questions or comments, please contact the undersigned.

Respectfully submitted,
Tetra Tech EBA Inc.



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APPENDIX A

H3D TECHNICAL DESCRIPTION

APPENDIX A: H3D TECHNICAL DESCRIPTION

1.0 INTRODUCTION

H3D is an implementation of the numerical model developed by Backhaus (1983; 1985) which has had numerous applications to the European continental shelf, (Duwe et al., 1983; Backhaus and Meir Reimer, 1983), Arctic waters (Kampf and Backhaus, 1999; Backhaus and Kampf, 1999) and deep estuarine waters, (Stronach et al., 1993). Locally, H3D has been used to model the temperature structure of Okanagan Lake (Stronach et al., 2002), the transport of scalar contaminants in Okanagan Lake, (Wang and Stronach, 2005), sediment movement and scour / deposition in the Fraser River, circulation and wave propagation in Seymour and Capilano dams, and salinity movement in the lower Fraser River. H3D forms the basis of the model developed by Saucier and co-workers for the Gulf of St. Lawrence (Saucier et al., 2003), and has been applied to the Gulf of Mexico (Rego et al., 2010). H3D and its hydrocarbon transport and weathering module have been used in three recent environmental assessment applications currently before the appropriate regulatory agencies. H3D was used to simulate an existing and proposed reservoir for BC Hydro's Site C Clean Energy Project. Temperature, ice cover, and sedimentation characteristics of the proposed reservoir were predicted, supported by model validations in existing Dinosaur Reservoir. Two reports are available at the provincial Environmental Assessment Office. H3D was used to do oil spill modelling for the environmental and engineering assessments for the proposed Gateway project involving oil shipment out of Kitimat. The modelling work forms part of the information package submitted to the National Energy Board which is currently under review. Similarly, H3D was used to assess the fate of accidental fuel spills arising from a proposed jet fuel terminal in the Fraser River. This modelling work is part of the information package submitted to the provincial Environmental Assessment Office.

2.0 THEORETICAL BASIS

H3D is a three-dimensional time-stepping numerical model which computes the three components of velocity (u,v,w) on a regular grid in three dimensions (x,y,z), as well as scalar fields such as temperature and contaminant concentrations. The model uses the Arakawa C-grid (Arakawa and Lamb, 1977) in space, and uses a two level semi-implicit scheme in the time domain. H3D bears many similarities to the well-known Princeton Ocean Model (POM) (Blumberg and Mellor, 1987) in terms of the equations it solves, but differs in how the time-domain aspects are implemented. H3D uses a semi-implicit scheme, allowing relatively large time steps, and does not separately solve the internal and external models as POM does. It also uses a considerably simpler turbulence scheme in the vertical. These considerations combined allow H3D to execute complex problems relatively quickly.

The equations to be solved are:

Mass Conservation:

$$\frac{\partial u}{\partial x} + \frac{\partial v}{\partial y} + \frac{\partial w}{\partial z} = 0 \quad (\text{A1})$$

At the end of each timestep equation, (A1) is used to diagnostically determine the vertical component of velocity (w) once the two horizontal components of velocity (u and v) have been calculated by the model.

X-directed momentum:

$$\frac{\partial u}{\partial t} + u \frac{\partial u}{\partial x} + v \frac{\partial u}{\partial y} + w \frac{\partial u}{\partial z} + g \frac{\partial \eta}{\partial x} + \frac{1}{\rho_o} \frac{\partial}{\partial x} \int_z^\eta (\rho_w - \rho_o) g dz - f v \frac{\partial}{\partial x} A_H \frac{\partial u}{\partial x} - \frac{\partial}{\partial y} A_H \frac{\partial u}{\partial y} - \frac{\partial}{\partial z} A_V \frac{\partial u}{\partial z} = 0. \quad (\text{A2})$$

Y-directed momentum:

$$\frac{\partial v}{\partial t} + u \frac{\partial v}{\partial x} + v \frac{\partial v}{\partial y} + w \frac{\partial v}{\partial z} + g \frac{\partial \eta}{\partial y} + \frac{1}{\rho_o} \frac{\partial}{\partial y} \int_z^\eta (\rho_w - \rho_o) g dz + f u \frac{\partial}{\partial x} A_H \frac{\partial v}{\partial x} - \frac{\partial}{\partial y} A_H \frac{\partial v}{\partial y} - \frac{\partial}{\partial z} A_V \frac{\partial v}{\partial z} = 0. \quad (\text{A3})$$

Water surface elevation determined from the vertically-integrated continuity equation:

$$\frac{\partial \eta}{\partial t} = - \frac{\partial}{\partial x} \int_{-H}^\eta u dz - \frac{\partial}{\partial y} \int_{-H}^\eta v dz. \quad (\text{A4})$$

The effect of wind forcing introduced by means of the surface wind-stress boundary condition:

$$\left(A_V \frac{\partial u}{\partial z}, A_V \frac{\partial v}{\partial z} \right)_{z=\eta} = \frac{\rho_a}{\rho_w} C_{D,air} \bar{U}_{wind} \left| \bar{U}_{wind} \right|. \quad (\text{A5})$$

The effect of bottom friction introduced by the bottom boundary condition:

$$\left(A_V \frac{\partial u}{\partial z}, A_V \frac{\partial v}{\partial z} \right)_{z=-H} = K_{bottom} \bar{U}_{bottom} \left| \bar{U}_{bottom} \right|. \quad (\text{A6})$$

The bottom friction coefficient is usually understood to apply to currents at an elevation of one metre above the bottom. The bottom-most vector in H3D will, in general, be at a different elevation, i.e., at the midpoint of the lowest computational cell. H3D uses the 'law of the wall' to estimate the flow velocity at one metre above the bottom from the modelled near-bottom velocity.

The evolution of scalars, such as salinity, temperature, or suspended sediment, is given by the scalar transport/diffusion equation:

$$\frac{\partial S}{\partial t} + u \frac{\partial S}{\partial x} + v \frac{\partial S}{\partial y} + w \frac{\partial S}{\partial z} - \frac{\partial}{\partial x} N_H \frac{\partial S}{\partial x} - \frac{\partial}{\partial y} N_H \frac{\partial S}{\partial y} - \frac{\partial}{\partial z} N_V \frac{\partial S}{\partial z} = Q. \quad (\text{A7})$$

In the above equations:

$u(x,y,z,t)$: component of velocity in the x direction;

$v(x,y,z,t)$: component of velocity in the y direction;

$w(x,y,z,t)$: component of velocity in the z direction;

$S(x,y,z,t)$: scalar concentration;

$Q(x,y,z,t)$: source term for each scalar species

f : Coriolis parameter, determined by the earth's rotation and the local latitude;

$A_H(\partial u / \partial x, \partial u / \partial y, \partial v / \partial x, \partial v / \partial y)$: horizontal eddy viscosity;

$A_V(\partial u / \partial z, \partial v / \partial z, \partial \rho_{water} / \partial z)$: vertical eddy viscosity;

N_H : horizontal eddy diffusivity;

$N_V(\partial u / \partial z, \partial v / \partial z, \partial \rho_{water} / \partial z)$: vertical eddy diffusivity;

$C_{D,air}$: drag coefficient at the air-water interface;

$C_{D,bottom}$: drag coefficient at the water/sea bottom interface;

ρ_a : density of air;

$\rho_w(x,y,z,t)$: density of water;

ρ_o : reference density of water;

$\eta(x,y,t)$: water surface elevation;

$H(x,y)$: local depth of water.

The above equations are formally integrated over the small volumes defined by the computational grid, and a set of algebraic equations results, for which an appropriate time-stepping methodology must be found. Backhaus (1983, 1985) presents such a procedure, referred to as a semi-implicit method. The spatially-discretized version of the continuity equation is written as:

$$\eta^{(1)} = \eta^{(0)} - \alpha \frac{\Delta t}{\Delta l} (\delta_x U^{(1)} + \delta_y V^{(1)}) - (1 - \alpha) \frac{\Delta t}{\Delta l} (\delta_x U^{(0)} + \delta_y V^{(0)}) \quad (A8)$$

where superscript (0) and (1) refer to the present and the advanced time, δ_x and δ_y are spatial differencing operators, and U and V are vertically integrated velocities. The factor α represents an implicit weighting, which must be greater than 0.5 for numerical stability. $U^{(0)}$ and $V^{(0)}$ are known at the start of each computational cycle. $U^{(1)}$, and similarly $V^{(1)}$, can be expressed as:

$$U^{(1)} = U^{(0)} - g\alpha\Delta t\eta_x^{(1)} - g(1-\alpha)\Delta t\eta_x^{(0)} + \Delta tX^{(0)} \quad (A9)$$

where $X^{(0)}$ symbolically represents all other terms in the equation of motion for the u - or v -component, which are evaluated at time level (0): Coriolis force, internal pressure gradients, non-linear terms, and top and bottom stresses. When these expressions are substituted into the continuity equation (A4), after some further manipulations, there results an elliptic equation for $\delta_{i,k}$, the change in water level over one timestep at grid cell i,k (respectively the y and x directions):

$$\delta_{i,k} - (ce\delta_{i,k+1} + cw\delta_{i,k-1} + cn\delta_{i-1,k} + cs\delta_{i+1,k}) = Z_{i,k} \quad (\text{A10})$$

where ce , cw , cn , and cs are coefficients depending on local depths and the weighting factor (α), and $Z_{i,k}$ represents the sum of the divergence formed from velocities at time level (0) plus a weighted sum of adjacent water levels at time level (0).

Once equation (A10) is solved for $\delta_{i,k}$, the water level can be updated:

$$\eta_{i,k}^{(1)} = \eta_{i,k}^{(0)} + \delta_{i,k} \quad (\text{A11})$$

and equation (A9) can be completed.

At the end of each timestep, volume conservation is used to diagnostically compute the vertical velocity $w(j,i,k)$ from the two horizontal components u and v .

2.1 Vertical Grid Geometry

In the vertical, the levels near the surface are typically closely spaced to assist with resolving near-surface dynamics. In addition, the model is capable of dealing with relatively large excursions in overall water level as the water level rises and falls in response to varying inflows and outflows, by allowing the number of near-surface layers to change as the water level varies. That is, as water levels rise in a particular cell, successive layers above the original layer are turned on and become part of the computational mesh. Similarly, as water levels fall, layers are turned off. This procedure has proven to be quite robust, and allows for any reasonable vertical resolution in near-surface waters. When modelling thin river plumes in areas of large tidal range, the variable number of layers approach allows for much better control over vertical resolution than does the σ -coordinate method.

In addition to tides, the model is able to capture the important response, in terms of enhanced currents and vertical mixing, to wind-driven events. This is achieved by applying wind stress to each surface grid point on each time step. Vertical mixing in the model then re-distributes this horizontal momentum throughout the water column. Similarly, heat flux through the water surface is re-distributed by turbulence and currents in temperature simulations.

2.2 Turbulence Closure

Turbulence modelling is important in determining the correct distribution of velocity and scalars in the model. The diffusion coefficients for momentum (A_H and A_V) and scalars (N_H and N_V) at each computational cell are dependent on the level of turbulence at that point. H3D uses a shear-dependent turbulence formulation in the horizontal, (Smagorinsky, 1963). The basic form is:

$$A_H = A_{H0} dx dy \sqrt{\left(\frac{du}{dx}\right)^2 + \left(\frac{dv}{dy}\right)^2 + \frac{1}{2}\left(\frac{\partial v}{\partial x} + \frac{\partial u}{\partial y}\right)^2} \quad (\text{A12})$$

The parameter A_{H0} is a dimensionless tuning variable, and experience has shown it to lie in the range of 0.25 to 0.45 for most water bodies such as rivers, lakes and estuaries.

A shear and stratification dependent formulation, the Level 2 model of Mellor and Yamada (1982), is used for the vertical eddy diffusivity. The basic theory for the vertical viscosity formulation is taken from an early paper, Mellor and Durbin (1975). The evaluation of length scale is based on a methodology presented in Mellor and Yamada (1982).

For scalars, both horizontal and vertical eddy diffusivity are taken to be similar to their eddy viscosity counterparts, but scaled by a fixed ratio from the eddy viscosity values. Different ratios are used for the horizontal and vertical diffusivities. If data is available for calibration, these ratios can be adjusted based on comparisons between modelled and observed data. Otherwise, standard values based on experience with similar previously modelled water bodies are used. In a recent reservoir simulation, the ratio of vertical eddy diffusivity to vertical eddy viscosity was 0.75 and the ratio between horizontal eddy diffusivity and horizontal eddy viscosity was 1.0.

2.3 Scalar Transport

The scalar transport equation implements a form of the flux-corrected algorithm (Zalesak, 1979), in which all fluxes through the sides of each computational cell are first calculated using a second-order method. Although generally more accurate than a first order method, second order flux calculations can sometimes lead to unwanted high frequency oscillations in the numerical solution. To determine if such a situation is developing, the model examines each cell to see if the computed second order flux would cause a local minimum or maximum to develop. If so, then all fluxes into or out of that cell are replaced by first order fluxes, and the calculation is completed. As noted, the method is not a strict implementation of the Zalesak method, but is much faster and achieves very good performance with respect to propagation of a Gaussian distribution through a computational mesh. It does not propagate box-car distributions as well as the full Zalesak method, but achieves realistic simulations of the advection of scalars in lakes, rivers and estuaries, which is the goal of the model. This scheme as implemented is thus a good tradeoff between precision and execution time, important since in many situations, where more than one scalar is involved, the transport-diffusion algorithm can take up more than half the execution time.

2.4 Heat Flux at the Air-Water Interface

The contribution of heat flux to the evolution of the water temperature field can be schematized as:

$$\frac{dT}{dt} = \frac{\Delta Q}{\rho * c_p * h}$$

where ΔQ is the net heat flux per unit area retained in a particular layer, ρ is the density of water, c_p is the heat capacity of water and h is the layer thickness.

Heat flux at the air-water interface incorporates the following terms:

Q_{in} : incident short wave radiation. Generally, this is not known from direct observations. Generally, it is estimated from the cloud cover and opacity observations at nearby stations, a theoretical calculation of radiation at the top of the atmosphere based on the geometry of the earth/sun system, and an empirical adjustment based on radiation measurements at Vancouver Airport and UBC respectively for the period 1974-1977. This procedure has worked well for many water bodies, notably Okanagan Lake and the waters of

the north coast of British Columbia, in terms of allowing H3D to reproduce the observed temperature distributions in space and time. Values for albedo as a function of solar height are taken from Kondratyev (1972).

Q_{back} : net long wave radiation, calculated according to Gill (1982), involving the usual fourth power dependence on temperature, a factor of 0.985 to allow for the non-black body behaviour of the ocean, a factor depending on vapor pressure to allow for losses due to back radiation from moisture in the air, and a factor representing backscatter from clouds.

Q_L and Q_H : latent and sensible heat flux. Latent heat flux (Q_L) is the heat carried away by the process of evaporation of water. Sensible heat flux (Q_S) is driven by the air-water temperature difference and is similar to conduction, but assisted by turbulence in the air. Latent and sensible heat flux is described by:

$$Q_L = 1.32e^{-3} * L * windspeed * (q_{obs} - q_{sat}) * latent_factor$$

$$Q_S = 1.46e^{-3} * \rho_{air} * c_p * windspeed * (T_{air} - T_{water}) * sensible_factor$$

Where q_{obs} and q_{sat} are the observed and saturated specific humidities, T_{air} and T_{water} are the air and water temperatures, L is the latent heat of evaporation of water, and c_p is the heat capacity of water. ' $latent_factor$ ' and ' $sensible_factor$ ' are scaling factors introduced to account for local factors, and can be adjusted, when needed, to achieve better calibration of the model. Typically, the only adjustment is that $Sensible_factor$ is doubled when the air temperature is less than the water or ice surface temperature to account for increased turbulence in an unstable air column.

Light absorption in the water column. As light passes through the water column it is absorbed and the absorbed energy is a component of the energy balance that drives water temperature. H3D assumes that light attenuation follows an exponential decay law:

$$E(z) = E(z_0) * e^{-k*(z-z_0)}$$

The model computes the energy at the top and bottom of each layer and the difference is applied to the general heat equation in that layer. The extinction coefficient (k) is related to the Secchi depth (D_s) by

$$k = \frac{2.1}{D_s}$$

Temperature is treated like any other scalar as far as advection and diffusion are concerned. Heat flux at the water-sediment interface is not currently included in H3D.

2.5 Ice

The ice model is generally based on processes described in Patterson and Hamblin (1988). The ice cover is characterized by a thickness, a fraction of the cell covered, and an ice surface temperature. The temperature of the bottom of the ice is assumed to be the temperature of melting, usually 0° C. The strategy is to compute the differences in heat flux at the top and bottom of the ice layer and use this difference to determine the growth or decay rate and the change in temperature of the ice. The heat flux at

the bottom of the ice layer is dependent on lake temperature and water velocity. The heat flux at the top is dependent on meteorological processes and the surface temperature of the ice. The surface heat flux to the top of the ice sheet is calculated in a similar way as for open water, except that latent heat flux term (Q_L) also includes the heat of fusion. Albedo is also altered to account for ice/snow cover.

In order to start ice formation, once the surface water temperature drops below 3° C in a particular cell, a test ice layer of thickness 1 cm is initialized. If the test thickness melts in one time step, then the system cannot support ice cover in that cell at that time. If it survives, then the amount of ice in that cell is converted to a 1 cm thick region with coverage calculated from the mass of ice formed. In this way, a relatively robust start is made to ice formation.

The frictional interaction between the bottom of the ice and the immediately adjacent water is parameterized according to Nezhikhovskiy (1964).

2.6 Validation

Three validations of H3D's water level and temperature prediction skill are discussed below.

2.6.1 Strait of Georgia/Point Atkinson Tide: Wave Propagation

A fundamental concern with a circulation model such as H3D is how well it propagates waves, the carriers of information through the system. Figure A-1 presents results of a simulation of tides in the Strait of Georgia and Juan de Fuca Strait, with tidal elevations prescribed at the entrance to Juan de Fuca Strait and at a section north of Texada Island in the Strait of Georgia. The complex dynamics of the northern passes, such as Discovery Passage and Seymour Narrows, are thus avoided, allowing a test of H3D's wave propagation capabilities. The figure plots the modelled water level at Point Atkinson in red, and the observed water level in black. There is nearly perfect agreement, with the slight difference resulting from small storm surge events. This validation demonstrates that the selection of grid schematization (Arakawa C-grid) and the semi-implicit time-stepping approach have produced a system that can accurately propagate information through a water body.

2.6.2 Okanagan Lake Temperature Profiles

Obtaining good reproduction of the seasonally-evolving temperate structure of a lake indicates that the heat flux across the air-water interface is accurately parameterized and that the transport-diffusive processes operating in the water column are also accurately reproduced by the model. Figure A-2 presents a comparison of observed and computed temperature profiles at the northern end of Okanagan Lake near Vernon, in April, August, October and December of 1997. The agreement is very good as the model reproduced the transition from a well-mixed condition in the spring to the development of a strong thermocline in the summer, the deepening of the upper layer during the fall cooling period, and a return to isothermal conditions in winter. There is little doubt that H3D can compute accurate temperature distributions in water bodies, as long as adequate meteorological data is available. For this simulation, the meteorological data was obtained from Penticton Airport: winds, rotated to follow the thalweg of the valley; cloud cover, air temperature and relative humidity.

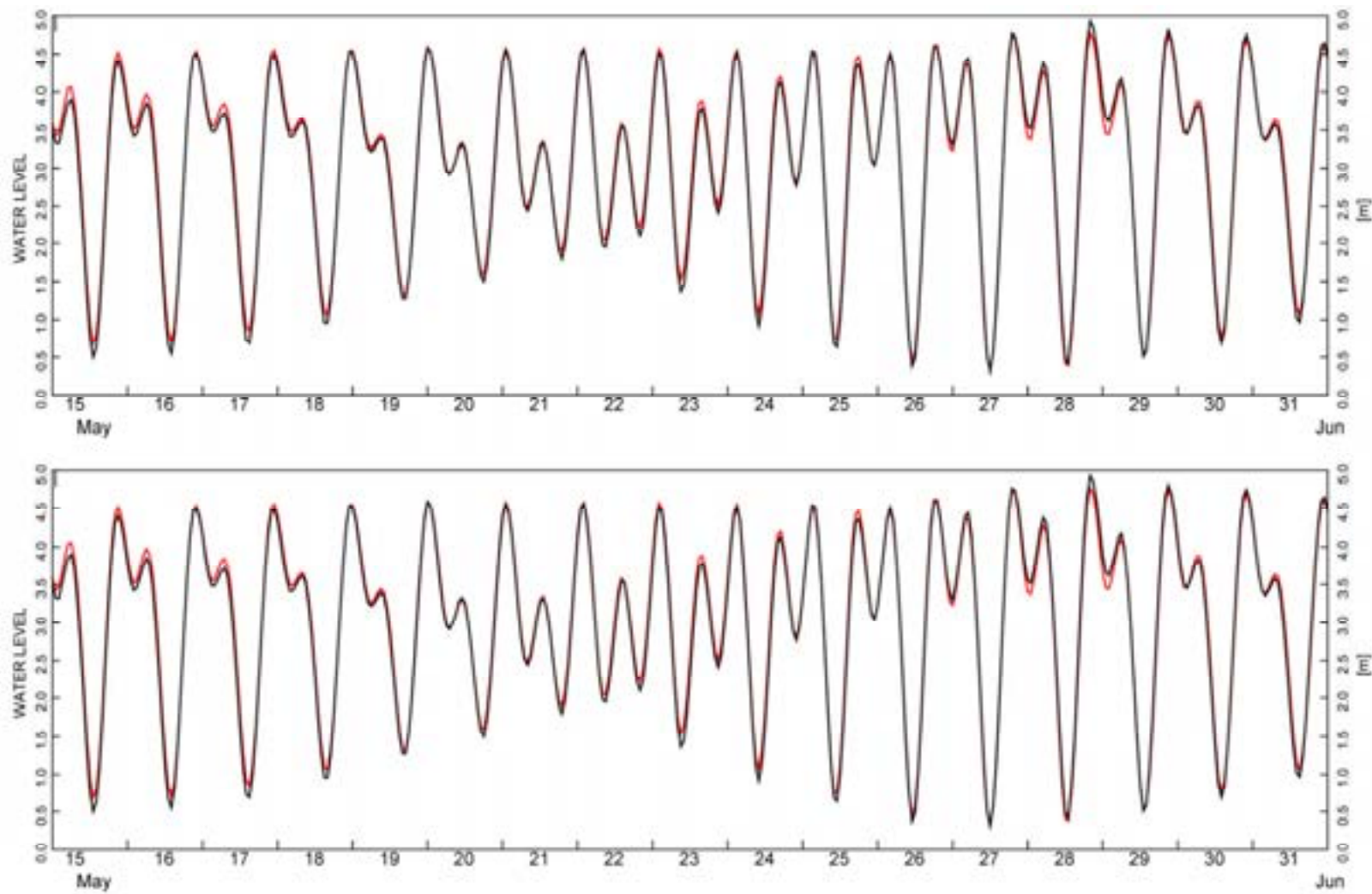
2.6.3 Thermistor Response: Okanagan Lake

Okanagan Lake is subject to significant fluctuations in the vertical thermal structure during the summer stratified period. Figure A-3 shows a temperature time-series at a site on the north side of the William R. Bennett Bridge which exhibits significant temperature excursions at periods of about 60 hours, or 2.5 days. Figure A-4 shows the modelled time series of temperature at three selected depths, 51 m, 21 m and 9 m. The occurrence and magnitude of the temperature fluctuations is generally predicted by the model, but the reproduction is not perfect: the occurrence and timing of the temperature events is quite good, but the modelled peaks appear to be generally somewhat broader in time. It was found that there were considerable differences in the simulated behaviour depending on whether winds at Kelowna Airport, which is situated in a side-valley, were included in the model or not. It is also clear that H3D can generally reproduce internal seiches in a lake, as long as adequate spatial resolution is used. This is particularly apparent when the coherent internal waves that propagate up and down the lake are examined in a longitudinal section, illustrated in two snapshots from a model simulation of such an event in Figure A-5.

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LEGEND

- Solid lines represent observed profiles
- Dash lines represent modelled profiles

NOTES

STATUS

CLIENT

-

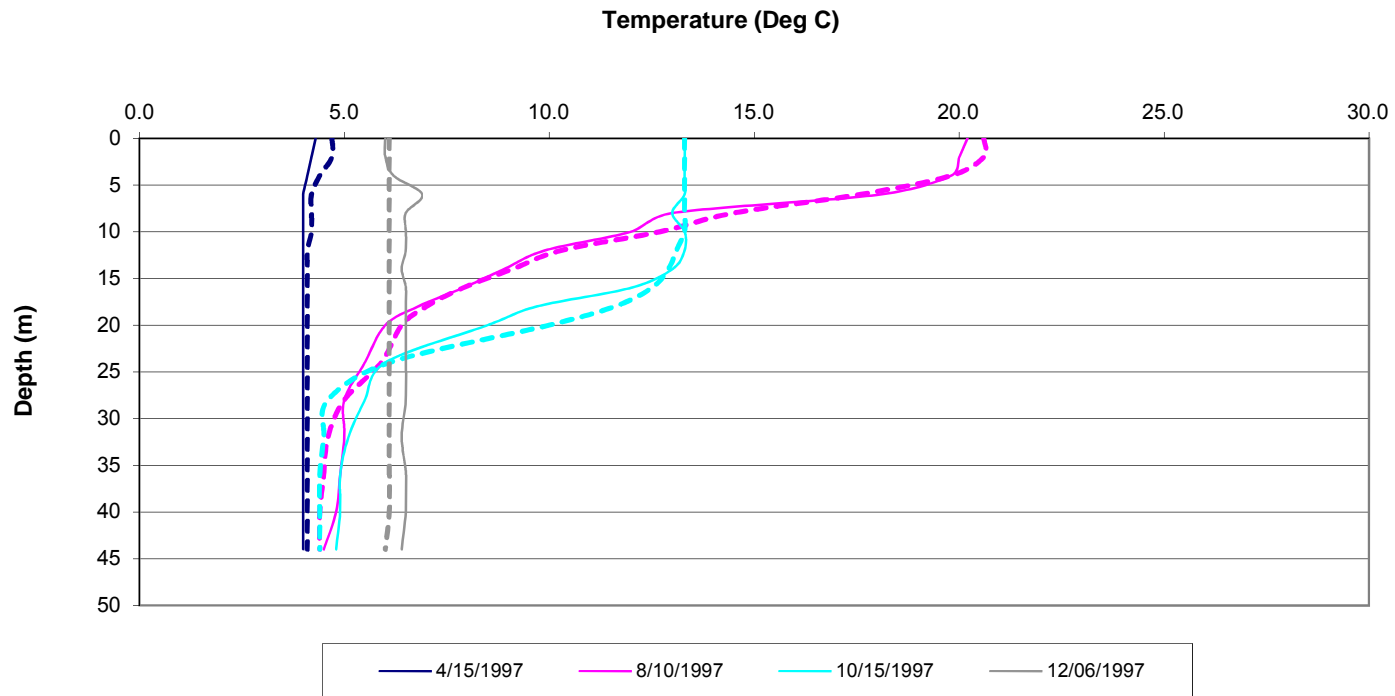


H3D TECHNICAL DESCRIPTION

**H3D Validation
Tidal Reproduction**

| | | | | |
|----------------------------|----------------------------|-------------------|--------------------|-------------------|
| PROJECT NO. V132 | DWN AL | CKD JAS | APVD JAS | REV 001 |
| OFFICE EBA-VANC | DATE August 2011 | | | |

Figure A-1



LEGEND

- Solid lines represent observed profiles
- Dash lines represent modelled profiles

NOTES

STATUS
ISSUED FOR USE

CLIENT

-

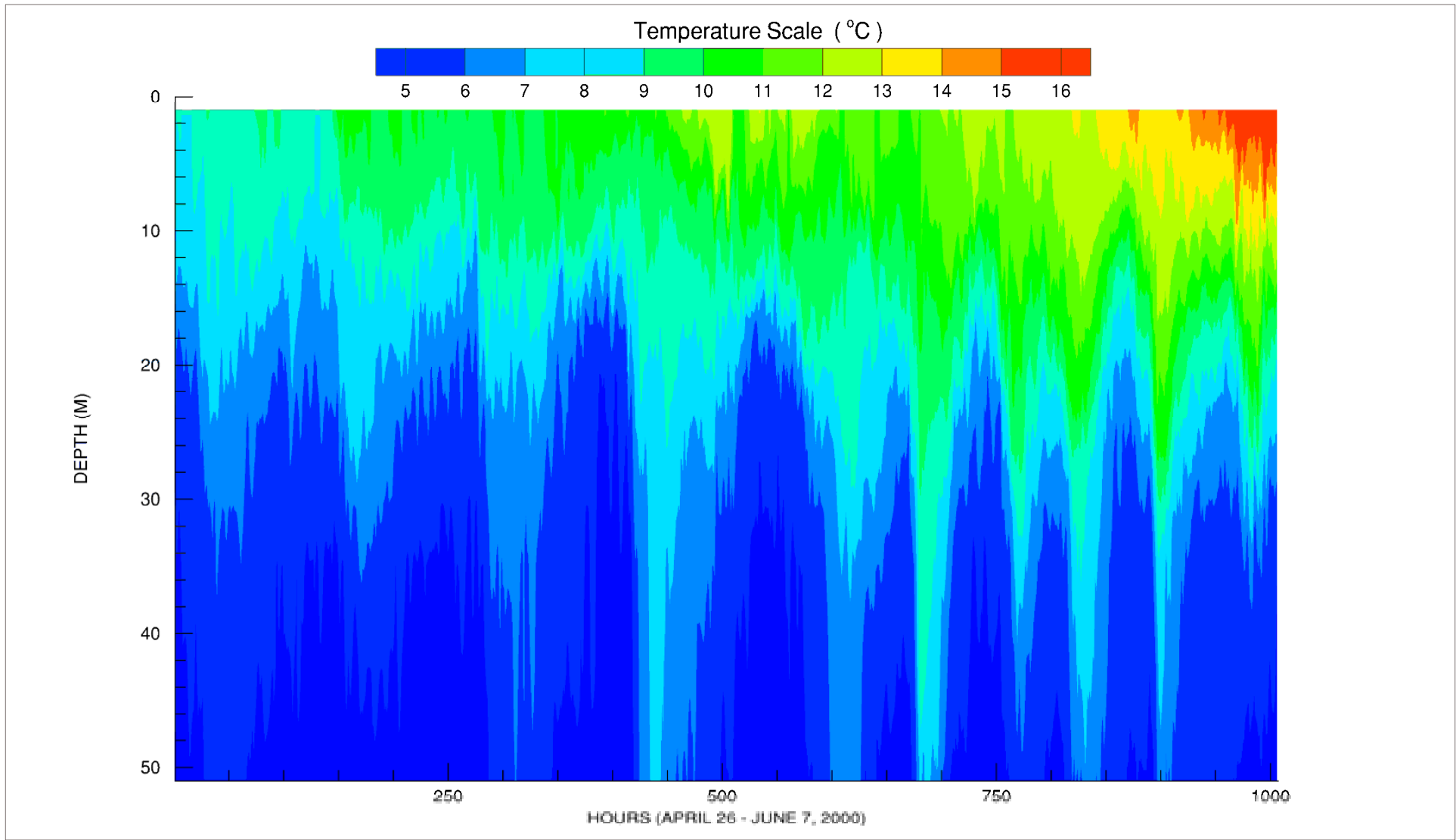


H3D TECHNICAL DESCRIPTION

**H3D Validation
Comparison of Observed and Modelled
Temperature Profiles at Vernon**

| | | | | |
|----------------------------|------------------------------|-------------------|--------------------|-------------------|
| PROJECT NO. V132 | DWN AL | CKD JAS | APVD JAS | REV 001 |
| OFFICE EBA-VANC | DATE August , 2011 | | | |

Figure A-2



LEGEND

NOTES

CLIENT

H3D TECHNICAL DESCRIPTION

**H3D VALIDATION
SEICHES IN OKANAGAN LAKE
(OBSERVED DATA)**

STATUS
ISSUED FOR USE



PROJECT NO.
V132

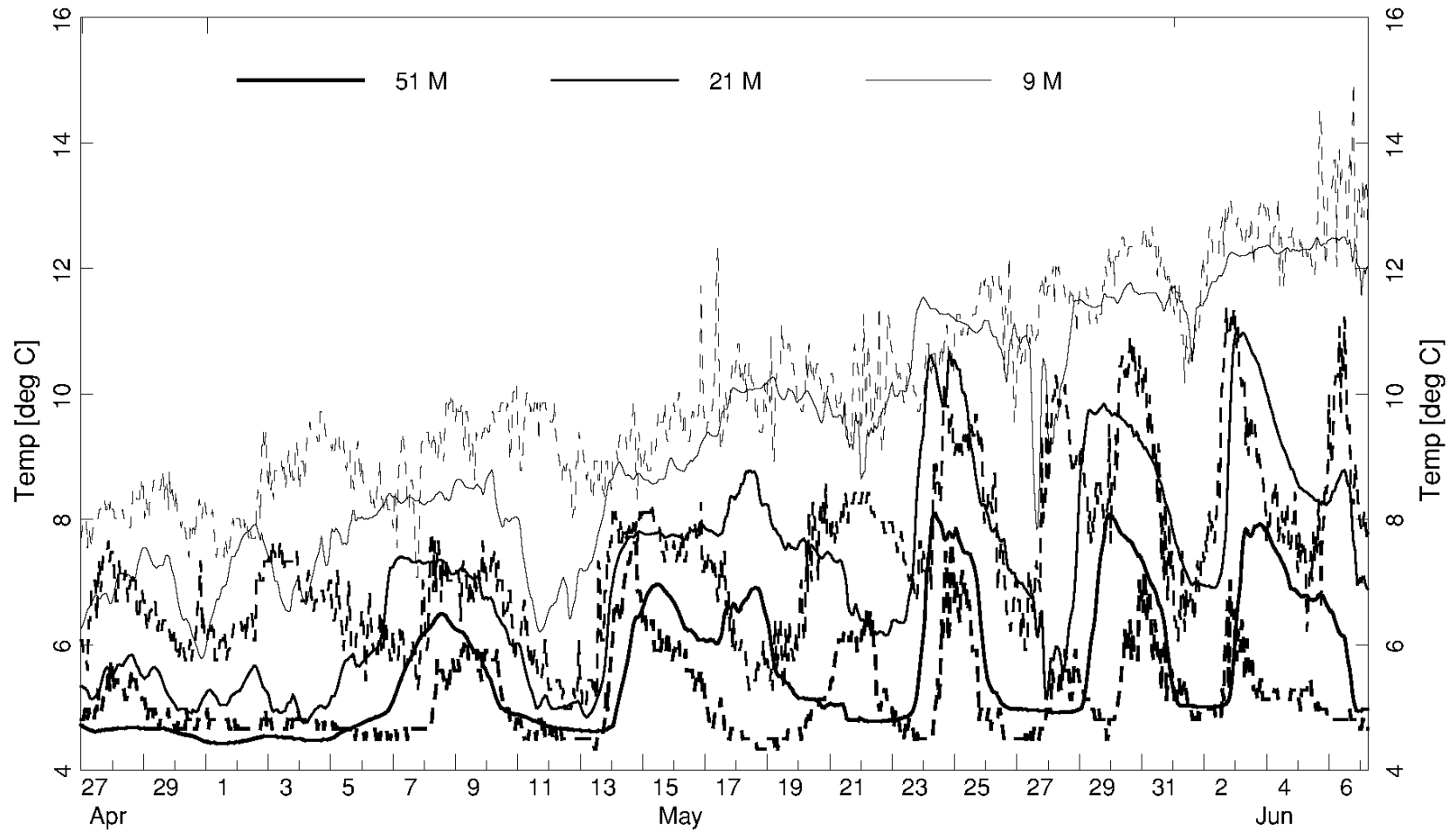
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|-----------|------------|-------------|----------|
| DWN EW | CKD JAS | APVD JAS | REV 0 |
|-----------|------------|-------------|----------|

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EBA-VANC

DATE
August 2, 2011

Figure A-3

TS-A: NORTH STRING



LEGEND

Dashed Lines: Observed Temperature
 Solid Lines: Modelled Temperature

NOTES

STATUS
 ISSUED FOR USE

CLIENT



H3D TECHNICAL DESCRIPTION

H3D VALIDATION INTERNAL SEICHE DYNAMICS OKANAGAN LAKE

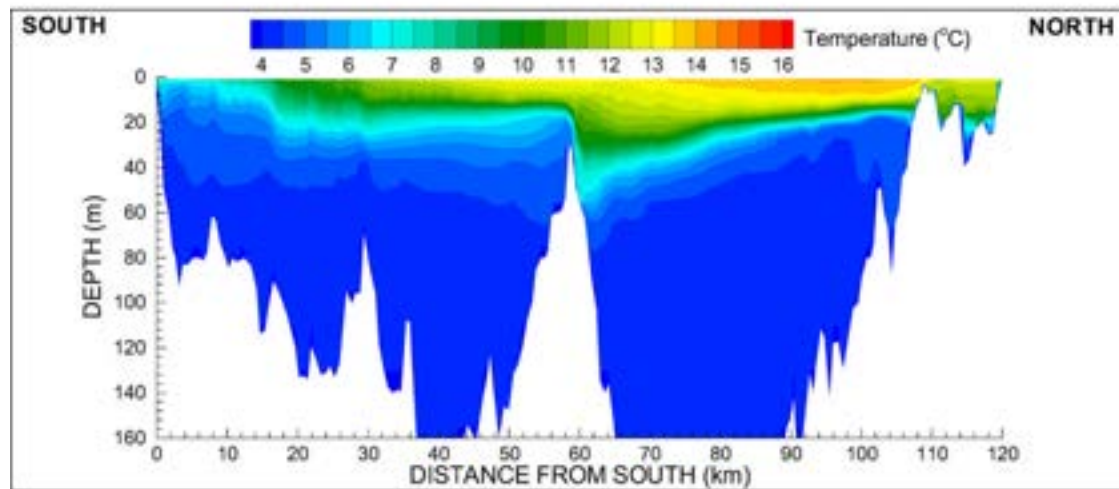
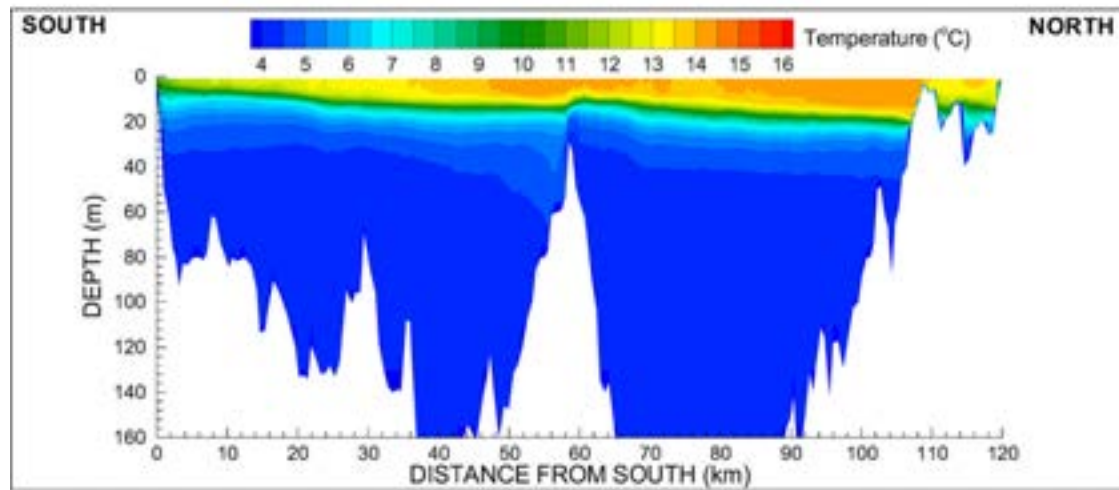
PROJECT NO.
 V132

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|-----|-----|------|-----|
| DWN | CKD | APVD | REV |
| EW | JAS | JAS | 0 |

OFFICE
 EBA-VANC

DATE
 August 2, 2011

Figure A-4



LEGEND

NOTES

CLIENT

H3D TECHNICAL DESCRIPTION

**H3D VALIDATION
INTERNAL SEICHE DYNAMICS
OKANAGAN LAKE**

STATUS
ISSUED FOR USE



PROJECT NO.
V132

| | | | |
|-----|-----|------|-----|
| DWN | CKD | APVD | REV |
| EW | JAS | JAS | JAS |

OFFICE
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DATE
August 2, 2011

Figure A-5

APPENDIX B

TETRA TECH EBA'S GENERAL CONDITIONS

GENERAL CONDITIONS

HYDROTECHNICAL

This report incorporates and is subject to these “General Conditions”.

1.0 USE OF REPORTS AND OWNERSHIP

This report pertains to a specific site, a specific development, and a specific scope of work. The report may include plans, drawings, profiles and other supporting documents that collectively constitute the report (the “Report”).

The Report is intended for the sole use of Tetra Tech EBA’s Client (the “Client”) as specifically identified in the Tetra Tech EBA Services Agreement or other Contract entered into with the Client (either of which is termed the “Services Agreement” herein). Tetra Tech EBA does not accept any responsibility for the accuracy of any of the data, analyses, recommendations or other contents of the Report when it is used or relied upon by any party other than the Client, unless authorized in writing by Tetra Tech EBA.

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Where Tetra Tech EBA has expressly authorized the use of the Report by a third party (an “Authorized Party”), consideration for such authorization is the Authorized Party’s acceptance of these General Conditions as well as any limitations on liability contained in the Services Agreement with the Client (all of which is collectively termed the “Limitations on Liability”). The Authorized Party should carefully review both these General Conditions and the Services Agreement prior to making any use of the Report. Any use made of the Report by an Authorized Party constitutes the Authorized Party’s express acceptance of, and agreement to, the Limitations on Liability.

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2.0 ALTERNATIVE REPORT FORMAT

Where Tetra Tech EBA submits both electronic file and hard copy versions of the Report or any drawings or other project-related documents and deliverables (collectively termed Tetra Tech EBA’s “Instruments of Professional Service”), only the signed and/or sealed versions shall be considered final. The original signed and/or sealed version archived by Tetra Tech EBA shall be deemed to be the original. Tetra Tech EBA will archive the original signed and/or sealed version for a maximum period of 10 years.

Both electronic file and hard copy versions of Tetra Tech EBA’s Instruments of Professional Service shall not, under any circumstances, be altered by any party except Tetra Tech EBA. Tetra Tech EBA’s Instruments of Professional Service will be used only and exactly as submitted by Tetra Tech EBA.

Electronic files submitted by Tetra Tech EBA have been prepared and submitted using specific software and hardware systems. Tetra Tech EBA makes no representation about the compatibility of these files with the Client’s current or future software and hardware systems.

3.0 STANDARD OF CARE

Services performed by Tetra Tech EBA for the Report have been conducted in accordance with the Services Agreement, in a manner consistent with the level of skill ordinarily exercised by members of the profession currently practicing under similar conditions in the jurisdiction in which the services are provided. Professional judgment has been applied in developing the conclusions and/or recommendations provided in this Report. No warranty or guarantee, express or implied, is made concerning the test results, comments, recommendations, or any other portion of the Report.

If any error or omission is detected by the Client or an Authorized Party, the error or omission must be immediately brought to the attention of Tetra Tech EBA.

4.0 ENVIRONMENTAL AND REGULATORY ISSUES

Unless expressly agreed to in the Services Agreement, Tetra Tech EBA was not retained to investigate, address or consider, and has not investigated, addressed or considered any environmental or regulatory issues associated with the project.

5.0 DISCLOSURE OF INFORMATION BY CLIENT

The Client acknowledges that it has fully cooperated with Tetra Tech EBA with respect to the provision of all available information on the past, present, and proposed conditions on the site, including historical information respecting the use of the site. The Client further acknowledges that in order for Tetra Tech EBA to properly provide the services contracted for in the Services Agreement, Tetra Tech EBA has relied upon the Client with respect to both the full disclosure and accuracy of any such information.

6.0 INFORMATION PROVIDED TO TETRA TECH EBA BY OTHERS

During the performance of the work and the preparation of this Report, Tetra Tech EBA may have relied on information provided by persons other than the Client.

While Tetra Tech EBA endeavours to verify the accuracy of such information, Tetra Tech EBA accepts no responsibility for the accuracy or the reliability of such information even where inaccurate or unreliable information impacts any recommendations, design or other deliverables and causes the Client or an Authorized Party loss or damage.

7.0 GENERAL LIMITATIONS OF REPORT

This Report is based solely on the conditions present and the data available to Tetra Tech EBA at the time the Report was prepared.

The Client, and any Authorized Party, acknowledges that the Report is based on limited data and that the conclusions, opinions, and recommendations contained in the Report are the result of the application of professional judgment to such limited data.

The Report is not applicable to any other sites, nor should it be relied upon for types of development other than those to which it refers. Any variation from the site conditions present at or the development proposed as of the date of the Report requires a supplementary investigation and assessment.

It is incumbent upon the Client and any Authorized Party, to be knowledgeable of the level of risk that has been incorporated into the project design, in consideration of the level of the hydrotechnical information that was reasonably acquired to facilitate completion of the design.

The Client acknowledges that Tetra Tech EBA is neither qualified to, nor is it making, any recommendations with respect to the purchase, sale, investment or development of the property, the decisions on which are the sole responsibility of the Client.

8.0 JOB SITE SAFETY

Tetra Tech EBA is only responsible for the activities of its employees on the job site and was not and will not be responsible for the supervision of any other persons whatsoever. The presence of Tetra Tech EBA personnel on site shall not be construed in any way to relieve the Client or any other persons on site from their responsibility for job site safety.